Chromatography

Columns & Supplies Catalogue

HPLC

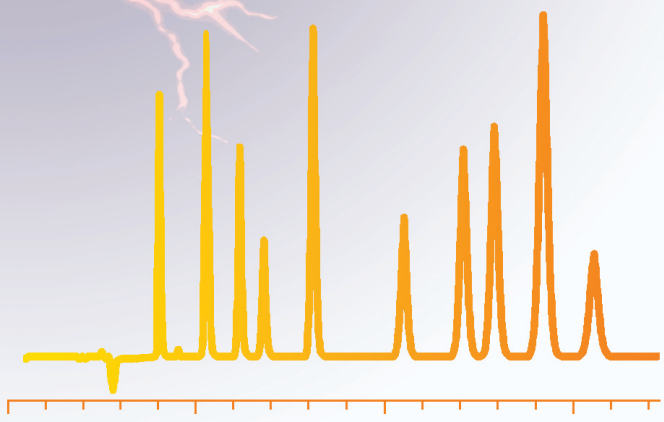
GC

TLC

SPE & Flash

Syringe Filters

Vials



. . . we Meet your Needs

MACHEREY-NAGEL
www.mn-net.com
MN Since 1911

Contents

New products for SPE and Flash chromatography

CHROMABOND® HR-Xpert

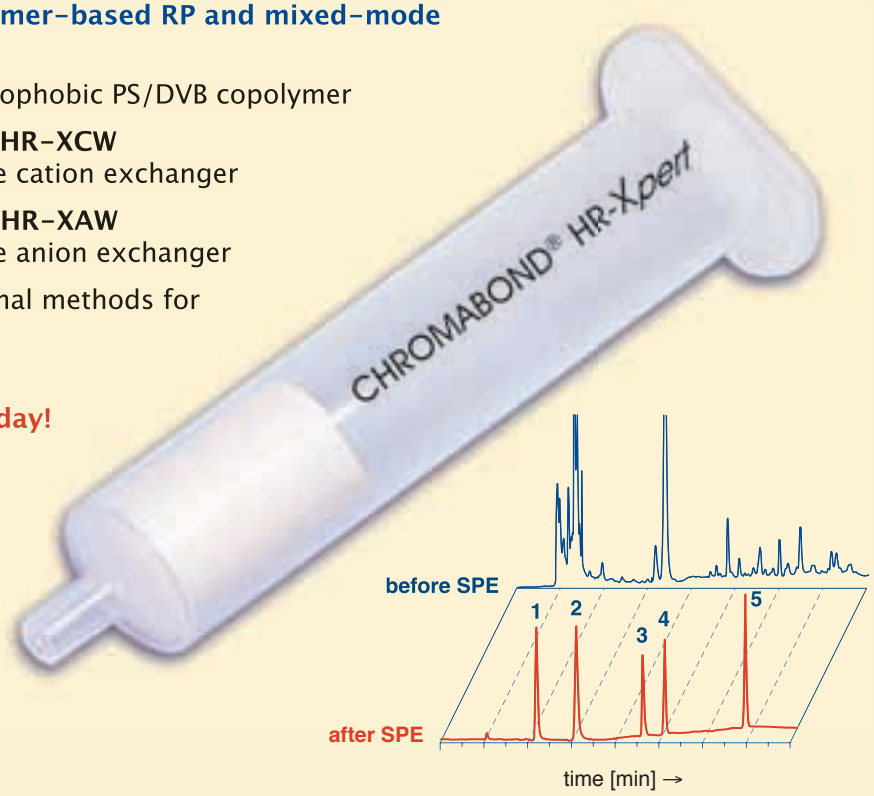
your way to cleaner samples by SPE

innovative concept of five polymer-based RP and mixed-mode ion exchange phases for SPE

- **CHROMABOND® HR-X** · hydrophobic PS/DVB copolymer
- **CHROMABOND® HR-XC** and **HR-XCW**
  strong and weak mixed-mode cation exchanger
- **CHROMABOND® HR-XA** and **HR-XAW**
  strong and weak mixed-mode anion exchanger
- suitable adsorbents and optimal methods for sample preparation, cleaning and concentration

… **order your FREE samples today!**
info@mn-net.com

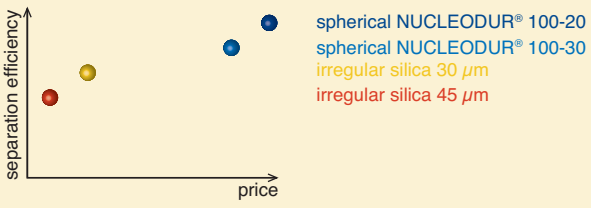
page 10



CHROMABOND® Flash RS cartridges

ideal for Flash separations from 10 mg up to 160 g

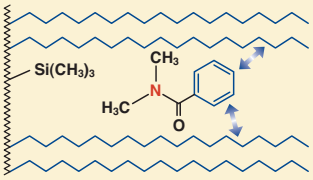
- for convenient operation and reliable upscaling ready-to-use Flash cartridges for the ISCO® Companion® and other Teledyne Isco CombiFlash® systems, or as stand-alone version for all pump/detector combinations, e.g. from Biotage®, Büchi®
- increases flexibility
- saves time and money
- improves analytical safety



page 58

NUCLEODUR® C_{18} HTec — reaching new dimensions in preparative HPLC

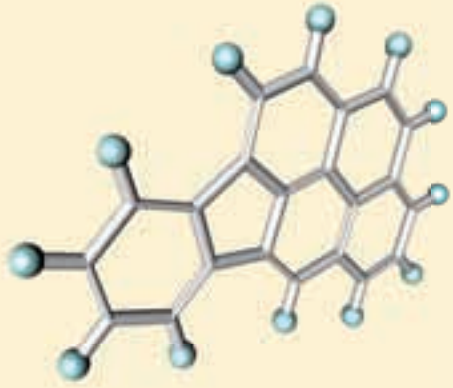
- reliable and durable standard RP phase for up-scaling to preparative scale
- high loadability and excellent stability
- outstanding base deactivation
- suitable for **LC/MS** due to low bleeding characteristics
- pH stability 1 – 11
- available in preparative and analytical column dimensions
- **recommended application:** sophisticated analytical and preparative separations of basic, neutral and acidic pharmaceuticals, derivatised amino acids, pesticides, fat-soluble vitamins, aldehydes, ketones and phenolic compounds



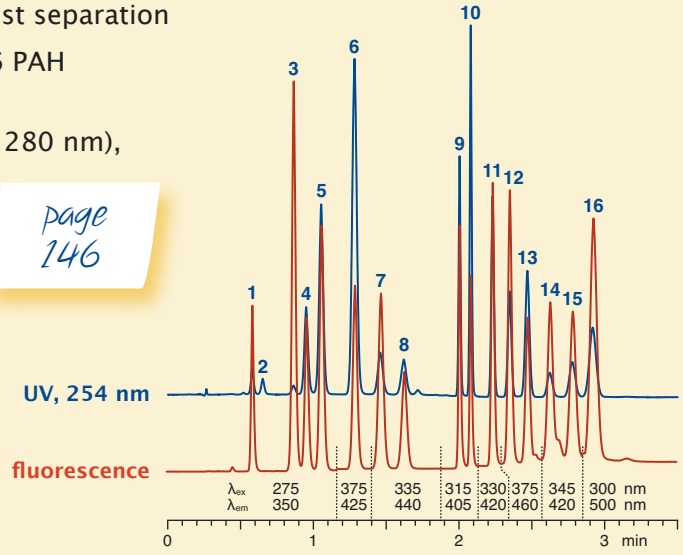
page 118

NUCLEODUR® C_{18} PAH — fastest separation of 16 EPA PAHs

- polymeric coating with exceptional steric selectivity for PAHs
- robust 3 µm NUCLEODUR® particles for fastest separation
- allows efficient gradient separation of the 16 PAH according to EPA
- suitable for detection of PAHs by UV (250 to 280 nm), diode array or fluorescence detection



page 146



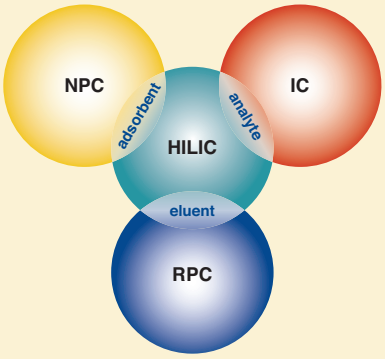
check application notes at *www.mn-net.com/apps*

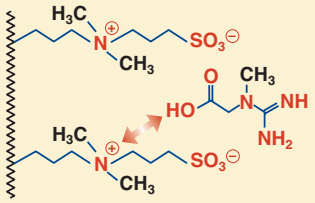
High Performance Liquid Chromatography

New products for HPLC

NUCLEODUR® HILIC

zwitterionic phase for hydrophilic compounds





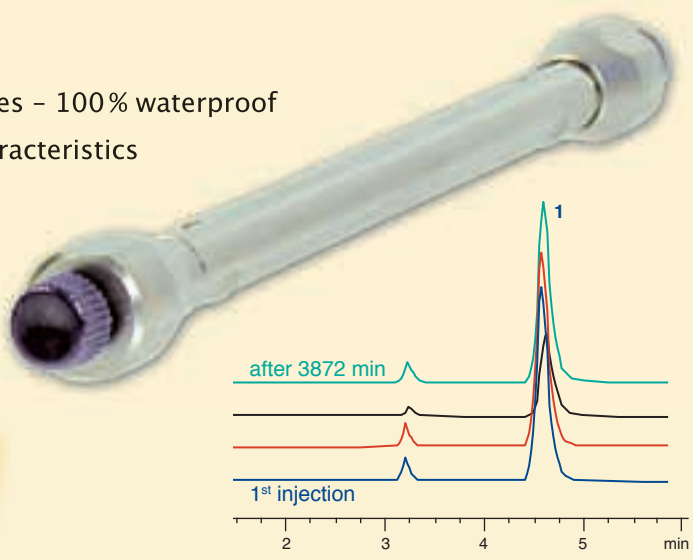
- zwitterionic ammonium sulfonic acid modification
- ideal for reproducible and stable chromatography of highly polar analytes
- very short column conditioning period
- for analytical and preparative separations
- pH stability 2 – 8.5
- **recommended application:** hydrophilic compounds such as organic polar acids and bases, polar natural compounds, nucleosides, oligonucleotides, amino acids, peptides, water soluble vitamins, …

page 124

NUCLEODUR® NH_2

100 % stable in water

- aminopropyl modification – USP L8
- multi-mode columns (RP, NP and IC)
- stable towards highly aqueous mobile phases – 100 % waterproof
- suitable for **LC/MS** due to low bleeding characteristics
- pH stability 2–8
- columns available in RP and NP mode
- **recommended application:** polar compounds under RP conditions (sugars, DNA bases), hydrocarbons under NP conditions



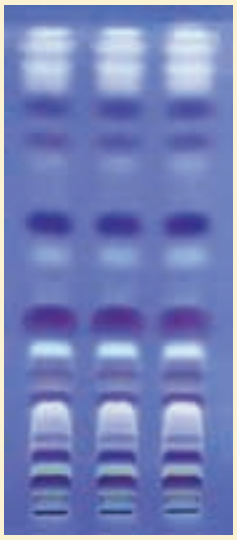
page 128

New plates for TLC

ALUGRAM® Xtra SIL G

unmodified standard silica layers on aluminium

- **outstanding wettability for precise colorization results,** even with 100% aqueous eluents
- **excellent separation efficiency** and reproducibility from lot to lot
- **easy and reliable cutting** due to an optimized binder system, no flaking of silica



Page 188

OPTIMA® BioDiesel

GC columns for the analysis of biodiesel (DIN EN 14214 / ASTM D 6751)

- **OPTIMA® BioDiesel M**
  for analysis of methanol in accordance with DIN EN 14110
- **OPTIMA® BioDiesel F**
  for analysis of FAMEs in accordance with DIN EN 14103
- **OPTIMA® BioDiesel G**
  for analysis of glycerol and glycerides in accordance with DIN EN 14105

page 246

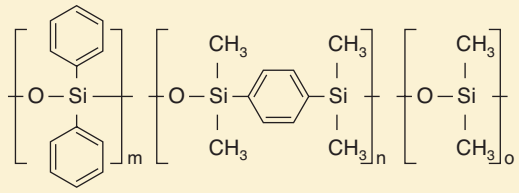
New phases for GC

New midpolar ultra low bleed phases

OPTIMA® 35 MS

silarylene phase

chemically bonded cross-linked silarylene phase with selectivity similar to 35 % phenyl / 65 % methyl polysiloxane



- USP G42

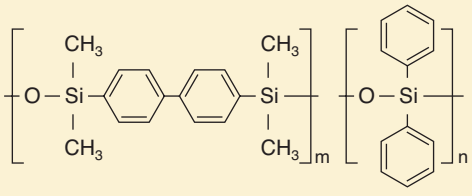
- **very low column bleeding,** midpolar phase, recommended for ion-trap detectors
- optimum column for confirmation of analytical results in combination with a 1 MS or 5 MS
- polymer without CN groups
- **recommended application:** allround phase for environmental analyses, ultra trace analyses, EPA methods, pesticides, PCBs, food and drug analyses

page 229

OPTIMA® 17 MS

silarylene phase

- medium polar silarylene phase with selectivity analogue to 50 % phenyl – 50 % methylpolysiloxane



page 231

- **very low column bleeding,** midpolar phase, recommended for ion-trap detectors
- ideal for ion trap detectors

  optimum reference column in combination with a 1 MS or 5 MS

  no CN groups in the polymer
- **recommended application:** all-round phase for environmental analyses, ultra-trace analyses, EPA methods, pesticides, PCBs, food and drug analyses
- USP G3

New phase for high temperature GC

OPTIMA® 5 HT

nonpolar phase for high temperature GC

- ultra low bleed silarylene phase with 5-type polarity

  nonpolar phase, ideal for MS detectors, can be rinsed with solvents
- **recommended application:**
  for simulated distillation, hydrocarbon, fuel and oil analysis, high-boiling analytes
- USP G27 / G36

page 249

Contents

Solid Phase Extraction (SPE)

Sample Clarification

Vials and Accessories

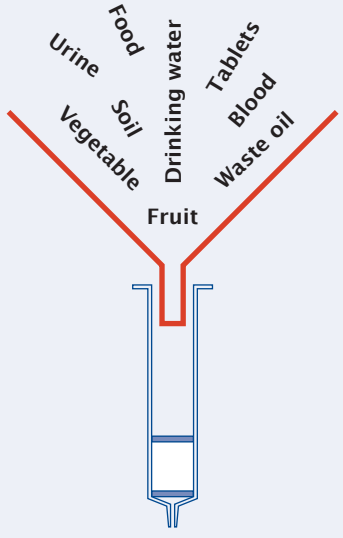
Basic principles of SPE

Solid phase extraction (SPE) is a powerful method for sample preparation and is used by most chromatographers today.

More than 20 years ago MACHEREY-NAGEL designed and introduced CHROMABOND® SPE cartridges containing silica-based adsorbents. Since then we developed the widest range of phases and products for SPE based on silica and polymeric materials.

SPE has capabilities in a broad range of applications:

- environmental analyses
- pharmaceutical and biochemical analyses
- organic chemistry
- food analysis



Pesticides
PAHs PCBs
Drugs
Dyes
Vitamins

SPE is a form of digital (step-wise) chromatography designed to extract, partition, and / or adsorb one or more components from a liquid phase (sample) onto a stationary phase (adsorbent or resin). An adsorbed substance can be removed from the adsorbent by step-wise increase of elution strength of the eluent (step gradient technique). SPE extends a chromatographic system's lifetime, improves qualitative and quantitative analysis, and the demand placed on an analytical instrument is considerably lessened.

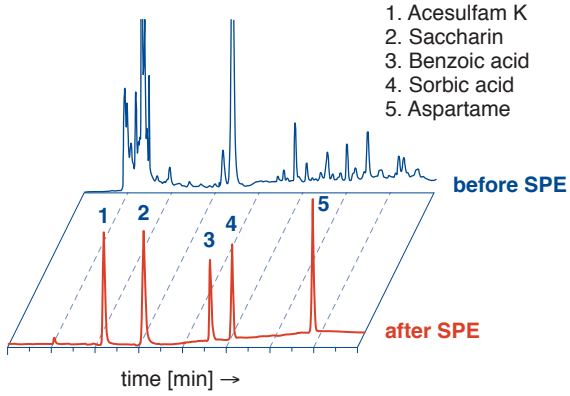
In general, SPE is used for three important purposes in state-of-the-art analyses:

- concentration of the analyte
  (up to factor 10.000 – increase of chromatographic sensibility / improved limits of detection)
- removal of interfering compounds
  (protection of subsequent analyses like HPLC, GC, TLC, UV or IR spectroscopy, ...)
- changing an analyte's environment to a simpler matrix more suitable for subsequent analyses

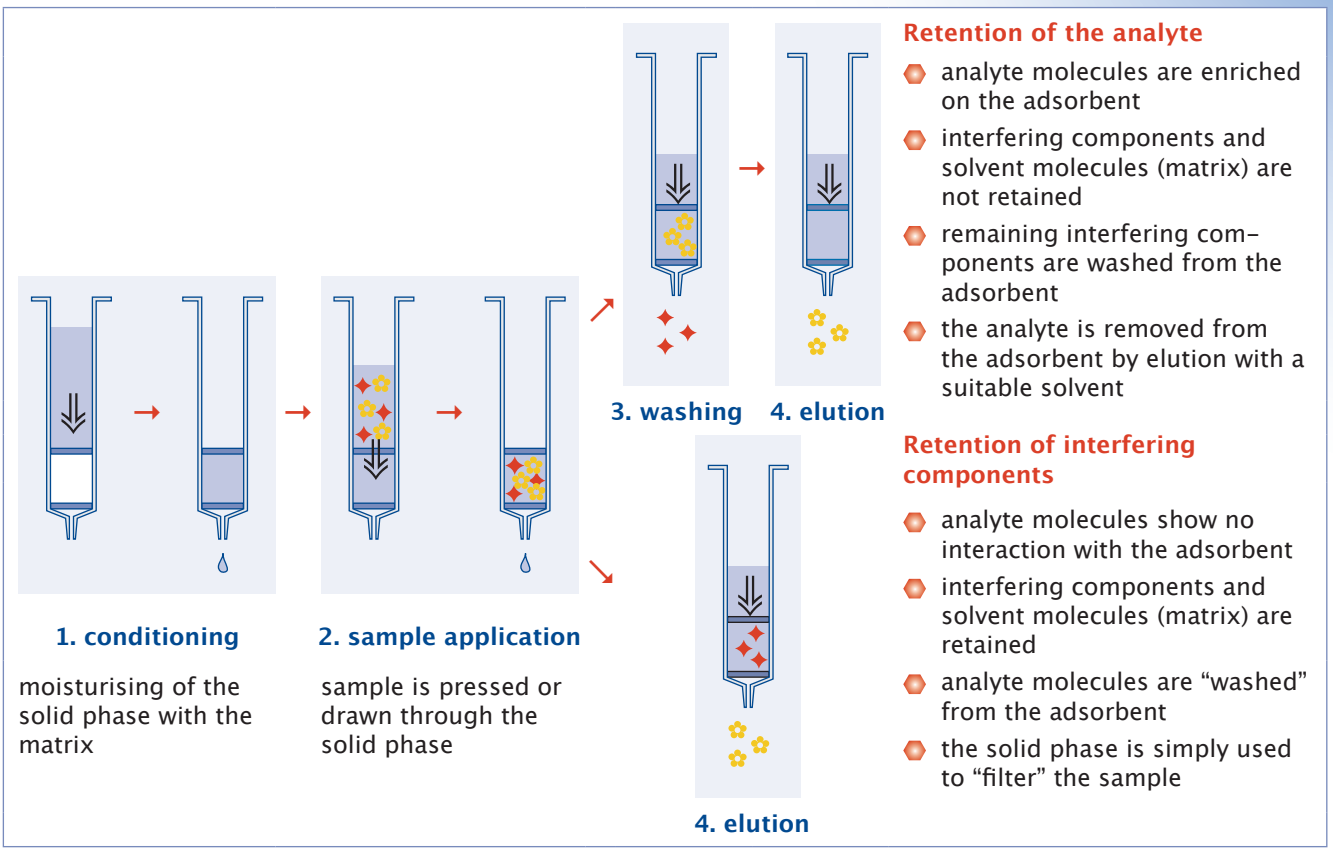
Advantages of SPE compared to classical liquid-liquid extraction:

- lower consumption of solvents
- faster – enormous time savings
- lower costs per sample
- potential for automation
- high consistency in individual sample handling
- more specific selectivity because of the broad range of adsorbents and different retention mechanisms
- optimisation of extraction by variation or adjusting of the solid phase and chromatographic conditions

Separation of food additives



Basic principles of SPE



Retention of the analyte

- analyte molecules are enriched on the adsorbent
- interfering components and solvent molecules (matrix) are not retained
- remaining interfering components are washed from the adsorbent
- the analyte is removed from the adsorbent by elution with a suitable solvent

Retention of interfering components

- analyte molecules show no interaction with the adsorbent
- interfering components and solvent molecules (matrix) are retained
- analyte molecules are "washed" from the adsorbent
- the solid phase is simply used to "filter" the sample

Since analytes can be either adsorbed on the SPE packing material or directly flow through while the interfering substances are retained, two general separation procedures are possible – both cases are shown in the figure above.

Main steps of the SPE procedure

1. Conditioning of the adsorbent

Conditioning of the adsorbent is necessary in order to ensure reproducible interaction with the analyte. Conditioning, also called solvation, results in a wetting of the adsorbent and thus produces an environment, which is suitable for adsorption of the analyte. Nonpolar adsorbents are usually conditioned with 2 – 3 column volumes of a solvent, which is miscible with water (methanol, THF, 2-propanol etc.), followed by the solvent in which the analyte is dissolved (pure matrix, e.g. water, buffer). Polar adsorbents are conditioned with nonpolar solvents.

After the conditioning step the adsorbent bed **must not run dry**, because otherwise solvation is destroyed (deconditioning).

2. Sample application (adsorption)

Sample application can be performed with positive or negative pressure with a flow rate of ~3 ml/min. Sample volumes vary from a few ml up to liters.

3. Washing of the adsorbent

Washing of the adsorbent is usually achieved with a special wash solution; however, in some cases it may not be necessary. If the polarity difference between wash solution and eluent is very large, or if both are not miscible, drying of the adsorbent bed after washing is recommended to improve elution and recovery.

4. Elution

Elution with a suitable eluent should not be too fast. The elution speed depends on the column or cartridge dimension and the quantity of adsorbent (about 1 ml/min).

Basic principles of SPE

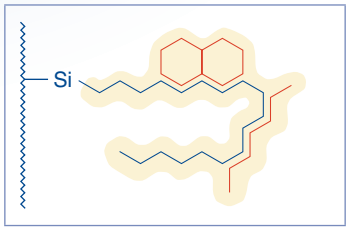
Molecular interactions in SPE

SPE adsorbents are most commonly categorised by the nature of their primary interaction mechanism with the analyte of interest. The three most common extraction mechanisms used in SPE are reversed phase (RP), normal phase (NP) and ion exchanger.

Typical extraction mechanisms

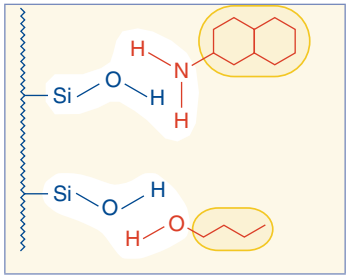
Reversed Phase	Extraction of hydrophobic or polar organic analytes from aqueous matrix
Normal Phase	Extraction of polar analytes from non-polar organic solvents
Ion Exchanger	Extraction of charged analytes from aqueous or non-polar organic samples

Types of retention mechanisms:



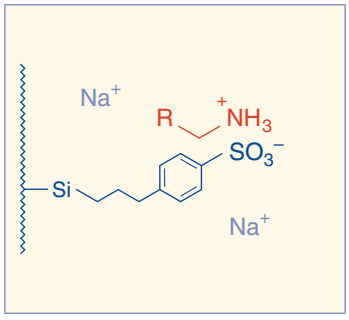
Nonpolar interactions

silica-based:	C_{18} ec, C_{18}, C_{18} Hydra, C_8, …
polymer-based:	HR-X, HR-P, Easy, PS-RP
interactions:	hydrophobic
sample:	mostly aqueous
elution:	solvents with lower polarity (compared to water) MeOH, CH_2Cl_2, $CHCl_3$, … hexane



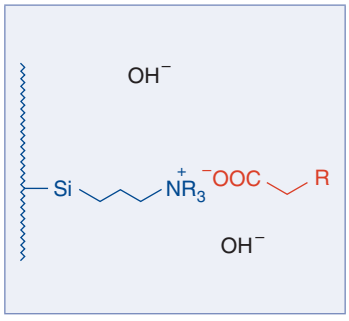
Polar interactions

silica-based:	SiOH, CN, NH_2, OH (diol), C_6H_5, …
other:	Alox, Florisil®, …
interactions:	hydrogen bonds, dipole-dipole and π-π interactions
sample:	mostly organic
elution:	polar solvents (compared to sample solvent) (nonprotic) ethers, ketones (MTBE, THF, acetone, …) CH_2Cl_2, $CHCl_3$, …



Cation exchangers

silica-based:	SA (SCX), PCA (WCX), PSA,
polymer-based:	HR-XC, HR-XCW, PS-H^+, …
interaction:	between charged analytes and functional group of cation exchanger
sample:	aqueous (pH 3-5)
elution:	acidic: pH 2 (e.g. HCl, or 20% AcOH in MeOH/acetonitrile) basic: pH 8-9 (e.g. 5% NH_3 in MeOH/acetonitrile) solvents or buffers with higher ionic strength and counter ions with high selectivity (e.g. Ca^{2+}, …)



Anion exchangers

silica-based:	SB (SAX), NH_2, DMA, …
polymer-based:	HR-XA, HR-XAW, PS-OH^-, …
interaction:	between charged analytes and functional group of anion exchanger
sample:	aqueous (pH 8-9)
elution:	basic: pH 10 (e.g. 20% NH_3 in MeOH/acetonitrile) acidic: pH 4-5 (e.g. HCl, or 5% AcOH in MeOH/acetonitrile) solvents or buffers with higher ionic strength and counter ions with high selectivity (e.g. citrate, …)

It should be noted, that in SPE the interactions described above are not found in pure form, but in combination. For example, modified silicas, unless they have been subjected to endcapping (silanisation of residual silanol groups with short-chain silanes), still possess free silanol groups, which can enter into secondary interactions.

Sample pretreatment

For direct extraction with adsorbents the sample matrix (sample environment) has to fulfil three conditions:

- the matrix has to be liquid, if possible with low viscosity
- solids should be removed from the liquid matrix
- the matrix (sample environment) should be suitable for retention of the analyte

For solid samples there are different methods to convert the sample into a suitable matrix:

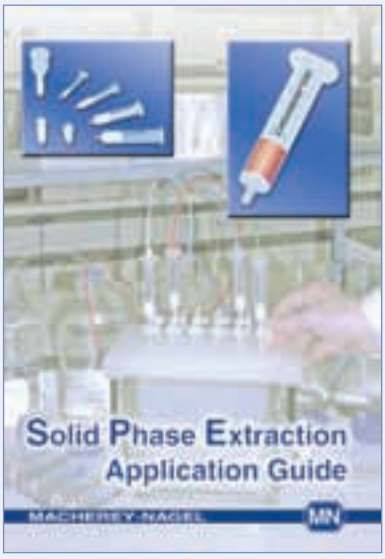
- dissolution of the solid sample in a suitable solvent
- lyophilisation of the sample and dissolution in a suitable solvent
- extraction of the solid sample with a suitable solvent
- homogenisation of the sample in a suitable solvent

In order to find the suitable solvent, one has to consider all desired sample components. Also, the suitable solvent should enhance retention of the analyte. For example, samples with large contents of solids are often homogenised in nonpolar solvents like hexane, while for samples with high water content dissolution in acids, bases, buffers or very polar solvents such as methanol is recommended.

Additionally, SPE allows to alter the properties of the sample matrix. If, for example, natural products are extracted with methanol or acetone, the polarity of the extracts can be increased by dilution with water, in order to enhance nonpolar solid phase extraction on the C_{18} material.

SPE Application Guide

- selection of more than **300 applications** from the fields
  - ✓ biological samples and natural compounds
  - ✓ pharmaceuticals and drugs
  - ✓ food and beverages
  - ✓ environmental samples and pollutants
- detailed application procedures and helpful hints: recovery rates, information for subsequent analysis (GC, HPLC, …), structural information of interesting compounds …
- explaining basics and principles of SPE: standard protocols for SPE phases, selection guide for SPE phases and solvents, sample pretreatment for difficult matrices
- detailed description of all standard and special phases and their fields of application, description and handling of CHROMABOND® hardware, accessories and manifolds
- latest and more applications at ***www.mn-net.com/apps***

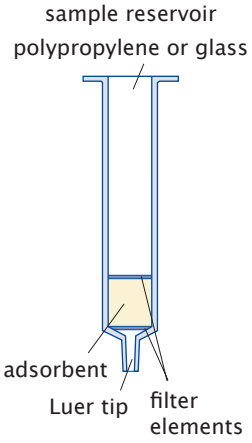


Our CHROMABOND® QC policy

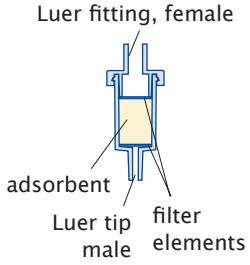
- **highest production standard**
  our facilities are EN ISO 9001:2008 certified
- all of our bonded phases and SPE products are vigorously tested for perfect **reproducibility** from lot-to-lot and within every single batch · careful attention to particle size distribution and pore diameters assures consistent column flow · chemical reproducibility is guaranteed by strict quality control throughout manufacturing
- all products are individually tested to meet our **strict quality specifications**, ensuring our outstanding product reproducibility, reliability and performance
- each product is supplied with a **certificate of analysis** stating the results of internal examinations and quality control

Basic principles of SPE

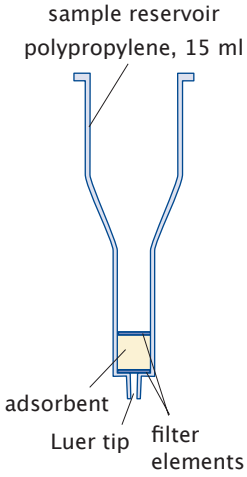
CHROMABOND®



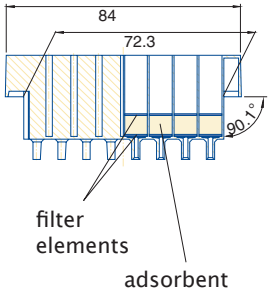
CHROMAFIX®



CHROMABOND® LV



CHROMABOND® MULTI 96



Design of columns, cartridges and 96-well plates

All CHROMABOND® columns, cartridges and 96-well plates are manufactured from polypropylene (PP) with lowest content of extractables (plasticizers, stabilisers, ...) offering blank value free results by usage of most common solvents. The high quality CHROMABOND® adsorbents are kept in place by chemically very inert polyethylene filter elements (PE, standard pore size 20 µm).

CHROMABOND® polypropylene columns

- PP columns with PE filter elements
- different sizes from 1, 3, 6 up to 150 ml
- adsorbent weights from 20 mg to 50 g
- male luer tip as exit
- compatible with most robots (e.g. Gilson ASPEC™, Caliper AutoTrace®, ...)

CHROMABOND® glass columns

- glass columns with chemically very inert glass fibre filter elements (nominal pore size 1 µm)
- two different sizes: 3 and 6 ml
- available with all CHROMABOND® phases
- excludes any influence from the column material (e.g. plasticizers, ...)

CHROMAFIX® cartridges

- PP cartridges with PE filter elements
- three different sizes with different adsorbent weights: **S**mall (0.4 ml), **M**edium (0.8 ml), **L**arge (1.8 ml)
- female Luer tip at the inlet, male Luer tip as exit
- offers alternative way of handling using positive pressure by syringes or peristaltic pumps
- especially suited for convenient solid phase extraction of small sample volumes

CHROMABOND® LV columns

- large volume PP columns with PE filter elements
- three different adsorbent weights (100, 200 and 500 mg)
- funnel-shaped reservoir with 15 ml volume
- especially for clinical samples – the whole sample (e.g. urine, serum, blood) can be applied to the column in one step
- can be directly used in the Zymate® lab robots of Zymark

CHROMABOND® MULTI 96 · SPE in 96-well format

- 96-well polypropylene plates with PE filter elements
- cavity volume 1.5 ml
- adsorbent weights from 25 to 100 mg
- supplied with any CHROMABOND® SPE adsorbents
- for simultaneous preparation of 96 samples
- easy method transfer from CHROMABOND® columns or CHROMAFIX® cartridges to CHROMABOND® MULTI 96
- readily adaptable to all common automated / robotic handling systems (for details see page 52)

SPE method development kits

For the development kits as well as for all individual CHROMABOND®, CHROMABOND® LV and CHROMAFIX® types columns are sealed in units of five columns each to prevent adsorption of contaminants from the environment, e.g. laboratory air.

Ordering information

Designation	Contents of the kit	REF
Investigating the best separation mechanism for a clean-up procedure		
CHROMABOND® HR-X*pert* development kit I	columns with 3 ml / 60 mg each: 10 columns with HR-X; 5 columns each with HR-XC, HR-XA, HR-XCW, HR-XAW	**730723**
CHROMABOND® HR-X*pert* development kit II	columns with 3 ml / 200 mg each: 10 columns with HR-X; 5 columns each with HR-XC, HR-XA, HR-XCW, HR-XAW	**730726**
CHROMABOND® polymer development kit	5 columns each with 3 ml / 200 mg: HR-X, HR-XC (MCX), HR-XA (MAX), HR-P, Easy, PS-H^+, PS-OH^-	**730288**
CHROMABOND® standard development kit	5 columns each with 3 ml / 500 mg: C_{18}, C_{18} ec, C_8, C_6H_5, NH_2, DMA, OH, CN, SiOH, SA (SCX), SB (SAX)	**730496**
Selecting the optimum RP phase for a clean-up procedure		
CHROMABOND® RP development kit I	10 columns each with 3 ml / 500 mg: C_{18}, C_{18} ec, C_8, C_4 and 10 columns each with 3 ml / 200 mg HR-P, HR-X	**730197**
CHROMABOND® RP development kit II	10 columns each with 1 ml / 100 mg: C_{18}, C_{18} ec, C_8, C_4, HR-P, HR-X	**730207**
CHROMAFIX® RP development kit I	10 cartridges each CHROMAFIX® **S**: C_{18}, C_{18} ec, C_8, C_4, HR-P, HR-X	**731883**
CHROMABOND® RP development kit III	10 columns each with 3 ml / 500 mg: C_{18}, C_{18} ec, C_{18} Hydra, C_8 and 10 columns each with 3 ml / 200 mg HR-P, HR-X	**730490**
CHROMABOND® RP development kit IV	10 columns each with 1 ml / 100 mg: C_{18}, C_{18} ec, C_{18} Hydra, C_8, HR-P, HR-X	**730491**
CHROMAFIX® RP development kit II	10 cartridges each CHROMAFIX® **S**: C_{18}, C_{18} ec, C_{18} Hydra, C_8, HR-P, HR-X	**731886**
CHROMABOND® RP development kit V	10 columns each with 3 ml / 500 mg: C_6H_5, NO_2, C_6H_{11} ec, C_4, C_2	**730492**
CHROMABOND® RP development kit VI	10 columns each with 1 ml / 100 mg: C_6H_5, NO_2, C_6H_{11} ec, C_4, C_2	**730493**
CHROMAFIX® RP development kit III	10 cartridges each CHROMAFIX® **S**: C_6H_5, NO_2, C_6H_{11} ec, C_4, C_2	**731887**
Selecting the optimum polar phase for a clean-up procedure		
CHROMABOND® polar development kit I	10 columns each with 3 ml / 500 mg: SiOH, Florisil®, NH_2, CN, OH	**730199**
CHROMABOND® polar development kit II	10 columns each with 1 ml / 100 mg: SiOH, Florisil®, NH_2, CN, OH	**730208**
CHROMAFIX® polar development kit	10 cartridges each CHROMAFIX® **S**: SiOH, Florisil®, NH_2, CN, OH	**731884**
Selecting the optimum ion exchanger for a clean-up procedure		
CHROMABOND® ion exchange development kit I	10 columns each with 3 ml / 500 mg: SA (SCX), SB (SAX), HR-XC (MCX), HR-XA (MAX), PS-OH^-, PS-H^+, DMA	**730206**
CHROMABOND® ion exchange development kit II	10 columns each with 1 ml / 100 mg: SA (SCX), SB (SAX), HR-XC (MCX), HR-XA (MAX), PS-OH^-, PS-H^+, DMA	**730209**
CHROMAFIX® ion exchange development kit I	10 cartridges each CHROMAFIX® **S**: SA (SCX), SB (SAX), HR-XC (MCX), HR-XA (MAX), PS-OH^-, PS-H^+, DMA	**731885**
CHROMABOND® cation exchange development kit I	10 columns each with 3 ml / 500 mg: SA (SCX), PSA, PCA, HR-XC (MCX), HR-XCW (WCX), PS-H^+	**730494**
CHROMAFIX® cation exchange development kit	10 cartridges each CHROMAFIX® **S**: SA (SCX), PSA, PCA, HR-XC (MCX), HR-XCW (WCX), PS-H^+	**731888**
Phase selection for clean-up procedures for environmental samples		
CHROMABOND® kit I for environmental sample preparation	10 columns each with 3 ml / 200 mg HR-P, 6 ml / 1000 mg C_{18} ec, 6 ml / 2000 mg C_{18} PAH, 6 ml / 500/1000 mg CN/SiOH, 3 ml / 500/500 mg SA/SiOH	**730205**
CHROMABOND® kit II for environmental sample preparation	5 columns each with 3 ml / 500/500 mg SiOH-H_2SO_4/SA, 3 ml / 500 mg SiOH, 6 ml / 1000 mg Florisil, 3 ml / 500/500 mg SA/SiOH, 6 ml / 700/2000/700 mg NAN	**730349**

Summary of MN phases for SPE

Code	Matrix	Modification / Application	Similar phases*	Page
Reversed phases				
HR-X	PS/DVB		ENVI-Chrom P · Strata™-X · Oasis® HLB · Nexus	12
Easy	PS/DVB	polar, bifunctional	Strata™-X · Oasis® HLB · Porapak™ RDX · Nexus, Bond Elut® PPL, Focus™ ·Styre Screen® DVB Bakerbond™ H_2O-philic DVB · Isolute® ENV+	18
HR-P	PS/DVB		Strata™ SDB-L ·Bond Elut® ENV, Bond Elut® LMS · DCS-PS/DVB, ENV PS-DVB · Bakerbond™ H_2O-phobic DVB · Isolute® 101 · LiChrolut® EN	19
PS-RP	PS/DVB	removal of organic components	like HR-P	20
C_{18} ec	silica	octadecyl, endcapped	Strata™ C18-E · Sep-Pak® tC18 · Bond Elut® C18 · DSC-18(Lt), ENVI-18, LC-18 · CLEAN-UP® C18, Bakerbond® Octadecyl · Isolute C18(EC), LiChrolut® RP-18 E	21
C_{18} ec f	silica	as above, fast flow		21
C_{18}	silica	octadecyl, not endcapped	Strata™ C18-U · Accubond® C18 · Bakerbond™ PolarPlus · Isolute® C18 · LiChrolut® RP-18	22
C_{18} f	silica	as above, fast flow		22
C_{18} PAH	silica	special octadecyl phase, for enrichment of PAHs from water	Bakerbond™ Octadecyl Lightload	40
C_{18} Hydra	silica	octadecyl, not endcapped, for polar analytes		23
C_8	silica	octyl	Strata™ C8 · Sep-Pak® C8 · Bond Elut® C8 · DSC-8, ENVI-8, LC-8 · CLEAN-UP® C8 · Accubond® C8 · Bakerbond™ Octyl · Isolute C8(EC)	24
C_4	silica	butyl		25
C_2	silica	dimethyl	Bond Elut® C2	25
C_6H_{11} ec	silica	cyclohexyl, endcapped		26
C_6H_5	silica	phenyl	Strata™ PH · Bond Elut® PH · DSC-Ph · CLEAN-UP® Phenyl · Accubond® Phenyl · Bakerbond™ Phenyl · Isolute PH(EC)	27
Normal phases				
SiOH	silica	unmodified	Strata™ Si-1 · Bond Elut® silica · DSC-Si, LC-Si · CLEAN-UP® silica · Accubond® silica, Bakerbond™ silica gel · Isolute® silica · LiChrolut® Si	30
NH_2	silica	aminopropyl	Strata™ NH_2 · Sep-Pak® NH_2 · Bond Elut NH_2 · DSC-NH_2, LC-NH_2 · CLEAN-UP® aminopropyl · Accubond® NH_2 · Bakerbond™ amino · Isolute® NH_2 · LiChrolut® NH_2	29
OH	silica	diol	DSC-Diol, LC-Diol · Accubond® Diol (OH)	28
CN	silica	cyano	Strata™ CN · Sep-Pak® CN · Bond Elut® CN-U· DSC-CN, LC-CN · CLEAN-UP® CN · Accubond® CN · Bakerbond™ cyano· Isolute® CN · LiChrolut® CN	28
Alox A	aluminium oxide acidic		LC-Alumina-A · Accubond® aluminium oxide A	31
Alox N	aluminium oxide neutral		LC-Alumina-N · Accubond® aluminium oxide N	31
Alox B	aluminium oxide basic		LC-Alumina-B · Accubond® aluminium oxide B	31
Florisil®	magnesium silicate		Strata™ FL-PR · Sep-Pak® Florisil® · Bond Elut® Florisil® · ENVI-Florisil®, LC-Florisil® · CLEAN-UP® Florisil® · Accubond® Florisil® · Bakerbond™ Florisil® · Isolute® FL · LiChrolut® Florisil®	32
PA	polyamide 6		DPA-6S	32
Ion exchangers				
SB	silica	quaternary ammonium anion exchanger (SAX)	Strata™ SAX, Sep-Pak® SAX, Bond Elut® SAX · DSC-SAX, LC-SAX · CLEAN-UP® Quaternary Amine · Accubond® SAX · Bakerbond™ Quaternary Amine · Isolute® SAX · LiChrolut® SAX	35

* phases which provide a similar selectivity based on chemical or physical properties (list not complete)

Summary of MN phases for SPE

Code	Matrix	Modification / Application	Similar phases*	Page
SA	silica	benzenesulphonic acid cation exchanger (SCX)	Strata™ SCX · Bond Elut® SCX · DSC-SCX, LC-SCX · CLEAN-UP® Benzenesulfonic Acid · Accubond® SCX · Bakerbond™ Aromatic Sulfonic Acid · Isolute® SCX · LiChrolut® SCX	34
PCA	silica	propylcarboxylic acid cation exchanger (WCX)	Strata™ WCX · Bond Elut® CBA · DSC-WCX, LC-WCX · CLEAN-UP® Carboxylic Acid · Bakerbond™ Carboxylic Acid · Isolute® CBA	33
PSA	silica	propylsulphonic acid cation exchanger		33
HR-XC	PS/DVB	strong mixed mode cation exchanger for basic analytes (MCX)	Oasis® MCX · HyperSep™ Retain™-CX· Strata™ X-C · Styre Screen® DBX	14
HR-XA	PS/DVB	strong mixed mode anion exchanger for acidic analytes (MAX)	Oasis® MAX · HyperSep™ Retain™-AX · Styre Screen® QAX	15
HR-XCW	PS/DVB	weak mixed mode cation exchanger for basic analytes (WCX)	Oasis® WCX · Strata™ X-CW	16
HR-XAW	PS/DVB	weak mixed mode anion exchanger for acidic analytes (WAX)	Oasis® WAX · Strata™ X-AW	17
PS-OH^-	PS/DVB	strong anion exchanger in OH^- form	Oasis® MAX	20
PS-H^+	PS/DVB	strong cation exchanger in H^+ form	Oasis® MCX · Strata™ X-C	20
PS-Mix	PS/DVB	mixture of PS-OH^- and PS-H^+		
PS-Ag^+	PS/DVB	strong cation exchanger in Ag^+ form		20
PS-Ba^{2+}	PS/DVB	strong cation exchanger in Ba^{2+} form		20
Phases for special applications				
Dry	Na_2SO_4	for drying organic samples		45
Drug	silica	bifunctional C_8/SA, for enrichment of drugs from urine	Strata™ Screen-C · Bond Elut® Certify I · DSC-MCAX · Clean Screen® DAU · Accubond® Evidex · Bakerbond™ Narc-2 · Isolute® HCX · LiChrolut® TSC · HyperSep™ Verify CX	36
Drug II	silica	bifunctional C_8/SB, for extraction of THC and derivatives and of acidic analytes from biological fluids	Strata™ Screen-A · Bond Elut Certify II · Clean Screen® THC · Bakerbond® Narc-1 · Isolute® HAX· HyperSep™ Verify AX	37
Crosslinks	cellulose	for enrichment of collagen crosslinks		38
Tetracycline	silica	special octadecyl phase, for enrichment of tetracyclines		38
AOX	PS/DVB	for extraction of AOX from water (DIN 38409 - H22)		39
CN/SiOH	silica	combination phase for enrichment of PAHs from soil		42
NH_2/C_{18}	silica	combination phase for enrichment of PAHs from water		40
Na_2SO_4/Florisil®		combination phase for extraction of hydrocarbons from water (DIN H-53 / ISO DIS 9377-4)		41
SA/SiOH	silica	combination phase for enrichment of PCB from waste oil		43
SiOH-H^+/SA	silica	combination phase, used together with SiOH for enrichment of PCB from oil		44
NAN	silica / $AgNO^3$ + Na_2SO_4	combination phase for enrichment of PCB from sludge		42
ABC18	silica	octadecyl, with ion exchange functions, for acrylamide analysis	Isolute® M-M	45
Diamino	silica	**p**rimary and **s**econdary **a**mine functions (PSA), for determination of pesticides in food samples (QuEChERS method)	Supelclean PSA, Bond Elut PSA	46
Phase separation		CHROMABOND® PTL/PTS		56
Liquid-liquid extraction		CHROMABOND® XTR	EXtrelut® · Chem Elut™ · Hydromatrix™	54

* phases which provide a similar selectivity based on chemical or physical properties (list not complete)

CHROMABOND® HR-X*pert*

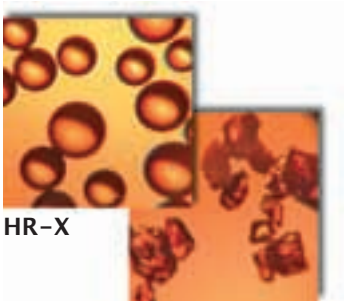
The professional concept of innovative SPE phases

The CHROMABOND® HR-X*pert* family comprises 5 polymer-based RP and mixed-mode ion exchange phases:

- **CHROMABOND® HR-X** hydrophobic PS/DVB copolymer
- **CHROMABOND® HR-XC** strong mixed-mode cation exchanger
- **CHROMABOND® HR-XA** strong mixed-mode anion exchanger
- **CHROMABOND® HR-XCW** weak mixed-mode cation exchanger
- **CHROMABOND® HR-XAW** weak mixed-mode anion exchanger

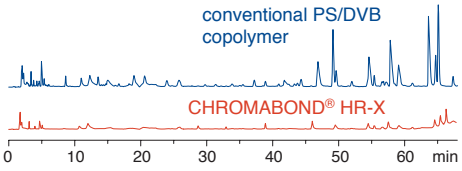
These innovative SPE phases offer

- **state-of-the-art spherical polymer**
  - broad spectrum of application with special suitability for enrichment of pharmaceuticals from biological matrices
  - ideal flow properties due to low content of particulate matter
- **optimised pore structure** and **high specific surface**
  - high loadability and outstanding elution properties
  - low solvent consumption
  - rapid, economical analyses
- **high-purity adsorber material**
  - allows highest reproducibility with extremely low blind values
  - reliable analyses at ultra trace level
  - no method adaptation for new batches necessary



conventional PS/DVB copolymer

Adsorbent blind values:



The HR-X*pert* concept guarantees:

- RP and mixed-mode SPE phases with distinct ion exchange and reversed phase properties
  your benefit: excellent enrichment of neutral, acidic and basic compounds
- modern, spherical support polymer with optimised pore structure and high surface
  your benefit: good reproducibility, reliable and cost-efficient analysis
- possibility for more aggressive washing procedures for matrix removal
  your benefit: cleaner samples and protection of your HPLC and GC instruments
- quantification of analytes also from heavily contaminated samples
  your benefit: lower limits of detection also for critical matrices

CHROMABOND® HR-X*pert* is the perfect combination for all tasks in sample preparation

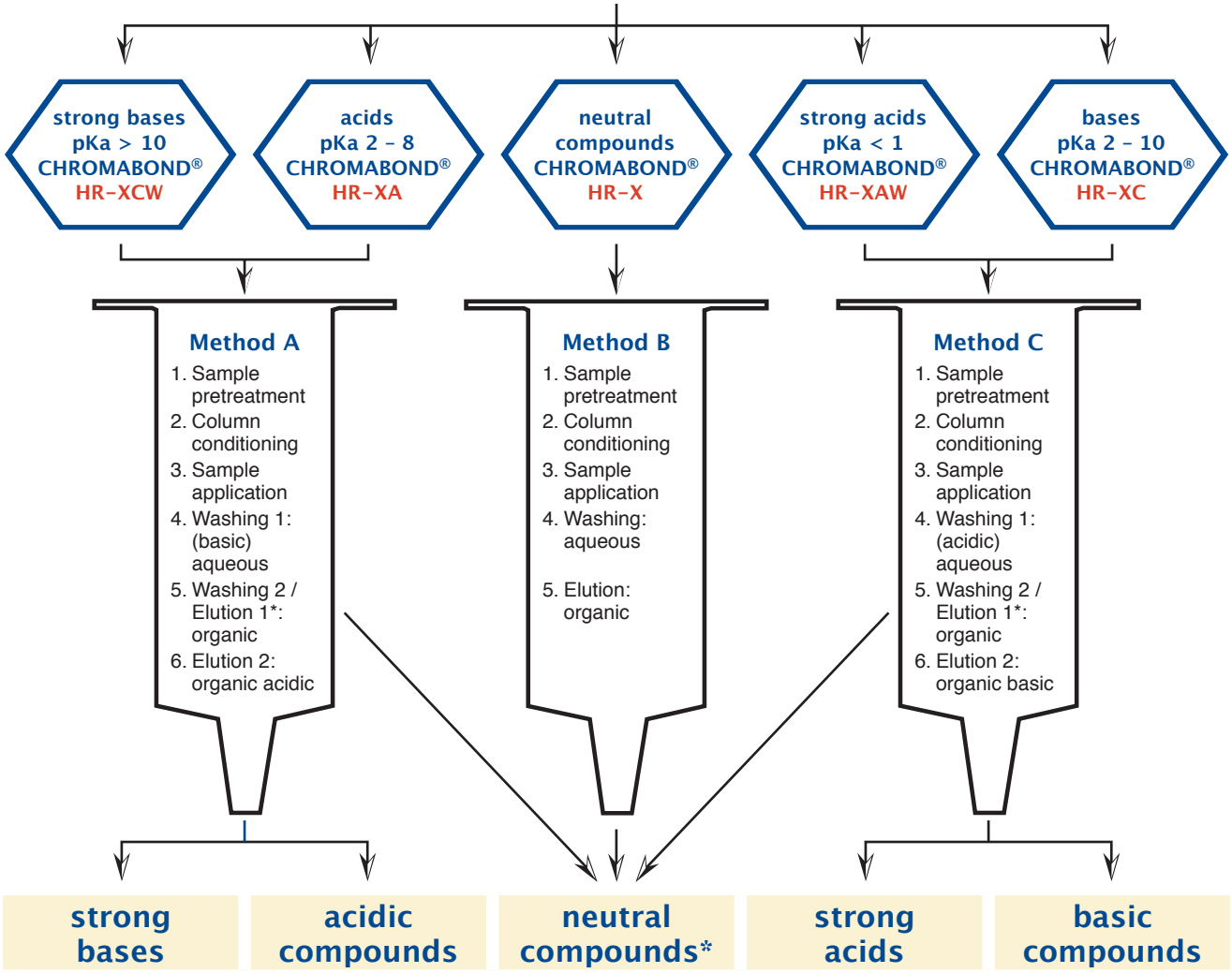
Similar phases:

CHROMABOND® HR-X:	Oasis® HLB, Strata™ X, Nexus, ENVI-Chrom P
CHROMABOND® HR-XC:	Oasis® MCX, Strata™ X-C, StyreScreen® DBX, HyperSep™ Retain™-CX
CHROMABOND® HR-XA:	Oasis® MAX, HyperSep™ Retain™-AX, StyreScreen® QAX
CHROMABOND® HR-XCW:	Oasis® WCX, Strata™-X-CW
CHROMABOND® HR-XAW:	Oasis® WAX, Strata™-X-AW

The CHROMABOND® HR-Xpert concept for neutral, acidic and basic analytes

3 paths – 1 goal: cleaner samples

Depending on the character of the analytes HR-Xpert offers suitable adsorbents and optimal methods for sample preparation, cleaning and concentration.



*** under organic washing and elution conditions the following compounds will be also eluted:**

HR-X: polar compounds such as organic acids and bases

HR-XC / HR- XCW: acidic components / impurities

HR-XA / HR- XAW: basic components / impurities

Polymer-based reversed phases for SPE

HR-X spherical, hydrophobic polystyrene-divinylbenzene adsorbent resin

- hydrophobic polystyrene-divinylbenzene copolymer
  pH stability 1 – 14
  high-purity material with highest reproducibility and lowest blank values due to a novel manufacturing process
  spherical particles 85 µm; pore size 55 – 60 Å
  very high surface 1000 m^2/g
  capacity 390 mg/g (caffeine in water)
  excellent recovery rates especially for the enrichment of pharmaceuticals / active ingredients due to the spherical structure of the particles, very homogeneous surface, and optimised pore structure
- recommended application:
  pharmaceuticals / active ingredients from tablets, creams and water / waste water
  drugs and pharmaceuticals from urine, blood, serum and plasma
  trace analysis of pesticides, herbicides, phenols, PAHs and PCBs from water

Solid Phase Extraction

Drugs from water

Column type:
CHROMABOND® HR-X / 3 ml / 200 mg
REF 730931
Sample: 1 µg/ml each in water
Column conditioning: 5 ml methanol, 5 ml dist. water
Sample application: slowly aspirate 500 ml water (pH 3) through the column
Column washing: 5 ml water
Elution: after drying 3 x 2 ml acetonitrile

Further analysis: HPLC on NUCLEODUR® C_{18} Gravity, 5 µm; see MN Appl. No. 121690

Recovery rate [%]

Compound	HR-X	Strata™ X
Ketoprofen	98	92
Ibuprofen	91	93
Pentobarbital	99	95
Meclofenamic acid	92	93
Protriptyline	63	45
Nortriptyline	53	39

MN Appl. No. 304240

Pesticides from water

Column type:
CHROMABOND® HR-X / 3 ml / 200 mg, REF 730931
CHROMABOND® Easy / 3 ml / 200 mg, REF 730754
Sample pretreatment: samples are spiked with 500 ng of each pesticide in 1000 ml water, adjusted to pH 2 with HCl (a) or pH 7
Column conditioning: 10 ml methanol, 10 ml dist. water
Sample application:
slowly pass 1000 ml spiked water sample through the column with the aid of a tubing adaptor (REF 730243)
Elution: after drying 5 ml methanol – THF (1:1, v/v)

Further analysis: HPLC

a) Recovery rates [%]

Compound	HR-X pH 2	Compound	HR-X pH 7
Metamitron	86	Desisopropylatrazine	90
Quinmerac	90	2,4-Dichlorobenzamide	95
Chloridazon	93	Desethylatrazine	89
Picloram	83	Hexazinone	95
Metribuzin	84	Bromacil	103
Cyanazine	83	Simazine	91
Metabenzthiazuron	94	Desethylterbuthylazine	89
Chlortoluron	91	Atrazine	88
Isoproturon	89	Metalaxyl	97
Diuron	91	Metazachlor	93
Dimethenamid-P	89	Propazine	88
Linuron	94	Terbuthylazine	86
Epoxyconazole	85	Metolachlor	97
Penconazole	90		
Alachlor	93		
Propiconazole-1	89		
Flufenacet	91		
Diflufenicam	58		
Triallate	42		

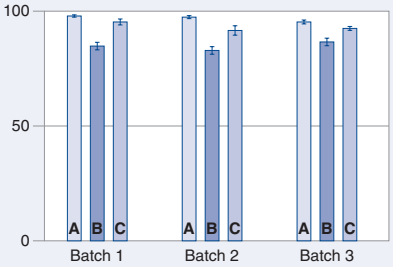
MN Appl. No. 304250/304260

Polymer-based reversed phases for SPE

Highest reproducibility

✓ within each batch ✓ from batch to batch

Compounds:
- A phenobarbital
- B pentobarbital
- C hexobarbital



Barbiturates from serum

Column type:
CHROMABOND® HR-X / 3 ml / 200 mg
REF 730931

Sample: 100 ng/ml each in serum
Column conditioning: 5 ml methanol, 5 ml dist. water
Sample application: 1 ml spiked serum
Column washing: 5 ml water
Elution: after drying 3 x 2 ml methanol

Further analysis: HPLC on NUCLEODUR® 100-5 C_{18} ec, see MN Appl. No. 117820

MN Appl. No. 304290

Standard protocol for CHROMABOND® HR-X

Column type:
CHROMABOND® HR-X / 3 ml / 200 mg
REF 730931

Sample pretreatment: if necessary, adjust pH value
Column conditioning: 5 ml methanol
Equilibration: 5 ml water
Sample application:
slowly aspirate the sample through the column
Column washing: 5 ml water – methanol (95:5, v/v)
Elution: after drying 3 x 2 ml methanol

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

MN Appl. No. 304310

Ordering information

	Volume	Adsorbent weight						Pack of
	CHROMABOND® HR-X polypropylene columns							
		30 mg	60 mg	100 mg	200 mg	500 mg	1 g	
	1 ml	**730934**		**730935**				30
	3 ml		**730936**		**730931**	**730937**		30
	6 ml				**730938**	**730939**		30
	15 ml					**730940**	**730941**	20
	CHROMABOND® HR-X polypropylene columns · BIGpacks							
					200 mg			
	3 ml				**730931.250**			250
	6 ml				**730938.250**	**730939.250**		250
	CHROMABOND® HR-X glass columns							
			60 mg		200 mg			
	3 ml		**730936G**					30
	6 ml				**730938G**			30
	CHROMABOND® LV-HR-X							
		30 mg	60 mg		200 mg			
	15 ml	**732130**	**732131**		**732132**			30
	CHROMABOND® MULTI 96 HR-X							
		96 x 25 mg		96 x 50 mg		96 x 100 mg		
		738530.025M		**738530.050M**		**738530.100M**		1
	CHROMABOND® HR-X adsorbent							
						730663		20 g

CHROMAFIX® cartridges on request

Polymer-based ion exchangers for SPE

HR-XC

NEW!

- strong acidic benzenesulphonic acid cation exchanger
  exchange capacity 1.0 meq/g, pKa < 1
- base material polystyrene-divinylbenzene copolymer
  pH stability 1 – 14
- high purity material, highest reproducibility and
  lowest blank values due to an optimised production process
- spherical particles size 85 µm; pore size 65 – 75 Å
  very large specific surface 800 m^2/g; pore volume 1.4 cm^3/g
  RP capacity 300 mg/g (caffeine in water)
- outstanding recovery rates especially for the enrichment of basic analytes

strong cation exchanger

- recommended application:
  basic active ingredients from heavily matrix-contaminated samples like e.g. urine, plasma, serum
- fungicides from food, melamine from milk
- basic analytes like e. g. amines
- bases with **pKa 2 – 10**

Standard protocol for CHROMABOND® HR-XC

Column type:
CHROMABOND® HR-XC / 3 ml / 200 mg
REF 730952

Sample pretreatment: individual sample preparation with reference to analytes and matrix
Column conditioning: 5 ml methanol
Equilibration: 5 ml water
Sample application: slowly aspirate sample through the column
Washing 1: 2 ml 0.1 mol/l HCl in water
Washing 2 / Elution 1: 2 ml methanol (neutral and acidic compounds); if necessary, further washing steps
Elution 2: after drying 5 ml methanol / 5 % NH_3 (basic compounds)

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

MN Appl. No. 304740

Fractionation of acidic, neutral and basic

Column type:
CHROMABOND® HR-XC / 3 ml / 200 mg
REF 730952

Sample: 1 ml spiked matrix, acidified with 200 µl 2 % H_3PO_4
Column conditioning: 5 ml methanol, then 5 ml water
Sample application: slowly aspirate sample through the column
Washing: 2 ml 0.1 mol/l HCl
Elution: 2.5 ml methanol (*fraction A:* neutral and acidic analytes); then 5 ml methanol – NH_3 90:10, v/v (*fraction B:* basic analytes)

Further analysis for fraction A: HPLC e. g. on NUCLEODUR® C_{18} Gravity, see MN Appl. No. 122230; for fraction B: HPLC on NUCLEODUR® C_8 Gravity, see MN Appl. No. 118520

Recovery rates [%]

Fraction A: neutral and acidic analytes

Compound	HR-XC
Suprofen	108
Naproxen	85
Tolmetin	73
Phenobarbital	108
Indomethacin	33
Hexobarbital	80

Fraction B: basic analytes

Compound	HR-XC	Oasis® MCX	Strata™ X-C
1. Doxepin	101	68	82
2. Imipramine	95	71	85
3. Amitriptyline	94	72	78
4. Trimipramine	92	70	81

MN Appl. No. 304780

Ordering information

CHROMABOND® HR-XC polypropylene columns

Volume	30 mg	60 mg	100 mg	150 mg	200 mg	500 mg	Pack of
1 ml	**730969**		**730049**				30
3 ml		**730956**			**730952**	**730953**	30
6 ml				**730957**		**730955**	30

CHROMAFIX® HR-XC cartridges

Size	S	M	L	
adsorbent weight ∅	155 mg	240 mg	500 mg	
	731755	**731756**	**731757**	50

CHROMABOND® HR-XC adsorbent

			730664	100 g

Polymer-based ion exchangers for SPE

HR-XA

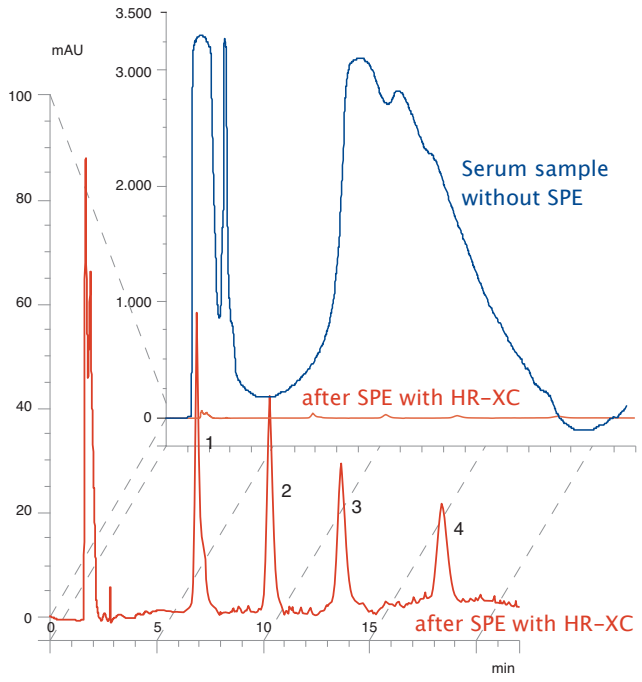
NEW!

- strong basic quaternary ammonium anion exchanger
  exchange capacity 0.25 meq/g, pKa ~ 18
  base material polystyrene-divinylbenzene copolymer
  pH stability 1 – 14
  high purity material with highest reproducibility and lowest blank values due to an optimised production process
  spherical particles size 85 µm; pore size 55 – 65 Å
  very large specific surface 850 m^2/g; pore volume 1.4 cm^3/g
  RP capacity 350 mg/g (caffeine in water)
  outstanding recovery rates especially for the enrichment of acidic analytes

strong anion exchanger

- recommended application:
  acidic active ingredients from heavily matrix-contaminated samples like e. g. urine, plasma, serum
  phenolic acids
  acidic herbicides
  weak/medium-strength acids with **pKa 2 – 8**

analytes from serum



Standard protocol for CHROMABOND® HR-XA

Column type:
CHROMABOND® HR-XA / 3 ml / 200 mg
REF 730951

Sample pretreatment: individual sample preparation with reference to analytes and matrix
Conditioning: 5 ml methanol
Equilibration: 5 ml water
Sample application: slowly aspirate sample through the column
Washing 1: 2 ml 0.1 mol/l NaOH in water
Washing 2 / Elution 1: 2 ml methanol (neutral and basic compounds), if necessary, further washing steps
Elution 2: after drying 5 ml methanol / 1 – 10 % formic acid (acidic compounds)

Further analyses: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

MN Appl. No. 304970

For further applications on CHROMABOND® polymer phases see our online application database at

www.mn-net.com/apps

Ordering information

Volume	Adsorbent weight						Pack of
CHROMABOND® HR-XA polypropylene columns							
	30 mg	60 mg	100 mg	150 mg	200 mg	500 mg	
1 ml	**730968**		**730727**				30
3 ml		**730950**			**730951**	**730954**	30
6 ml				**730958**		**730966**	30
CHROMAFIX® HR-XA cartridges							
Size		**S**		**M**		**L**	
Adsorbent weight ∅		155 mg		240 mg		500 mg	
		731768		**731769**		**731770**	50
CHROMABOND® HR-XA adsorbent							
						730671	100 g

Solid Phase Extraction

Polymer-based ion exchangers for SPE

HR-XCW

NEW!

- weak acidic carboxylic acid cation exchanger
  exchange capacity >0.7 meq/g, pKa ~ 5
- base material spherical PS/DVB copolymer
  pH stability 1 – 14
- high purity material, highest reproducibility and
  lowest blank values due to an optimised production process
- spherical particles size 85 µm; pore size 50 – 60 Å
  very large specific surface 850 m^2/g; pore volume 1.2 – 1.4 cm^3/g
  RP capacity 350 mg/g (caffeine in water)
- outstanding recovery rates especially for enrichment of strongly basic analytes

weak cation exchanger

- recommended application:
  basic compounds like quaternary amines
- active ingredients from heavily matrix-contaminated samples like e.g. urine, plasma, serum
- strong bases with **pKa > 10**

Standard protocol for CHROMABOND® HR-XCW

Column type:
CHROMABOND® HR-XCW / 3 ml / 200 mg
REF 730739

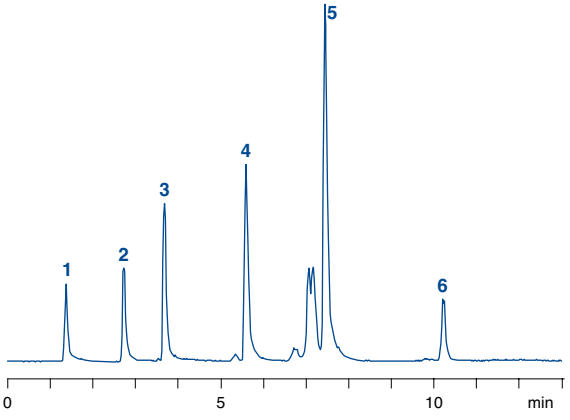
Sample pretreatment: individual sample preparation with reference to analytes and matrix
Column conditioning: 5 ml methanol
Equilibration: 5 ml acidified water
Sample application: slowly aspirate sample through the column
Washing 1: 2 ml acidified water
Washing 2 / Elution 1: 2 ml methanol (neutral and acidic compounds), if necessary, further washing steps
Elution 2: after drying 2 x 2 ml methanol / 1 – 5 % formic acid (strongly basic compounds)

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

MN Appl. No. 305300

Analysis of perfluorinated

Column: 125 x 2 mm NUCLEODUR® Sphinx RP, 3 µm
Eluent: A) 10 mM NH_4Ac in water – methanol (75:25, v/v);
B) 10 mM NH_4Ac in acetonitrile – methanol (75:25, v/v)
Gradient: 10 – 30 % B in 3 min, 30 – 55 % B in 8 min, 55 – 10 % B in 4 min
Flow rate: 0.30 ml/min, temperature 50 °C
Inj. volume: 2.5 µl (5 mg/l each after SPE enrichment)
Detection: MS, ESI negative



MN Appl. No. 123340

Ordering information

	Volume	Adsorbent weight					Pack of
	CHROMABOND® HR-XCW polypropylene columns						
		30 mg	60 mg	100 mg	150 mg	200 mg	500 mg	
	1 ml	**730731**		**730733**				30
	3 ml		**730735**			**730739**	**730741**	30
	6 ml				**730737**		**730743**	30
	CHROMAFIX® HR-XCW cartridges						
	Size	**S**		**M**			**L**	
	adsorbent weight ∅	155 mg		240 mg			500 mg	
		731774		**731775**			**731776**	50
	CHROMABOND® HR-XCW adsorbent							
							730674	100 g

Polymer-based ion exchangers for SPE

HR-XAW

NEW!

- weak basic secondary and tertiary ammonium anion exchanger, exchange capacity >0.5 meq/g, pKa ~ 6
- base material spherical PS/DVB copolymer
  pH stability 1 – 14
- high purity material with highest reproducibility and lowest blank values due to an optimised production process
- spherical particles size 85 µm; pore size 55 – 65 Å
  very large specific surface 850 m^2/g; pore volume 1.2 – 1.4 cm^3/g
  RP capacity 350 mg/g (caffeine in water)
- outstanding recovery rates especially for enrichment of acidic analytes

weak anion exchanger

- recommended application:
  perfluorinated surfactants
  acidic compounds like sulfonates
  active ingredients from heavily matrix-contaminated samples like e.g. urine, plasma, serum
  strong acids with **pKa < 1**

surfactants from water

Column type:
CHROMABOND® HR-XAW / 3 ml / 6 mg
REF 730747

Sample: 500 ml water, spiked with 1 ml standard solution (20 µg/l of each compound)
Conditioning: 2 ml methanol + 5 % ammonia, then 2 ml methanol, finally 2 ml water
Sample application: slowly aspirate sample through the column
Washing: 2 ml water, then 2 ml acetone – acetonitrile – formic acid (50:50:1, v/v/v), finally 2 ml methanol
Elution: 2 ml methanol with 5 % ammonia

Further analysis: evaporate to dryness in a stream of nitrogen under slight heating, and redissolve in a suitable solvent for HPLC

Recovery rates [%]:

Compound	Recovery
1 Perfluoropropionic acid (PFPrA)	103
2 Perfluoropentanoid acid (PFPeA)	94
3 Perfluorohexanoic acid (PFHxA)	94
4 Perfluorooctanoic acid (PFOA)	95
5 Perfluorooctane sulfonate K salt (PFOS)	81
6 Perfluorododecanoid acid (PFDoDA)	82

MN Appl. No. 305140

For an application in accordance with DIN 38407-42 see Appl. No. 305141 at *www.mn-net.com/apps.*

impregnated with fluorosurfactants?

Standard protocol for CHROMABOND® HR-XAW

Column type:
CHROMABOND® HR-XAW / 3 ml / 200 mg
REF 730748

Sample pretreatment: individual sample preparation with reference to analytes and matrix
Conditioning: 5 ml methanol
Equilibration: 5 ml water
Sample application: slowly aspirate sample through the column
Washing 1: 25 mM ammonium acetate
Washing 2 / Elution 1: 2 ml methanol (neutral and basic compounds), if necessary, further washing steps
Elution 2: after drying 2 x 2 ml methanol / 1 – 5 % ammonia (strongly acidic compounds)

Further analyses: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

MN Appl. No. 305200

Solid Phase Extraction

Ordering information

CHROMABOND® HR-XAW polypropylene columns

Volume	30 mg	60 mg	100 mg	150 mg	200 mg	500 mg	Pack of
1 ml	**730728**		**730729**				30
3 ml		**730747**			**730748**	**730744**	30
6 ml				**730749**		**730745**	30

CHROMAFIX® HR-XAW cartridges

Size	S	M	L	
Adsorbent weight ∅	155 mg	240 mg	500 mg	
	731771	**731772**	**731773**	50

CHROMABOND® HR-XAW adsorbent

			730673	100 g

Polymer-based reversed phases for SPE

Easy polar, bifunctionally modified polystyrene-divinylbenzene copolymer

- polar modified polystyrene-divinylbenzene copolymer with a weak anion exchanger

  specific surface 650 – 700 m^2/g, particle size 80 µm, pore size 50 Å, pH stability 1 – 14

The Easy effect:

- without preconditioning
- due to bifunctional modification much more hydrophilic than conventional polystyrene-divinylbenzene polymers
- easily wettable with water

- recommended application:

  polar herbicides / pesticides from water (acidic, neutral, basic)
  polar phenols from water
  polyaromatic compounds
  polychlorinated biphenyls
  drug analysis from urine, blood, serum, plasma, pharmaceuticals / active ingredients from tablets, creams

Recovery of pesticides

Private communication: Mr. Kühn, GUB, Waldshut Tiengen, Germany

Column type:
CHROMABOND® Easy/ 3 ml / 200 mg
REF 730754
Column conditioning:
1 ml water, 3 ml methanol, 1 ml water
Sample application: aspirate the sample through the column
Elution: 3 x 1 ml acetone

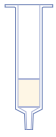
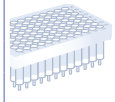
Further analysis:
HPLC with NUCLEOSIL® 120-5 C_{18}

MN Appl. No. 303220

Recovery rates [%]:

Compound	Recovery	Compound	Recovery
Desisopropylatrazine	90	Metalaxyl	96
2,6-Dichlorobenzamide	93	Isoproturon	94
Desethylatrazine	93	Diuron	94
Hexazinone	69	Metazachlor	97
Terbacil	65	Propazine	95
Simazine	81	Terbuthylazine	93
Cyanazine	93	Linuron	96
Desethylterbuthylazine	91	Metolachlor	97
Methabenzthiazuron	94	Triallate	61
Chlortoluron	91	Standard	64
Atrazine	92		

Ordering information

	Volume	Adsorbent weight					Pack of
	**CHROMABOND® Easy polypropylene columns**						
		30 mg	60 mg	100 mg	200 mg	500 mg	1 g	
	1 ml	**730751**		**730752**				30
	3 ml		**730753**		**730754**	**730759**		30
	6 ml				**730755**	**730756**		30
	15 ml					**730757**	**730758**	20
	CHROMABOND® Easy polypropylene columns · BIGpacks						
					200 mg			
	3 ml				**730754.250**			250
	6 ml				**730755.250**			250
	**CHROMABOND® LV-Easy**						
					200 mg			
	15 ml				**732472**			30
	**CHROMABOND® MULTI 96 Easy**						
		96 x 25 mg		96 x 50 mg		96 x 100 mg		
		738520.025M		**738520.050M**		**738520.100M**		1
	**CHROMABOND® Easy adsorbent**						
						730661		20 g

Glass columns on request.

HR-P

polystyrene-divinylbenzene adsorbent resin

- highly porous polystyrene-divinylbenzene copolymer
  specific surface 1200 m^2/g
  particle size 50 – 100 µm
  very high binding capacity, up to 30% of adsorbent weight (for comparison: silica adsorbents about 3%)
- recommended application:
  aromatic compounds
  phenols from water
  nitroaromatics from water
  pesticides from water
  PAHs from oil

Aromatic amines from water samples

Private communication M. Leß, T.C. Schmidt, Department of Chemistry, University Marburg, 1997

Compounds investigated: aromatic amines
Column type:
CHROMABOND® HR-P / 3 ml / 200 mg
REF 730108
Sample pretreatment: adjust to pH 9 using 10 mol/l NaOH
Column conditioning: 2 ml each of methanol, acetonitrile and 10^{-5} mol/l sodium hydroxide

Sample application:
aspirate sample through the column with about 10 ml/min
Column washing:
wash with 2 ml dist. water, dry 5 min under vacuum
Elution: 3 x 1 ml methanol – acetonitrile (1:1; v/v)

For recovery rates of numerous aromatic amines please see application 301810 at *www.mn-net.com*.

MN Appl. No. 301810

Ordering information

CHROMABOND® HR-P polypropylene columns

Volume	100 mg	200 mg	500 mg	1 g	Pack of
1 ml	**730280**				30
3 ml		**730108**	**730117**		30
6 ml		**730119**	**730111**	**730118**	30

CHROMABOND® HR-P polypropylene columns · BIGpack

Volume	200 mg	Pack of
3 ml	**730108.250**	250

CHROMABOND® HR-P glass columns

Volume	200 mg	500 mg	1 g	Pack of
3 ml	**730108G**			30
6 ml		**730111G**	**730118G**	30

CHROMABOND® LV-HR-P

Volume	200 mg	Pack of
15 ml	**732108**	30

CHROMAFIX® HR-P cartridges

Size	S	M	L	
Adsorbent weight ∅	200 mg	330 mg	680 mg	
	731839	**731840**	**731841**	50

CHROMABOND® MULTI 96 HR-P

	96 x 100 mg	
	738111.100M	1

CHROMABOND® HR-P adsorbent

	730615	20 g

Polymer-based phases for SPE

PS-RP / PS-OH⁻ / PS-H⁺ / PS-Mix PS-Ag⁺ / PS-Ba²⁺

phases for RP / ion chromatography

- base material: high purity polystyrene-divinylbenzene copolymers (PS/DVB), pore size 100 Å, particle size 100 µm

  very low degree of swelling, thus very well suited for chromatography

  reliable function over the whole pH range from 0 – 14

  different modifications for different applications from elimination of nonpolar compounds up to the removal of specific polar components

- recommended application:

  removal of interfering compounds
  → improves chromatographic separation, if the interfering components overlap with the analyte in the chromatogram
  → improves lifetime of the chromatographic column, since interfering components can irreversibly block the column packing

  enrichment of the analytes

Properties of the individual modifications:

PS-RP	hydrophobic PS/DVB copolymer	removal of organic interfering components from water
PS-OH⁻	strong PS/DVB anion exchanger, OH⁻ form capacity 0.6 meq/g	removal or concentration of anions from water increasing the pH value in acidic samples
PS-H⁺	strong PS/DVB cation exchanger, H⁺ form capacity 2.9 meq/g	removal or concentration of cations from water decreasing the pH value of basic samples
PS-Mix	mixture of PS-OH⁻ and PS-H⁺	desalting of water
PS-Ag⁺	strong PS/DVB cation exchanger, Ag⁺ form	removal of halide ions from water
PS-Ba²⁺	strong PS/DVB cation exchanger, Ba²⁺ form	removal of sulphate ions from water

Application 301930/302750: removal of halides from aqueous samples shown for the trace analysis of nitrate besides an excess of chloride or bromide

Compouds investigated: 20 ppm nitrate besides 2500 ppm chloride or 500 ppm bromide, respectively

Column type:
CHROMAFIX® PS-Ag⁺ (M)
0.8 ml / ∅ 480 mg, REF 731865

Column conditioning: 1 ml dist. water

Sample application and elution:
apply 4 x 1 ml sample fractions to the cartridge, discard 1st ml, collect 2nd, 3rd and 4th ml separately

Further analysis: HPLC with column 250 x 4 mm NUCLEOSIL® Anion II; eluent 2 mM potassium hydrogen phthalate pH 6, 2 ml/min; detection: indirect UV, 280 nm (see applications 110440 and 110450 at *www.mn-net.com*)

Ordering information

CHROMABOND® PS polypropylene columns

Phase	Volume / Adsorbent weight				Pack of
	3 ml 200 mg	3 ml 500 mg	6 ml 500 mg	6 ml 900 mg	
PS-RP	**730765**	**730692**	**730693**		30
PS-OH⁻	**730396**	**730344**	**730378**		30
PS-H⁺	**730690**	**730376**	**730377**		30
PS-Mix				**730310**	30

CHROMAFIX® PS cartridges

Phase	Size **S**	Adsorbent weight ∅	Size **M**	Adsorbent weight ∅	Size **L**	Adsorbent weight ∅	Pack of
PS-RP	**731877**	200 mg	**731875**	320 mg			50
PS-OH⁻	**731868**	200 mg	**731860**	380 mg	**731862**	800 mg	50
PS-H⁺	**731867**	230 mg	**731861**	430 mg	**731863**	900 mg	50
PS-Ag⁺	**731866**	240 mg	**731865**	480 mg			50
PS-Ba²⁺	**731871**	280 mg	**731870**	550 mg			50

C_{18} ec / C_{18} ec f (f = fast flow)

octadecyl silica, endcapped

- base material silica, pore size 60 Å, particle size 45 µm for **C_{18} ec**, 100 µm for **C_{18} ec f** (for fast flow), specific surface 500 m^2/g, pH stability 2 – 8
- octadecyl phases, endcapped, carbon content 14%
- very nonpolar, hydrophobic interactions with a wide variety of organic compounds
- advantageous for clean-up of samples with large structural variations (polarity differences)
- recommended application:
  nonpolar compounds
  aflatoxins, amphetamines, antibiotics, antiepileptics, barbiturates, caffeine, drugs, preservatives, fatty acids, nicotine, PAHs, pesticides, PCBs, heavy metals, vitamins
- very well suited for desalting of samples
- **C_{18} ec f** for viscous samples

Ordering information

CHROMABOND® C_{18} ec polypropylene columns

Volume	100 mg	200 mg	500 mg	1 g	2 g	5 g	10 g	Pack of
1 ml	**730011**							100
3 ml		**730012**	**730013**					50
6 ml			**730014**	**730015**	**730141**			30
15 ml					**730404**			20
45 ml						**730405**		20
70 ml							**730259**	10

CHROMABOND® C_{18} ec polypropylene columns · BIGpacks

Volume	500 mg	1 g	Pack of
3 ml	**730013.250**		250
6 ml	**730014.250**	**730015.250**	250

CHROMABOND® C_{18} ec glass columns

Volume	200 mg	500 mg	1 g	Pack of
3 ml	**730012G**	**730013G**		50
6 ml		**730014G**	**730015G**	30

CHROMABOND® LV-C_{18} ec

Volume	200 mg	500 mg	Pack of
15 ml	**732012**	**732013**	30

CHROMAFIX® C_{18} ec cartridges

Size	S	M	L	
Adsorbent weight ∅	270 mg	530 mg	950 mg	
	731804	**731805**	**731806**	50

CHROMABOND® MULTI 96 C_{18} ec

96 x 25 mg	96 x 50 mg	96 x 100 mg	
738011.025M	**738011.050M**	**738011.100M**	1

CHROMABOND® C_{18} ec adsorbent

		730611	100 g

CHROMABOND® C_{18} ec f polypropylene columns (fast flow)

Volume	200 mg	500 mg	1 g	Pack of
3 ml	**730269**	**730018**		50
6 ml		**730016**	**730010**	30

CHROMABOND® C_{18} ec f adsorbent (fast flow)

		730613	100 g

Silica-based reversed phases for SPE

C_{18} / C_{18} f (f = fast flow)

octadecyl silica

- base material silica, pore size 60 Å, particle size 45 µm for **C_{18}**, 100 µm for **C_{18} f** (for fast flow), specific surface 500 m^2/g, pH stability 2 – 8
  octadecyl phases, not endcapped, carbon content 14%
  similar to C_{18} ec, however possesses more free silanols (SiOH), which allow secondary interactions with polar groups of the analytes
- recommended application:
  nonpolar compounds
  pesticides
  C_{18} f for viscous samples

Ordering information

CHROMABOND® C_{18} polypropylene columns

Volume	100 mg	200 mg	500 mg	1 g	2 g	5 g	10 g	Pack of
1 ml	**730001**							100
3 ml		**730002**	**730003**					50
6 ml			**730004**	**730005**	**730130**			30
15 ml					**730028**			20
45 ml						**730400**		20
70 ml							**730261**	10

CHROMABOND® C_{18} polypropylene columns · BIGpacks

Volume	500 mg	1 g	Pack of
3 ml	**730003.250**		250
6 ml	**730004.250**	**730005.250**	250

CHROMABOND® C_{18} glass columns

Volume	500 mg	1 g	Pack of
3 ml	**730003G**		50
6 ml	**730004G**	**730005G**	30

CHROMABOND® LV-C_{18}

Volume	200 mg	Pack of
15 ml	**732002**	30

CHROMAFIX® C_{18} cartridges

Size	S	M	L	
Adsorbent weight ∅	270 mg	530 mg	950 mg	
	731801	**731802**	**731803**	50

CHROMABOND® MULTI 96 C_{18}

	96 x 25 mg	96 x 100 mg	
	738001.025M	**738001.100M**	1

CHROMABOND® C_{18} adsorbent

	730602	100 g

CHROMABOND® C_{18} f polypropylene columns (fast flow)

Volume	200 mg	500 mg	1 g	Pack of
3 ml	**730402**	**730008**		50
6 ml		**730403**	**730009**	30

CHROMABOND® C_{18} f adsorbent (fast flow)

	730612	100 g

C_{18} Hydra

octadecyl silica for polar analytes

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8

  special octadecyl phase for polar analytes, not end-capped, carbon content 15 %

- recommended application:

  more polar compounds like pesticides and their polar degradation products, phenols, phenoxycarboxylic acids, nitroaromatics, pharmaceuticals

Pesticides from water

Compounds investigated: triazines and carboxylic amides

Column type:
CHROMABOND® C_{18} Hydra / 6 ml / 2 g
REF 730301

Sample pretreatment: adjust 1000 ml water to pH 7 – 8 with diluted NH_3 and add 100 µl of the internal standards (1 µg/l).

Column conditioning: 2 x 5 ml methanol, then 2 x 5 ml dist. water

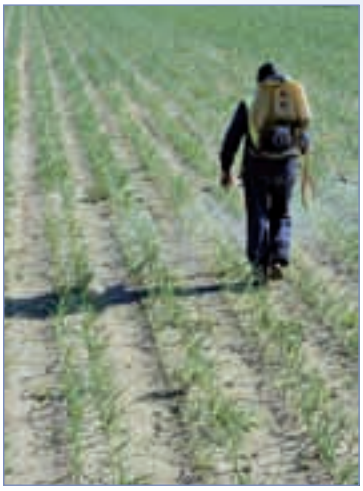
Sample application: force or aspirate the sample through the column. Then dry for 2 h with 2 bar N_2.

Elution: slowly aspirate 10 ml methanol through the column. Evaporate the eluate to dryness in a tapered flask with a rotation evaporator at 30 °C and store in a refrigerator for ~ 15 min. Redissolve the residue in 200 µl cold, fresh *n*-hexane and transfer the solution to a conic HPLC vial (e.g. REF 702891). Store the solution in a refrigerator until chromatography.

Recovery rates: between 95 and 100 %

Further analysis: GC with OPTIMA® δ-3 or OPTIMA® δ-6 (e.g. application 250420) or HPLC in accordance with EN ISO 11369: 1997 on NUCLEOSIL® 120-3 C_{18} (application 110880)

MN Appl. No. 302060



Ordering information

CHROMABOND® C_{18} Hydra polypropylene columns

Volume	50 mg	100 mg	200 mg	500 mg	1 g	2 g	3 g	Pack of
1 ml	**730294**	**730295**						100
3 ml			**730296**	**730297**	**730298**			50
6 ml				**730299**	**730300**	**730301**	**730302**	30

CHROMABOND® C_{18} Hydra glass columns

Volume	200 mg	500 mg	1 g	Pack of
3 ml	**730296G**	**730297G**	**730298G**	50
6 ml		**730299G**	**730300G**	30

CHROMABOND® LV-C_{18} Hydra

Volume	200 mg	Pack of
15 ml	**732295**	30

CHROMAFIX® C_{18} Hydra cartridges

Size	S	M	L	
Adsorbent weight ∅	270 mg	530 mg	950 mg	
	731730	**731731**	**731732**	50

CHROMABOND® MULTI 96 C_{18} Hydra

96 x 100 mg	
738294.100M	1

CHROMABOND® C_{18} Hydra adsorbent

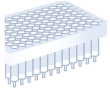
730628	100 g

Silica-based reversed phases for SPE

C_8 — octyl silica

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  octyl phase, not endcapped, carbon content 8 %
  similar to C_{18}, however slightly more polar
  secondary interactions with polar compounds are more pronounced due to shorter alkyl chains
- recommended application:
  pesticides, PCB

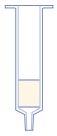
Ordering information

	Volume	Adsorbent weight				Pack of
	**CHROMABOND® C_8 polypropylene columns**					
		100 mg	200 mg	500 mg	1 g	
	1 ml	**730021**				100
	3 ml		**730022**	**730023**		50
	6 ml			**730024**	**730134**	30
	CHROMABOND® C_8 glass columns					
				500 mg		
	6 ml			**730024G**		30
	**CHROMABOND® LV-C_8**					
				500 mg		
	15 ml			**732023**		30
	**CHROMAFIX® C_8 cartridges**					
	Size			**M**		
	Adsorbent weight ∅			520 mg		
				731808		50
	**CHROMABOND® MULTI 96 C_8**					
					96 x 100 mg	
					738021.100M	1
	**CHROMABOND® C_8 adsorbent**					
					730601	100 g

C_4 butyl silica

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  butyl phase, not endcapped, carbon content 7%
  slightly more polar than C_{18} or C_8,
  due to shorter alkyl chains the silica surface is not completely shielded
- recommended application:
  compounds, which are too strongly retained on C_{18} or C_8
  e.g. analgetics from blood

Ordering information

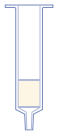
	Volume	Adsorbent weight			Pack of
	**CHROMABOND® C_4 polypropylene columns**				
		100 mg	500 mg		
	1 ml	**730225**			100
	3 ml		**730227**		50
	**CHROMAFIX® C_4 cartridges**				
	Size	**S**	**M**		
	Adsorbent weight ∅	220 mg	440 mg		
		731740	**731741**		50
	**CHROMABOND® C_4 adsorbent**				
				730651	100 g

Glass columns, LV columns and MULTI 96 on request.

C_2 dimethyl silica

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  dimethyl phase, not endcapped, carbon content 4%
  similar to C_4
- recommended application:
  e.g. antiepileptics from plasma

Ordering information

	Volume	Adsorbent weight			Pack of
	**CHROMABOND® C_2 polypropylene columns**				
		100 mg	500 mg	1 g	
	1 ml	**730169**			100
	3 ml		**730221**		50
	6 ml		**730409**	**730410**	30
	**CHROMABOND® C_2 adsorbent**				
				730652	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

Silica-based reversed phases for SPE

C_6H_{11} ec

cyclohexyl silica, endcapped

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  cyclohexyl phase, endcapped, carbon content 9%
  alternative phase for the mid-polar range
- recommended application:
  phenols from water
  chloroanilines from waste water
  anthelmintics from tissue

Comparison of different phases for phenol analysis

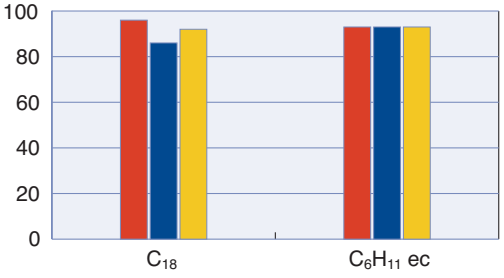
Compounds investigated: phenol, 2,4-dinitrophenol, pentachlorophenol

Column types:
CHROMABOND® C_{18} / 6 ml / 2000 mg, REF 730130
CHROMABOND® C_6H_{11} ec / 6 ml / 2000 mg, REF 730469

Column conditioning:
10 ml acetone, 10 ml methanol, and 10 ml dist. water (pH 2)

Sample application:
aspirate the sample through the column.

Elution: 10 ml methanol



phenol 2,4-dinitrophenol pentachlorophenol

MN Appl. No. 302150

Ordering information

	Volume	Adsorbent weight		Pack of
	CHROMABOND® C_6H_{11} ec polypropylene columns			
		500 mg	1 g	
	3 ml	**730442**		50
	6 ml	**730443**	**730444**	30
	CHROMABOND® C_6H_{11} ec adsorbent			
			730631	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

For further applications on CHROMABOND® phases see our online application database at

www.mn-net.com/apps

C_6H_5 — phenyl silica

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  phenyl phase, carbon content 8%
  polarity similar to C_8
  in addition to hydrophobic interactions more selective adsorption is possible by π–π interactions due to the electron density of the phenyl ring

- recommended application:
  aflatoxins
  caffeine
  phenols

Flavour compounds from brandy

Compounds investigated: asarone, quinine, coumarin, quassinl

Column type:
CHROMABOND® C_6H_5 / 6 ml / 1000 mg
REF 730412

Sample pretreatment:
mix 10 ml sample with 90 ml water and 10 g sodium chloride and adjust to pH 7 with 0.1 mol/l sodium hydroxide solution

Column conditioning:
10 ml methanol, then 10 ml dist. water

Sample application:
slowly force or aspirate the sample through the column

Column washing:
2.5 ml water, then 2.5 ml pentane

Elution:
1) 2 x 2.5 ml pentane – diethyl ether (7:3, v/v): asarone, coumarin
2) 10 ml 1 mol/l basic methanol – diethyl ether (9:1, v/v): quinine
3) 5 ml chloroform: quassin

MN Appl. No. 300170

Ordering information

Volume	Adsorbent weight			Pack of
CHROMABOND® C_6H_5 polypropylene columns				
	100 mg	200 mg	500 mg	
1 ml	**730083**			100
3 ml		**730411**	**730084**	50
CHROMABOND® C_6H_5 adsorbent				
			730606	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

Silica-based normal phases for SPE

CN

cyanopropyl silica

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  cyanopropyl phase, carbon content 5.5 %
  polar to mid-polar
  in addition to weak hydrophobic interactions selective interactions are possible due to the high electron density of the CN group
- recommended application:
  cyclosporins
  carbohydrates

Ordering information

Volume	Adsorbent weight				Pack of
CHROMABOND® CN polypropylene columns					
	100 mg	200 mg	500 mg		
1 ml	**730061**				100
3 ml		**730420**	**730063**		50
6 ml			**730421**		30
CHROMABOND® CN adsorbent					
				730607	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

OH

diol silica

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  diol phase, carbon content 5.5 %
  polar
  properties similar to SiOH
- recommended application:
  antibiotics
  prostaglandins

Ordering information

Volume	Adsorbent weight				Pack of
CHROMABOND® OH polypropylene columns					
	100 mg	200 mg	500 mg		
1 ml	**730051**				100
3 ml		**730417**	**730053**		50
6 ml			**730418**		30
CHROMABOND® OH adsorbent					
				730605	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

NH_2 — aminopropyl silica

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  aminopropyl phase, carbon content 3.5 %
  polar, weak anion exchanger
- recommended application:
  trace elements
  lipids

Metals: trace elements from water

Compounds investigated: Al, Be, Cu, Cr(VI), Mo(VI), V(V)

Column type:
CHROMABOND® NH_2 / 3 ml / 500 mg
REF 730033

Sample pretreatment:
mix 100 ml water sample with 5 ml 0.001 % alizarinsulphonic acid solution and adjust to pH 5.5 with acetic acid or sodium acetate

Column conditioning:
2 column volumes 1 mol/l nitric acid, then 2 column volumes dist. water

Sample application:
force or aspirate sample through the column with 3 – 4 ml/min

Column washing:
2 ml dist. water; dry column under vacuum for 4 min

Elution:
2 column volumes 2 mol/l nitric acid

MN Appl. No. 301910

Ordering information

Volume	Adsorbent weight				Pack of
CHROMABOND® NH_2 polypropylene columns					
	100 mg	200 mg	500 mg	1 g	
1 ml	**730031**				100
3 ml		**730413**	**730033**		50
6 ml			**730180**	**730626**	30
CHROMABOND® NH_2 polypropylene columns · BIGpack					
			500 mg		
3 ml			**730033.250**		250
CHROMABOND® NH_2 glass columns					
			500 mg	1 g	
3 ml			**730033G**		50
6 ml			**730180G**	**730626G**	30
CHROMABOND® LV-NH_2					
			500 mg		
15 ml			**732033**		30
CHROMAFIX® NH_2 cartridges					
Size		**S**			
Adsorbent weight ∅		220 mg			
		731813			50
CHROMABOND® MULTI 96 NH_2					
				96 x 100 mg	
				738031.100M	1
CHROMABOND® NH_2 adsorbent					
				730603	100 g

Silica-based normal phases for SPE

SiOH

unmodified silica

- unmodified, weakly acidic silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8

  very polar

  adsorbs humidity from air, for this reason it should be kept well closed and if necessary dried before use

  due to its high affinity for polar compounds it should not be conditioned with polar (e. g. methanol) or water-containing solvents

- recommended application:

  aflatoxins
  chloramphenicol
  pesticides
  steroids
  vitamins

Ordering information

CHROMABOND® SiOH polypropylene columns

Volume	100 mg	200 mg	500 mg	1 g	2 g	5 g	10 g	50 g	Pack of
1 ml	**730071**								100
3 ml		**730214**	**730073**						50
6 ml			**730070**	**730075**	**730107**				30
15 ml					**730217**				20
45 ml						**730406**			20
70 ml							**730072**		10
150 ml								**730473**	10

CHROMABOND® SiOH polypropylene columns · BIGpacks

Volume	500 mg	1 g	2 g	Pack of
3 ml	**730073.250**			250
6 ml		**730075.250**	**730107.250**	250

CHROMABOND® SiOH glass columns

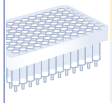
Volume	200 mg	500 mg	1 g	2 g	Pack of
3 ml	**730214G**	**730073G**			50
6 ml		**730070G**	**730075G**	**730107G**	30

CHROMABOND® LV-SiOH

Volume	200 mg	500 mg	Pack of
15 ml	**732072**	**732073**	30

CHROMAFIX® SiOH cartridges

Size	S	M	L	
Adsorb. weight ∅	230 mg	420 mg	880 mg	
	731828	**731829**	**731830**	50



CHROMABOND® MULTI 96 SiOH

96 x 100 mg	
738071.100M	1

CHROMABOND® SiOH adsorbent

730608	100 g

Alox A / Alox N / Alox B — aluminium oxide, acidic, neutral, basic

- aluminium oxide, high purity, pore volume 0.90 ml/g, particle size 60 – 150 µm, specific surface 150 m^2/g
- recommended application: together with phase SA for PCB and pesticides

Properties of the individual modifications:

Alox A:	aluminium oxide, acidic	pH value 4 ± 0.5
Alox N:	aluminium oxide, neutral	pH value 7 ± 0.5
Alox B:	aluminium oxide, basic	pH value 9.5 ± 0.5

Ordering information

Phase	Volume	Adsorbent weight			Pack of
CHROMABOND® Alox polypropylene columns					
		500 mg	1 g	4 g	
Alox A	3 ml	**730452**			50
Alox A	6 ml	**730453**	**730017**		30
Alox A	45 ml			**730455**	20
Alox N	3 ml	**730446**			50
Alox N	6 ml	**730447**	**730139**		30
Alox N	45 ml			**730250**	20
Alox B	3 ml	**730429**			50
Alox B	6 ml	**730466**	**730020**		30
Alox B	45 ml			**730467**	20
CHROMABOND® Alox glass columns					
			1 g		
Alox N	6 ml		**730139G**		30
Alox B	6 ml		**730020G**		30
CHROMABOND® LV-Alox					
			1 g		
Alox A	15 ml		**732210**		30
Alox N	15 ml		**732091**		30
Alox B	15 ml		**732205**		30
CHROMAFIX® Alox cartridges					
	Size	**M**		**L**	
	Adsorb. weight ∅	850 mg		1700 mg	
Alox N		**731844**		**731845**	50
CHROMABOND® MULTI 96 Alox					
				96 x 100 mg	
Alox A				**738253.100M**	1
Alox N				**738251.100M**	1
Alox B				**738252.100M**	1
CHROMABOND® Alox adsorbents					
Alox A				**730642**	100 g
Alox N				**730641**	100 g
Alox B				**730640**	100 g

Normal phases for SPE

Florisil®

magnesium silicate

- matrix magnesium silicate (MgO – SiOH 15:85), high purity, particle size 150 – 250 µm
- recommended application: organic tin compounds, aliphatic carboxylic acids, PCBs, PAHs

Ordering information

	Volume	Adsorbent weight				Pack of
	CHROMABOND® Florisil® polypropylene columns					
		200 mg	500 mg	1 g	2 g	
	3 ml	**730457**	**730081**			50
	6 ml		**730238**	**730082**	**730239**	30
	CHROMABOND® Florisil® polypropylene columns · BIGpack					
				1 g		
	6 ml			**730082.250**		250
	CHROMABOND® Florisil® glass columns					
				1 g	2 g	
	6 ml			**730082G**	**730239G**	30
	CHROMAFIX® Florisil® cartridges					
	Size			**L**		
	Adsorbent weight ∅			990 mg		
				731848		50
	CHROMABOND® Florisil® adsorbent					
				730622		100 g

LV columns and MULTI 96 on request.

PA

polyamide 6

- matrix polyamide 6, unmodified, high purity, particle size 40 – 80 µm
- recommended application: flavonoids, PAHs

Ordering information

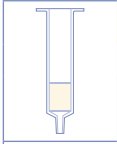
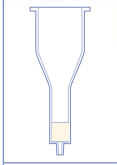
	Volume	Adsorbent weight				Pack of
	CHROMABOND® PA polypropylene columns					
		200 mg	500 mg	1 g		
	3 ml	**730384**	**730126**			50
	6 ml		**730007**	**730127**		30
	CHROMAFIX® PA cartridges					
	Size	**S**		**L**		
	Adsorbent weight ∅	170 mg		620 mg		
		731849		**731851**		50
	CHROMABOND® PA adsorbent					
				730660		100 g

Glass columns, LV columns and MULTI 96 on request.

PCA propylcarboxylic acid cation exchanger based on silica

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  propylcarboxylic acid modified silica
  weakly acidic cation exchanger (WCX)
- recommended application:
  strong cations

Ordering information

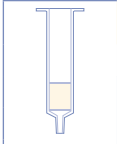
	Volume	Adsorbent weight			Pack of
	**CHROMABOND® PCA polypropylene columns**				
		500 mg	1 g		
	3 ml	**730482**			50
	6 ml	**730483**	**730484**		30
	**CHROMABOND® LV-PCA**				
		500 mg			
	15 ml	**732482**			30
	**CHROMABOND® PCA adsorbent**				
				730629	100 g

Glass columns, CHROMAFIX® cartridges and MULTI 96 on request.

PSA propylsulphonic acid cation exchanger based on silica

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  propylsulphonic acid modified silica
  very strong cation exchanger (capacity ~ 0.7 meq/g)
  contrary to the SA phase no π–π interactions
- recommended application:
  weak cations

Ordering information

	Volume	Adsorbent weight			Pack of
	**CHROMABOND® PSA polypropylene columns**				
		100 mg	500 mg	1 g	
	1 ml	**730460**			100
	3 ml		**730462**		50
	6 ml			**730464**	30
	**CHROMABOND® PSA adsorbent**				
				730630	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

Silica-based ion exchangers for SPE

SA benzenesulphonic acid cation exchanger based on silica (SCX)

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  benzenesulphonic acid modified silica
  strongly acidic cation exchanger (capacity ~ 0.5 meq/g)
  adsorbent with hydrophobic and π–π interactions (benzene ring)
  ion exchange of organic compounds from aqueous matrix
  elution of interesting compounds with solvent systems, which compensate the ionic and nonpolar interactions, e.g. methanolic HCl
- recommended application:
  amino acids
  amines
  chlorophyll
  PCB

Sulfonamides in meat and kidney

B. Pacciarelli et al., Mitt. Gebiete Lebensm. Hyg. 82 (1991) 45 – 55

Compounds investigated: sulfaguanidine, sulfanilamide, sulfadiazine, sulfathiazole, sulfapyridine, sulfamerazine, sulfamethizole, sulfadimidine, sulfamethoxypyridazine, sulfachlorpyridazine, sulfadoxine, sulfadimethoxine

Column type:
CHROMABOND® SA (≡ SCX) / 3 ml / 500 mg
REF 730077

Sample pretreatment: homogenise 10 g sample and 60 ml dichloromethane – acetone (1:1, v/v) for 30 s with a Polytron. Centrifuge the homogenisate for 10 min at 2500 rpm. Filter the organic phase and wash the filter residue with a little dichloromethane – acetone. Add 5 ml glacial acetic acid to the filtered extract.

Column conditioning: apply 6 ml hexane and suck air until the column is dry (10 min). Then apply 6 ml dichloromethane – acetone – glacial acetic acid (10:10:1, v/v/v). Now the column must not run dry.

Sample application: 1/10 of the extract volume, flow rate about 2 ml/min; the column must not run dry

Column washing: 5 ml water, then 5 ml methanol; dry for 10 min under vacuum. Now suck NH_3 gas through the column until the acid is neutralised. To control the neutralisation process, press air through the column: a wet pH paper should indicate a neutral or basic pH value.

Elution: 3 ml methanol (1 – 2 ml/min); carefully concentrate the eluate on a rotation evaporator (40 °C/100 mbar), dissolve the residue in 0.5 ml of 5.5 % acetonitrile in buffer (1.641 g sodium acetate in 1 l water, adjusted to pH 5 with glacial acetic acid) and centrifuge.

Further analysis: HPLC

MN Appl. No. 302710

Ordering information

Volume	Adsorbent weight				Pack of
CHROMABOND® SA polypropylene columns					
	100 mg	200 mg	500 mg	1 g	
1 ml	**730076**				100
3 ml		**730275**	**730077**		50
6 ml			**730425**	**730212**	30
CHROMABOND® SA polypropylene columns · BIGpack					
			500 mg		
3 ml			**730077.250**		250
CHROMABOND® LV-SA					
			500 mg		
15 ml			**732083**		30
CHROMAFIX® SA cartridges					
Size	**S**		**M**	**L**	
Adsorbent weight ∅	220 mg		450 mg	920 mg	
	731831		**731832**	**731833**	50
CHROMABOND® MULTI 96 SA					
				96 x 100 mg	
				738141.100M	1
CHROMABOND® SA adsorbent					
				730609	100 g

Glass columns on request.

SB quaternary ammonium anion exchanger based on silica (SAX)

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  silica modified with quaternary amine
  strongly basic anion exchanger (capacity ~ 0.3 meq/g)
  not suited for very strong anions such as sulphonic acids, because these are difficult to elute
- recommended application:
  organic acids
  caffeine
  saccharin

Vitamins: folic acid from food (e.g. wheat germs)

Column type:
CHROMABOND® SB (≡ SAX) / 3 ml / 500 mg
REF 730079

Sample pretreatment:
homogenise 10 g food sample in 100 ml 0.01 M phosphate buffer pH 7.4 and filter

Column conditioning: 2 column volumes *n*-hexane, then 2 column volumes methanol, finally 2 column volumes dist. water

Sample application: force or aspirate 10 ml of the filtrate through the column

Column washing: 2 column volumes dist. water

Elution: 5 ml 10 % sodium chloride in 0.1 M sodium acetate buffer

MN Appl. No. 300650

Ordering information

Volume	Adsorbent weight				Pack of
CHROMABOND® SB polypropylene columns					
	100 mg	200 mg	500 mg	1 g	
1 ml	**730078**				100
3 ml		**730322**	**730079**		50
6 ml			**730426**	**730323**	30
CHROMABOND® SB polypropylene columns · BIGpack					
			500 mg		
3 ml			**730079.250**		250
CHROMABOND® LV-SB					
			500 mg		
15 ml			**732088**		30
CHROMAFIX® SB cartridges					
Size	**S**		**M**	**L**	
Adsorbent weight ∅	230 mg		460 mg	920 mg	
	731834		**731835**	**731836**	50
CHROMABOND® MULTI 96 SB					
				96 x 100 mg	
				738101.100M	1
CHROMABOND® SB adsorbent					
				730610	100 g

Glass columns on request.

Special phases for SPE · pharmaceutical applications

Drug

special silica phase for drug analysis

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  special bifunctional modification – C_8 / SA (strong cation exchanger – benzenesulphonic acid)
- recommended application:
  enrichment of acidic, neutral and basic drugs from urine or plasma

Drugs from blood serum

W. Weinmann, M. Renz, C. Pelz, P. Brauchle, S. Vogt, S. Pollak, Blutalkohol 35 (1998), 1 – 9

Compounds investigated:
benzoylecgonine, amphetamine, codeine, morphine

Column type:
CHROMABOND® Drug / 3 ml / 200 mg
REF 730168

Sample pretreatment:
0.1 ml blood serum are mixed with 1.4 ml of a 0.1 mol KH_2PO_4 buffer (pH 6) and centrifuged

Column conditioning:
2 ml methanol, then 2 ml 0.1 mol KH_2PO_4 buffer (pH 6)

Sample application:
slowly force or aspirate the supernatant from the sample pre-treatment through the column

Column washing:
2 ml 0.1 mol KH_2PO_4 buffer (pH 6), then 1 ml 0.1 mol acetic acid, then 2 ml methanol;
finally dry the column first by centrifugation (2 min, 4000 U/min), then under vacuum for 10 min

Elution:
1.5 ml dichloromethane – 2-propanol – 25 % ammonia solution (80:20:2, v/v/v)

Further analysis: HPLC with NUCLEOSIL® 100-5 C_{18} AB (application 110240) or GC/MS after derivatisation with perfluoropropanoic acid anhydride/pentafluoropropanol, e. g. with column OPTIMA® 5 MS, 0.25 mm film, 30 m x 0.25 mm ID, (REF 726220.30)

MN Appl. No. 302020

Poppy seeds as source of opiates

Ordering information

Volume	Adsorbent weight			Pack of
CHROMABOND® Drug polypropylene columns				
	100 mg	200 mg	500 mg	
1 ml	**730681**			100
3 ml		**730168**	**730684**	50
6 ml			**730682**	30
CHROMABOND® Drug polypropylene columns · BIGpack				
		200 mg		
1 ml		**730168.250**		250
CHROMABOND® LV-Drug				
		200 mg		
15 ml		**732168**		30
CHROMABOND® MULTI 96 Drug				
			96 x 100 mg	
			738161.100M	1

Drug II

extraction of THC and derivatives, acidic analytes from biological fluids (urine, blood, etc.)

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  special bifunctional modification – C_8 / SB (strong anion exchanger – quaternary amine $-NR_3^+$)
  two primary retention mechanisms facilitate use of very strong interferant-eluting solvents, resulting in very pure extracts
- recommended application:
  extraction of THC and derivatives from urine, blood, serum, plasma
  acidic analytes from biological fluids

11-nor-Δ9-THC-carboxylic acid from urine

Compounds investigated:
tetrahydrocannabinol, 11-nor-Δ9-THC-carboxylic acid

Column type:
CHROMABOND® Drug II / 3 ml / 200 mg
REF 730680

Sample pretreatment: add 300 µl 10 M potassium hydroxide solution and internal standard (for GC/MS deuterium labelled 11-nor-9-THC-carboxylic acid) to 5 ml urine. Vortex the sample and then hydrolyse at 60 °C for 15 min. Cool sample and add 200 µl glacial acetic acid and 2 ml 50 mM ammonium acetate solution. If necessary, adjust sample pH to 6 – 7.

Column conditioning: 2 ml methanol, then 2 ml dist. water; equilibrate column with 2 ml 50 mM ammonium acetate buffer

Sample application: slowly force or aspirate the sample through the column (1 – 2 ml/min)

Column washing: elute interferants with 10 ml methanol – water (1:1, v/v); dry the column for 10 min at high vacuum; further wash the column with 2 ml acetonitrile and dry for another 2 min

Elution: elute THC metabolites with 3 ml hexane – ethyl acetate – glacial acetic acid (75:25:1, v/v/v)

Further analysis: we recommend GC/MS on an OPTIMA® 5 MS column after derivatisation with 50 µl SILYL-991 (REF 701480; BSTFA – TMCS 99:1) at 70 °C / 20 min; inject 1 – 2 µl onto the GC column.

Recovery rates: 70 – 80%

MN Appl. No. 303880

Ordering information

Volume	Adsorbent weight			Pack of
CHROMABOND® Drug II polypropylene columns				
	100 mg	200 mg	500 mg	
1 ml	**730685**			100
3 ml		**730680**	**730686**	50
6 ml			**730683**	30
CHROMABOND® LV-Drug II				
		200 mg		
15 ml		**732681**		30
CHROMABOND® MULTI 96 Drug II				
			96 x 100 mg	
			738680.100M	1

SPE phases for pharmaceutical applications

Crosslinks — special phase for enrichment of collagen crosslinks

- special cellulose phase for enrichment of collagen crosslinks
- recommended application: collagen crosslinks in urine

Pyridinoline and deoxypyridinoline are collagen crosslinks occurring in bones and cartilage. If these substances are released, they can be detected in the urine. In cases of increased bone catabolism (e.g. during osteoporosis) the urine concentrations of pyridinoline and deoxypyridinoline are increased.

Pyridinium crosslinks from urine

Compounds investigated: pyridinoline, deoxypyridinoline

Column type:
CHROMABOND® Crosslinks / 3 ml, 300 mg
REF 730458

Sample pretreatment: 250 µl urine and 50 µl of an internal standard (e.g. pyridoxine) are hydrolysed in 250 µl conc. HCl at about 100 – 105 °C for 12 – 16 h. Then 2.5 ml wash solution (*n*-butanol – glacial acetic acid 80:20, v/v) are added to the hydrolysate.

Column conditioning:
5 ml of the wash solution

Sample application:
force or aspirate the pre-treated sample through the column. Discard the flow-through. Wash with 15 – 25 ml of the wash solution.

Elution:
force or aspirate 3 – 5 ml dist. water through the column

MN Appl. No. 302070

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® Crosslinks polypropylene columns		
	300 mg	
3 ml	**730458**	50

Product for research purposes only (see page 296)

Tetracycline — special phase for enrichment of tetracyclines

- silica phase with special C_{18} modification, tested for tetracyclines
  constant recovery rates for the title compounds (every batch individually tested)
- recommended application: tetracyclines from biological samples

Tetracyclines from musculature

Private communication of Mr. Lippold, Chemisches Landesuntersuchungsamt (Chem. Research Agency) Freiburg, Germany

Compounds investigated:
tetracycline, oxytetracycline, chlorotetracycline (100 – 500 mg/kg)

Column type:
CHROMABOND® Tetracycline / 6 ml / 500 mg
REF 730315

Sample pretreatment:
see detailed description in appl. 302030 at *www.mn-net.com*

Column conditioning:
1 column volume methanol, 1 column volume dist. water, then 1 column volume EDTA – succinate buffer (see above)

CAUTION: DO NOT LET THE COLUMN RUN DRY!

Sample application:
force or aspirate 50 ml of the eluate from the sample pretreatment through the CHROMABOND® column

Elution:
with 7.5 ml methanol into a 25-ml tapered flask. Add 1 ml of an ethylene glycol / methanol mixture (22 g ethylene glycol filled up to 100 ml with methanol) and evaporate to dryness with a rotation evaporator (max. 40 °C). Fill up the residue to 400 ml with 0.1 M McIlvain-EDTA buffer (52.5 g citric acid · H_2O, 44.5 g Na_2HPO_4 · H_2O and 93 g Titriplex III dissolved in 2.5 l dist. water, adjusted to pH 4 with NaOH).

Further analysis:
HPLC with column 250 x 4 mm NUCLEOSIL® 100-5 C_{18} HD, REF 721850.40 (application 110710)
Recovery rates: tetracycline, chlorotetracycline ~ 50 – 70 %, oxytetracycline ~ 60 – 80 %

MN Appl. No. 302030

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® Tetracycline polypropylene columns		
	500 mg	
6 ml	**730315**	30
Product for research purposes only (see page 296)		

AOX

AOX from waters with high salt loads (DIN 38409 – H22)

- special PS/DVB phase
- recommended application: extraction of AOX (adsorbable organically bonded halogens) from waters containing high salt loads / organic pollutants in accordance with DIN 38409 – H22

AOX from water (DIN 38409 – H 22)

Column type:
CHROMABOND® AOX / 6 ml / 500 mg
REF 730111.AOX

Column conditioning:
5 ml methanol, 10 ml dist. water.
Do not let the column run dry!

Sample application:
force or aspirate 100 ml original or diluted sample (pH 1) through the column (3 – 5 ml/min).
Do not let the column run dry!

Column washing:
50 ml nitrate rinsing solution (dissolve 17 g $NaNO_3$ in 100 ml dist. water, add 1.4 ml HNO_3 10 M, fill up to 1000 ml; take 50 ml and fill to 1000 ml with dist. water). Discard the flow-through.

Elution:
slowly aspirate 1 x 1 ml, then 1 x 4 ml methanol and 10 ml dist. water through the column.
Collect eluates in 100 ml volumetric flask and fill to 100 ml with dist. water.

MN Appl. No. 302080

Ordering information

Volume	Adsorbent weight		Pack of
CHROMABOND® AOX polypropylene columns			
	200 mg	500 mg	
6 ml	**730119.AOX**	**730111.AOX**	30

SPE phases for environmental analysis

C_{18} PAH

octadecyl silica for PAH analysis

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  special octadecyl modification for enrichment of PAH, not endcapped, carbon content 14 %
- recommended application:
  PAHs from water

PAHs from water

Column type:
CHROMABOND® C_{18} PAH / 6 ml / 2 g
REF 730166

Sample pretreatment:
mix 1000 ml water sample with 10 ml methanol

Column conditioning:
1 column volume methanol, then 1 column volume dist. water

Sample application: aspirate 1000 ml water sample through the column (~ 15 to 20 ml/min), then dry column (stream of nitrogen or 24 h in a desiccator over P_2O_5)

Elution: elute with 4 ml acetonitrile / toluene (3:1, v/v) and then evaporate or fill up to the volume required

Recovery rates: (50 ng/l per component): Naphthalene 87 %, Acenaphthylene 89 %, Acenaphthene 90 %, Fluorene 82 %, Phenanthrene 85 %, Anthracene 90 %, Fluoranthene 89 %, Pyrene 89 %, Benz[a]anthracene 87 %, Chrysene 95 %, Benzo[b] fluoranthene 91 %, Benzo[k]fluoranthene 89 %, Benzo[a]pyrene 90 %, Dibenz[ah]anthracene 97 %, Benzo[ghi]perylene 91 %, Indeno[1,2,3-cd]pyrene 96 %

MN Appl. No. 301250

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® C_{18} PAH polypropylene columns		
	2 g	
6 ml	**730166**	30
CHROMABOND® C_{18} PAH glass columns		
6 ml	**730166G**	30
CHROMABOND® C_{18} PAH adsorbent		
	730616	100 g

NH_2/C_{18}

combination phase for PAH analysis

- special combination phase:
  aminopropyl phase for removal of interfering humic acids
  octadecyl phase for enrichment of PAH
- recommended application:
  PAHs from water containing humic acids

PAHs from water containing humic acids

Column type:
CHROMABOND® NH_2/C_{18}, 6 ml, 500 mg/1 g glass column
REF 730620 G

Sample pretreatment:
mix 500 ml water sample with 25 ml 2-propanol

Column conditioning: 10 ml dichloromethane, 10 ml methanol, then 10 ml dist. water – 2-propanol (9:1, v/v)

Sample application: aspirate 500 ml prepared water sample through the column (~ 5 ml/min)

Column washing: 2 ml dist. water – 2-propanol (9:1, v/v), then dry column (about 20 min, vacuum)

Elution: 4 x 0.5 ml CH_2Cl_2 (let percolate first 0.5 ml into the column packing without vacuum, then apply light vacuum), if necessary evaporate in a stream of N_2 and fill up with a suitable solvent

MN Appl. No. 301260

Ordering information

Volume	Adsorbent weight		Pack of
CHROMABOND® NH_2/C_{18} polypropylene columns			
	500/500 mg	500 mg/1 g	
6 ml	**730618**	**730620**	30
CHROMABOND® NH_2/C_{18} glass columns			
6 ml	**730618G**	**730620G**	30

Na_2SO_4 / Florisil® hydrocarbons from water acc. to DIN H-53 / ISO DIS 9377-4

- special combination phase of sodium sulphate and Florisil®
- recommended application: hydrocarbons from drinking, surface and waste waters

Hydrocarbons from water

Column type:
CHROMABOND® Na_2SO_4/Florisil®, 2000/2000 mg, 6 ml glass column, REF 730249 G

Internal standard solution:
dissolve 20 mg *n*-tetracontane ($C_{40}H_{82}$) in petroleum ether, add 20 ml *n*-decane ($C_{10}H_{22}$) and fill up to one litre with petroleum ether. For preparation of the extraction solution dilute standard solution 1:10 with petroleum ether.

Sample pretreatment:
adjust 900 ml water (10 °C) with HCl (12 mol/l) to pH 2 and add 80 g $MgSO_4$. Add 50 ml of the extraction solution, close the bottle and stir the suspension intensely for 30 min. Add enough dist. water to separate the organic from the aqueous phase.

Column conditioning: 5 ml petroleum ether

Sample application:
slowly aspirate or force the sample through the column

Elution:
wash with 10 ml petroleum ether. Evaporate the combined solution from sample application and elution to 1 ml at about 75 °C. If necessary, fill up to 1 ml again. (If the hydrocarbon content is high, evaporation to 1 ml may not be necessary.)

Recovery rates: must be > 80 % for *n*-tetracontane.

MN Appl. No. 302090

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® Na_2SO_4 / Florisil® polypropylene columns		
	2 g/2 g	
6 ml	**730249**	30
CHROMABOND® Na_2SO_4 / Florisil® glass columns		
	2 g/2 g	
6 ml	**730249G**	30
CHROMABOND® Na_2SO_4 / Florisil® glass columns · BIGpack		
	2 g/2 g	
6 ml	**730249G.250**	250

SPE phases for environmental analysis

CN/SiOH

combination phase for PAH analysis

- special combination phase
  cyanopropyl phase for selective adsorption of polycyclic aromatics via π–π interactions
  unmodified silica phase for removal of polar compounds
- recommended application:
  extraction of the 16 PAHs according to EPA from soil samples

PAHs from soil

Column type:
CHROMABOND® CN/SiOH, 6 ml, 500/1000 mg
REF 730135

Sample pretreatment:
dry 30 g soil with sodium sulphate and reflux 4 h with 250 ml petroleum ether in a Soxhlet extractor. For low PAH contents (colourless or weakly coloured extracts) concentrate extract to 1/10 of its volume in a rotation evaporator.

Column conditioning:
4 ml petroleum ether

Sample application:
aspirate 20 ml of the extract through the column

Column washing:
2 ml petroleum ether

Elution:
2 x 2 ml acetonitrile / toluene (3:1, v/v), then evaporate or fill to the volume required

Further analysis: HPLC, e.g. with column 250 x 3 mm NUCLEOSIL® 5 C_{18} PAH, REF 720117.30
For recovery rates see application 301310 at *www.mn-net.com*

MN Appl. No. 301310

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® CN/SiOH polypropylene columns		
	500 mg/1 g	
3 ml	**730112**	50
6 ml	**730135**	30
CHROMABOND® CN/SiOH polypropylene columns · BIGpack		
	500 mg/1 g	
6 ml	**730135.250**	250
CHROMABOND® CN/SiOH glass columns		
	500 mg/1 g	
6 ml	**730135G**	30

NAN

special phase for PCB analysis

- special combination phase:
  N: sodium sulphate for removal of trace water;
  A: SiOH/$AgNO_3$ phase for removal of sulphur, sulphur-containing and polar compounds
- recommended application
  extraction of PCB from sludge

PCB from sludge

Compounds investigated: polychlorinated biphenyls (PCB)
This method can also be used for soil samples.

Column type:
CHROMABOND® NAN, 6 ml, 700/2000/700 mg
REF 730149

Sample pretreatment: extract 2 g lyophilised sludge with 70 ml *n*-hexane, evaporate extract and fill to 10 ml with *n*-hexane

Column conditioning: 10 ml *n*-hexane
Sample application: aspirate 2 ml extract into the column
Elution: slowly aspirate 40 ml *n*-hexane through the column with light vacuum, then evaporate and fill to 5 ml with *n*-hexane
Recovery rates:
PCB-28 104 %, PCB-52 100 %, PCB-101 99 %, PCB-138 98 %, PCB-153 101 %, PCB-180 98 %, PCB-209 104 %

MN Appl. No. 301400

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® NAN polypropylene columns		
	400/1400/400 mg	
3 ml	**730109**	50
6 ml		30
	700/2000/700 mg	
6 ml	**730149**	30
CHROMABOND® NAN polypropylene columns · BIGpack		
	700/2000/700 mg	
6 ml	**730149.250**	250
CHROMABOND® NAN glass columns		
	700/2000/700 mg	
6 ml	**730149G**	30
CHROMABOND® NAN adsorbent		
	730619	100 g

SA/SiOH

combination phase for PCB analysis

- special combination phase:
  SA: strongly acidic cation exchanger based on silica with benzenesulphonic acid modification
  SiOH: unmodified silica for removal of polar compounds
- recommended application:
  extraction of PCBs from waste oil (hexane extract)

PCB from waste oil

Column type:
CHROMABOND® SA/SiOH, 3 ml, 500/500 mg
REF 730132

Column conditioning: 1 ml *n*-hexane
Sample application: apply 250 µl waste oil sample to the column and aspirate or force it into the adsorbent with 2 x 1 ml *n*-hexane

MN Appl. No. 301390

Elution: aspirate or force another 2 x 500 µl *n*-hexane through the column; collect all *n*-hexane fractions and if necessary adjust to a concentration suitable for subsequent analysis by either evaporating *n*-hexane in a stream of nitrogen or by dilution with *n*-hexane
Recovery rates:
PCB 28 97 %, PCB 52 96 %. PCB 101 95 %, PCB 138 90 %, PCB 153 95 %, PCB 180 96 %, PCB 209 100 %

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® SA/SiOH polypropylene columns		
	500/500 mg	
3 ml	**730132**	50
CHROMABOND® SA/SiOH polypropylene columns · BIGpack		
	500/500 mg	
3 ml	**730132.250**	250

SPE phases for environmental analysis

SiOH-H^+/SA — combination phase for PCB analysis

- special combination phase

  SiOH-H^+: H_2SO_4-impregnated silica phase for oxidation of accompanying compounds to ionic and/or polar compounds

  SA: strongly acidic cation exchanger based on silica with benzenesulphonic acid modification for removal of ionic and sulphur-containing compounds

  This combination column is used together with a SiOH column. Both columns together are available as Kombi-Kit PCB.

- recommended application:

  extraction of PCB from oil with reference to German industrial standard DIN 51527, part 1

PCB in oil samples

determination with reference to German industrial standard DIN 51527

Column type:
CHROMABOND® SiOH-H_2SO_4/SA 3 ml, 500/500 mg and CHROMABOND® SiOH / 3 ml / 500 mg
Cat. Nos. 730085 and 730073
or Kombi-Kit PCB, REF 730125

Sample pretreatment:
extract oil-contamined solids with *n*-hexane. Homogenise other oil samples and dissolve 1.5 to 2.0 g in 50 ml *n*-hexane. Water which may cause turbidities can be removed with sodium sulphate.

Column conditioning:
let 1 ml *n*-hexane flow through the CHROMABOND® SiOH-H_2SO_4/SA column

Sample application:
aspirate or force 500 µl sample through the CHROMABOND® SiOH-H_2SO_4/SA column. This phase offers better removal of interfering substances due to sulphonation. Place CHROMABOND® SiOH-H_2SO_4/SA column on top of the SiOH column with the aid of an adaptor and after at least 30 s flush sample into the SiOH column with 2 x 1 ml *n*-hexane.

Elution:
elute SiOH column with 3 x 0.5 ml *n*-hexane; adjust to a suitable concentration for subsequent GC analysis by evaporation of *n*-hexane in a stream of nitrogen or by dilution with *n*-hexane

Recovery rates:
PCB-28 99 %, PCB-52 95 %, PCB-101 99 %, PCB-138 94 %, PCB-153 99 %, PCB-180 96 %, PCB-209 101 %

MN Appl. No. 301380

Ordering information

Volume	Adsorbent weight		Pack of
CHROMABOND® SiOH-H^+/SA polypropylene columns			
	500/500 mg		
3 ml		**730085**	50
CHROMABOND® SiOH-H^+/SA polypropylene columns · BIGpack			
	500/500 mg		
3 ml		**730085.250**	250
CHROMABOND® SiOH-H^+/SA glass columns			
	500/500 mg		
3 ml		**730085G**	50
Kombi-Kit for extraction of PCB from oil with reference to DIN 51527, part 1			
	25 columns each of CHROMABOND® SiOH-H^+/SA and CHROMABOND® SiOH	**730125**	1 kit

SPE phases for food analysis

Dry

special phase for drying of organic samples

- anhydrous high-purity sodium sulphate which forms Glauber's salt with traces of water

  for removal of larger quantities of water several cartridges can be combined in series
- recommended application:

  removal of traces of water from organic solutions

Ordering information

	Adsorbent weight			Pack of
CHROMAFIX® Dry cartridges				
Size	**S**	**M**	**L**	
Adsorbent weight ∅	780 mg	1500 mg	2800 mg	
	731852	**731853**	**731854**	50

ABC18

special phase for analysis of acrylamide in food

- octadecyl silica phase with ion exchange functions for acrylamide analysis
- recommended application:

  clean-up of acrylamide from ultra-heated starch-containing food, such as potato chips and other snacks, french fries, crispbread, cereals etc.

Important notes:

- For "Determination of Acrylamide in Foods, SPE Clean-up Procedure for LC-MS-MS" please see application 303580 at *www.mn-net.com/apps*.
- Acrylamide is created at temperatures above 100 °C from sugar and proteins, e.g. from potatoes or grain during the process of frying, baking, roasting or grilling. The formation depends on temperature, starting at 120 °C and increasing with more elevated temperatures. In cooked food, no acrylamide is found.
- Minimum concentration of acrylamide should be 70 µg/kg
- The procedure includes no concentration step.
- Acrylamide and the isotopically labelled form, is carcinogenic, mutagenic and neurotoxic.

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® ABC18 polypropylene columns		
	500 mg	
6 ml	**730533**	30

SPE phases for food analysis

Diamino special silica phase for determination of pesticides in food samples

- base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8
  Primary and **S**econdary **A**mine functions (PSA), 5 % C
  removes polar compounds (e. g. organic acids, pigments, sugars) from matrices like fruit or vegetables
  similar phases: Supelclean PSA, Bond Elut PSA
- recommended application:
  special SPE phase for quick and cheap determination of pesticides in strongly matrix-contaminated samples by GC or HPLC (**QuEChERS** method = **Qu**ick **E**asy **Ch**eap **E**ffective **R**ugged **S**afe)

QuEChERS method and pre-mixes

Within a few years after its development by Anastassiades et al. the QuEChERS method has gained a leading position for determination of pesticide residues in food samples by GC-MS or LC-MS, allowing rapid and cheap clean-up of strongly matrix-contaminated samples.

Standard clean-up of food samples

10 g sample are homogenised with 10 ml acetonitrile. After adding the internal standard the sample is shaken with 4 g $MgSO_4$ and 1 g NaCl and afterwards centrifuged.
1 ml of the supernatant is spiked with 25 mg CHROMABOND® Diamino and 150 mg $MgSO_4$ and shaken again. After centrifugation the supernatant is injected into GC/MS.

MN Appl. No. 303770

For optimising the extraction of pH-dependent compounds, for minimising decomposition of sensitive substances, and for broadening the matrix spectrum, different modifications of the QuEChERS method have been elaborated.

In addition to the required adsorbent CHROMABOND® Diamino MACHEREY-NAGEL offers a number of individually weighed and **premixed extraction** and **buffer** mixtures, specially composed for different sample matrices.

For extraction, the European standard EN 15662 recommends a citrate extraction mix (Mix I), while AOAC standard 2007.1 uses an acetate extraction mix (Mix II).

For clean-up, the Diamino phase (PSA) removes e.g. sugars and organic acids. $MgSO_4$ removes water, C_{18} ec removes nonpolar interferences such as fats and the Carbon phase removes pigments, sterols, and nonpolar interferences.

For selection of the proper clean-up mix see table on opposite page.

For detailed instructions please visit *www.mn-net.com* or the original references at *www.quechers.com*.

Ordering information

	Volume	Description		Composition	REF	Pack of
	**CHROMABOND® QuEChERS extraction buffer mixes**					
	15 ml*	Mix I	citrate extraction mix	4 g $MgSO_4$, 1 g NaCl, 0.5 g Na_2H citrate · 1.5 H_2O, 1 g Na_3 citrate · 2 H_2O	**730970**	50
	15 ml*	Mix II	acetate extraction mix	6 g $MgSO_4$, 1.5 g Na acetate	**730971**	50
	CHROMABOND® QuEChERS clean-up mixes					
	15 ml*	Mix III	Diamino clean-up mix	0.15 g CHROMABOND® Diamino with 0.9 g $MgSO_4$	**730972**	50
	15 ml*	Mix IV	Diamino/Carbon clean-up mix	0.15 g CHROMABOND® Diamino with 0.9 g $MgSO_4$ and 15 mg Carbon	**730973**	50
	15 ml*	Mix V	Diamino/Carbon clean-up mix	0.15 g CHROMABOND® Diamino with 0.9 g $MgSO_4$ and 45 mg Carbon	**730975**	50
	15 ml*	Mix VI	Diamino/C_{18} ec clean-up mix	0.15 g CHROMABOND® Diamino with 0.9 g $MgSO_4$ and 150 mg C_{18} ec	**730974**	50
	**CHROMABOND® Diamino polypropylene columns**					
	3 ml	adsorbent weight 200 mg			**730561**	50
	6 ml	adsorbent weight 500 mg			**730562**	30
	**CHROMABOND® Diamino adsorbent**					
					730653.20	20 g
					730653	100 g
	CHROMABOND® QuEChERS accessories					
		50 ml polypropylene centrifuge tube with screw cap			**730223**	50

* 15 ml centrifuge tubes with screw cap (2 ml or 50 ml centrifuge tubes on request)

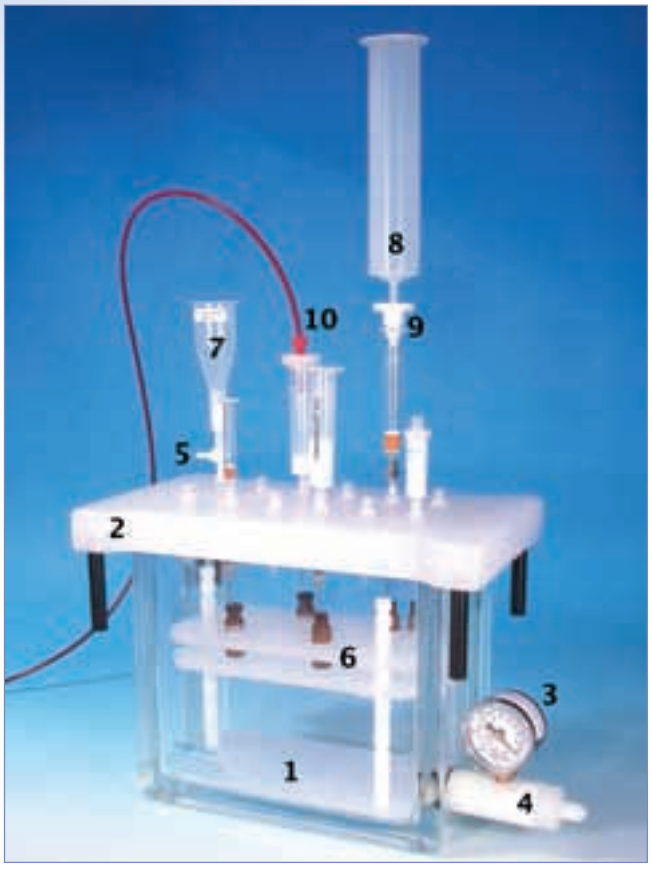
A number of custom-made QuEChERS mixes is available on request.

QuEChERS mixes

Sample property			
low fat content (e.g. apples, strawberries)	moderate content of chlorophyll and carotinoids (e. g. carrots, lettuce)	higher content of chlorophyll and carotinoids (e. g. bell peppers, spinach)	higher fat content (e. g. avocado)
CHROMABOND® QuEChERS extraction mixes			
citrate or acetate extraction	citrate or acetate extraction	citrate extraction	citrate extraction
Mix I or Mix II	Mix I or Mix II	Mix II	Mix II
CHROMABOND® QuEChERS clean-up mixes			
Diamino clean-up	Diamino/Carbon clean-up	Diamino/Carbon clean-up (higher Carbon content)	Diamino/C_{18} ec clean-up
Mix III	Mix IV	Mix V	Mix VI
			

CHROMABOND® vacuum manifolds

- for simultaneous preparation of up to 12, 16 or 24 samples
- replacement parts and accessories for special applications



Vacuum manifold for 12 columns

1 rectangular glass cabinet; 2 sizes available:
small for up to 12 CHROMABOND® columns or CHROMAFIX® cartridges;
large for up to 16 CHROMABOND® LV columns or up to 24 CHROMABOND® columns or CHROMAFIX® cartridges (depending on lid)

2 polypropylene lid

3 vacuum gauge for pressure reading

4 control valve for adjustment of vacuum

5 replaceable valves for vacuum control of individual SPE columns

5 variable rack with exchangeable partitions, which accept a wide variety of vessels like test tubes, measuring flasks, scintillation vials, autosampler vials, plastic vials etc.

7 CHROMABOND® LV columns with 15 ml sample reservoir for medium size samples

8 polypropylene sample reservoirs (30 or 70 ml)

9 adaptor for sample reservoirs

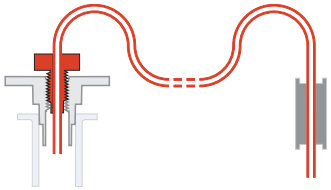
10 CHROMABOND® tubing adaptors

Full description and manual can be downloaded from *www.mn-net.com*

Ordering information

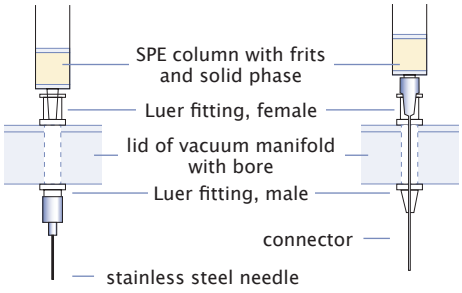
Description	Pack of	REF
Vacuum manifold complete consists of: glass cabinet with lid and lid gasket, removable needles on lower side of lid, vacuum gauge, control valve, valves and caps, variable rack:		
for up to 12 columns or cartridges (including PP tank)	1	**730150**
for up to 16 LV columns	1	**730360**
for up to 24 columns or cartridges	1	**730151**
Glass cabinets without accessories (1)		
for 12 columns	1	**730173**
for 16 LV or 24 columns	1	**730174**
Lids with gaskets (2)		
for 12 columns (including Luer fittings and valves **(5)**)	1	**730175**
for 16 LV columns (including Luer fittings and valves **(5)**)	1	**730365**
for 24 columns (including Luer fittings and valves **(5)**)	1	**730176**
Gaskets for lid, for 12 columns	2	**730177**
Gaskets for lid, for 24 columns	2	**730178**

Ordering information

Description		Pack of	REF
General accessories for vacuum manifolds			
Luer stoppers for vacuum manifold, blue		12	**730194**
Luer fittings for lid, female	 female	12	**730183.12**
Luer fittings for lid, male	 male	12	**730184.12**
Valves, plastic		12	**730185**
Stainless steel needles		12	**730152**
Polypropylene needles		12	**730154**
PP tanks for vacuum manifold for 12 columns	(not available for 16- or 24-position manifold)	2	**730233**
Vacuum gauge, complete with accessories		1	**730179**
Drying attachment and collecting racks for evaporation of eluates			
Drying attachment, for 12 columns **(11)**		1	**730187**
Drying attachment, for 24 columns		1	**730188**
Collecting rack for 12 columns **(6)**		1	**730157**
Collecting rack for 16 LV columns		1	**730366**
Collecting rack for 24 columns		1	**730153**
Products for protection from cross contamination			
Valve, brass, tarnished		1	**730189.1**
Valves, as above		12	**730189.12**
Stainless steel connectors		12	**730106**
PTFE connectors	(application of connectors see below)	12	**730564**
PTFE connectors with valve		12	**730563**
Tubing adaptors for application of large sample volumes (10)			
for 1, 3 and 6 ml glass columns		4	**730387**
for 1, 3 and 6 ml polypropylene columns		4	**730243**
for 15, 45 and 70 ml polypropylene columns		4	**730386**
(PTFE tube length approx. 1 m)			

Protection from cross contamination

For special applications, which require maximum protection from cross contamination we supply chrome-plated brass valves and stainless steel or PTFE connectors, the application of which is shown below. These special connectors are fitted through the lid; thus the sample only has contact with the inert connector and can flow directly into the receptacle.



Drying attachment

If the eluate has to be evaporated, this can be performed with the so-called drying attachment (**11**, see below). This special lid has a gas connector on one side (**12**), from which the gas is fed simultaneously to the 12 or 24 stations (**13**). Thus 12 or 24 eluates can be evaporated simultaneously by just changing the lid and applying a stream of inert gas, e.g. nitrogen.

Accessories for SPE

CHROMABOND® empty columns and accessories

- for individual packing of SPE columns with CHROMABOND® adsorbents

Ordering information

Description		Pack of	REF
Empty polypropylene columns with PE frits, 1 ml		100	**730159**
Empty polypropylene columns with PE frits, 3 ml		50	**730160**
Empty polypropylene columns with PE frits, 6 ml		30	**730161**
Empty polypropylene columns with PE frits, 15 ml	one filter element is already inserted in the polypropylene column	20	**730230**
Empty polypropylene columns with PE frits, 30 ml		20	**730380**
Empty polypropylene columns with PE frits, 45 ml		20	**730355**
Empty polypropylene columns with PE frits, 70 ml		20	**730158**
Empty polypropylene columns with PE frits, 150 ml		20	**730474**
PE frits for polypropylene columns 1 ml		250	**730164**
PE frits for polypropylene columns 3 ml		250	**730162**
PE frits for polypropylene columns 6 ml		250	**730163**
PE frits for polypropylene columns 15 ml		250	**730351**
PE frits for polypropylene columns 30 ml		250	**730034**
PE frits for polypropylene columns 45 ml		250	**730356**
PE frits for polypropylene columns 70 ml		250	**730026**
PE frits for polypropylene columns 150 ml		250	**730475**
Empty glass columns with glass fibre frits, 3 ml	one filter element is already inserted in the polypropylene column	50	**730171**
Empty glass columns with glass fibre frits, 6 ml		30	**730172**
Glass fibre frits for glass columns 3 ml		250	**730191**
Glass fibre frits for glass columns 6 ml		250	**730192**
Empty LV polypropylene columns with PE frits, 15 ml, for 100 mg adsorbent weight		50	**732500**
Empty LV polypropylene columns with PE frits, 15 ml, for 200/500 mg adsorbent weight		50	**732501**
PE frits for LV polypropylene columns 15 ml for 100 mg adsorbent weight		250	**732019**
PE frits for LV polypropylene columns 15 ml for 200/500 mg adsorbent weight		250	**732020**
Adaptor (PVDF) for glass columns (3 and 6 ml)		4	**730104.4**
Adaptors as above		10	**730105**
Adaptor (PP) for polypropylene columns (1, 3 and 6 ml)		4	**730100.4**
Adaptors as above		10	**730101**
Adaptor (PE) for polypropylene columns (15, 45, 70 ml)		4	**730350.4**
Adaptors as above		10	**730385**
Adaptor (PE) for polypropylene columns (30 and 70 ml)		1	**730566**
Reservoir columns for application of medium-size samples			
Reservoir column 30 ml, polypropylene, with one adaptor for 1, 3, 6 ml CHROMABOND® polypropylene columns		1	**730102**
10 Reservoir columns 30 ml, polypropylene with one adaptor for 1, 3, 6 ml CHROMABOND® polypropylene columns		1 kit	**730103**
Reservoir column 70 ml, polypropylene, with one adaptor for 1, 3, 6 ml CHROMABOND® polypropylene columns		1	**730381**
10 Reservoir columns 70 ml, polypropylene with one adaptor for 1, 3, 6 ml CHROMABOND® polypropylene columns		1 kit	**730382**
Reservoir column 70 ml, polypropylene, with one adaptor for 15, 45, 70 ml CHROMABOND® polypropylene columns		1	**730388**
10 Reservoir columns 70 ml, polypropylene with one adaptor for 15, 45, 70 ml CHROMABOND® polypropylene columns		1 kit	**730389**

Automated and on-line SPE

Performing Solid Phase Extraction (SPE) manually can be time consuming and nerve-racking, especially when recovery and reproducibility are lacking due to sample variability. If SPE can be reliably automated, it becomes a much more efficient and reproducible process

On-line SPE is a powerful method in automated sample preparation where the SPE hardware is technically integrated into a HPLC system. Crude samples are placed in an autosampler and processed fully automatic prior to injection into a GC (MS) or LC (MS) system.

MN offers different on-line column configurations designed to fit your on-line SPE analysis needs and filled with a choice of different adsorbents, modifications and particle sizes:

- Special SPE columns already equipped with special caps and needles to be used in the SPE unit of the **Gerstel** MultiPurposeSampler (**MPS),** available in 1, 3 and 6 ml.
- Columns for **Gilson ASPEC™** systems are ready-to-use assembled with caps. In addition to the columns and phases listed below, all 1, 3 and 6 ml CHROMABOND® polypropylene columns from our program can be supplied assembled with ASP caps.

Please contact us for further information or special request at info@mn-net.com.

Columns for the Gilson ASPEC™

SPE cartridges for Gerstel MPS system

Gerstel MPS system

Ordering information

Gilson ASPEC™ columns

Column size	Weight [mg]	Pack of [columns]	REF
CHROMABOND® SiOH			
1 ml	100	100	**730071ASP**
3 ml	500	100	**730073ASP**
6 ml	1000	100	**730075ASP**
CHROMABOND® C18 ec			
1 ml	100	100	**730011ASP**
3 ml	500	100	**730013ASP**
6 ml	1000	100	**730015ASP**

Ordering information

Gerstel MPS columns

Column size	Weight [mg]	Pack of [columns]	REF
CHROMABOND® SiOH			
3 ml	200	50	**730214MPS**
3 ml	500	50	**730073MPS**
6 ml	1000	30	**730075MPS**
CHROMABOND® C18 ec			
1 ml	100	100	**730011MPS**
3 ml	200	50	**730012MPS**
3 ml	500	50	**730013MPS**
CHROMABOND® HR-X			
1 ml	100	30	**730935MPS**
3 ml	200	30	**730931MPS**
6 ml	500	30	**730939MPS**

CHROMABOND® MULTI 96 for robot systems

Alternatively CHROMABOND® Multi 96 plates provide a means of high throughput sample preparation by processing 96 samples in a standard 8 x 12 microcolumn plate format compatible with standard 96-well plate liquid handling technologies and injection systems. CHROMABOND® Multi 96 plates are available for solid phase extraction (SPE) and for filtration.

CHROMABOND® MULTI 96 · SPE in microtitre format

- 96-well PP microtitre plates with PE filter elements
- cavity volume 1.5 ml
- adsorbent weights from 25 to 100 mg
- supplied with any CHROMABOND® SPE adsorbents
- for simultaneous preparation of 96 samples
- easy method transfer from CHROMABOND® columns or CHROMAFIX® cartridges to CHROMABOND® MULTI 96

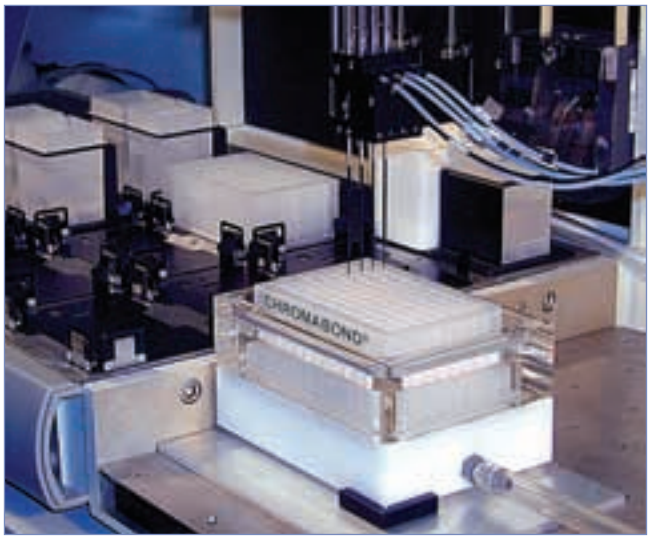
Advantages of this high-throughput system:

- simultaneous preparation of 96 samples; this means a 4-fold increase over traditional 24-position SPE processors
- economical by saving time and solvent
- use of multi-channel pipettors facilitates liquid transfer steps
- readily adaptable to all common automated / robotic handling systems
- minimised dead volume (≤ 40 µl)

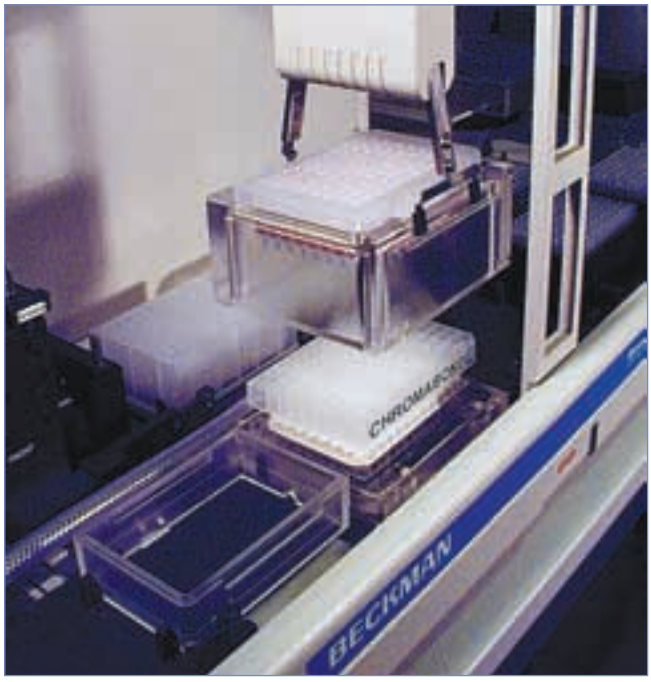
Instrument compatibility

CHROMABOND® MULTI 96 SPE microtitre or filtration plates are compatible with e.g. the following liquid handling and/or SPE automation systems:

- Perkin Elmer MultiProbe® II
- Tomtec Quadra 3® and Quadra 3® SPE
- Hamilton Microlab® SPE Workstation
- Beckman Coulter Biomek® 2000
- Caliper Life Science RapidTrace®
- Gilson ASPEC™ XL4 and ASPEC™ XL
- Gilson 215 SPE Liquid Handler
- Tecan Genesis™ FE500



Multiprobe® II (Perkin-Elmer)



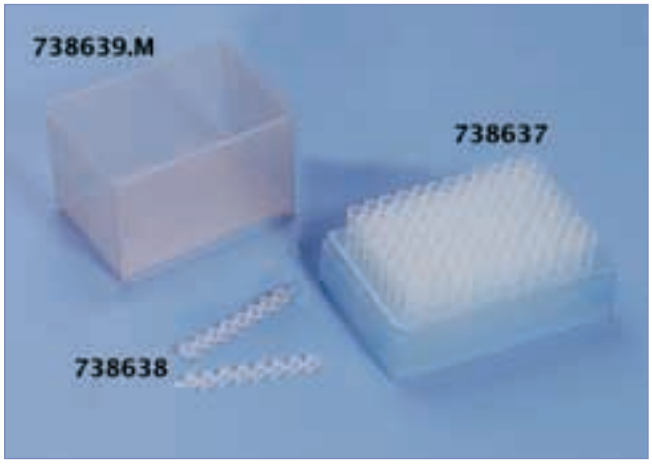
Biomek® 2000 (Beckman Coulter)

CHROMABOND® MULTI 96 vacuum manifold

- for handling of CHROMABOND® MULTI 96 SPE plates for up to 96 samples

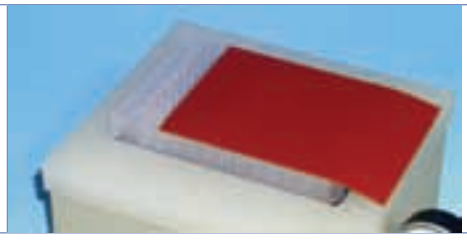
CHROMABOND® MULTI 96 is designed for use in common robotic workstations or commercially available liquid handling systems. Alternatively, use of multi-channel pipettors facilitates a manual liquid transfer. Extraction is carried our using the CHROMABOND® MULTI 96 vacuum manifold. With the help of the control valve the vacuum of the manifold can be adjusted leading to an optimum flow rate through the CHROMABOND® MULTI 96 SPE plate.

A reservoir tank and 96-well collection plates (96 x 0.5 or 96 x 2 ml) made of polypropylene can be supplied as accessories. An interesting alternative for collection of the eluates is a collection rack, which can be fitted with twelve 8-well strips of polypropylene tubes (each 1 ml). If you have to work on less than 96 samples, you can seal individual rows of the 96-well plate with a PTFE-covered rubber pad.



Ordering information

Description	Pack of	REF
CHROMABOND® MULTI 96 vacuum manifold with reservoir tank, vacuum gauge, and control valve	1	**738630.M**
96-well microtitre plates (polypropylene) 96 x 0.25 ml	10	**738651**
96-deep-well collecting plate (polypropylene) 96 x 2 ml	5	**738650.5**
Collection racks with polypropylene tube strips (twelve 8-well strips) 96 x 1.0 ml	5	**738637**
Polypropylene tube strips (twelve 8-well strips) 96 x 1.0 ml	10	**738652**
8-well strip sealing caps for PP tube strips (REF 738652)	30	**738638**
Reservoir tanks (polypropylene)	2	**738639.M**
Butyl rubber pad, PTFE covered for sealing of individual rows of the 96-well plate, 125 x 85 mm	1	**738645**



For CHROMABOND® MULTI 96 filter plates see page 75. The ordering information of 96-well plates packed with individual CHROMABOND® adsorbents is listed with the respective phases.

Kieselguhr phase for liquid–liquid extraction

CHROMABOND® XTR — for liquid–liquid extraction

- base material coarse-grained kieselguhr (also known as diatomaceous earth, hydromatrix, celite)
  large pore size, high pore volume, constantly high batch-to-batch quality
  pH working range 1 – 13
- **application:**
  liquid–liquid extraction of highly viscous aqueous solutions such as physiological fluids (blood, plasma, and serum) in clinical chemistry, dyes in textiles, environmental and food analysis without use of a separation funnel
  high water loadability without breakthrough of water during elution with organic solvents
  also suited for removing small amounts of water from solvents which are not miscible with water
- **advantages:**
  fast, reproducible and economical
  simultaneous preparation of several samples
  no problems with phase separation · no formation of emulsions
  high recovery rates
  saving of time and solvents
  organic solutions need not to be dried after separation

Solvents applicable for elution

- ✓ diethyl ether
- ✓ *tert*-butyl methyl ether
- ✓ ethyl acetate
- ✓ *n*-hexane
- ✓ cyclohexane
- ✓ toluene
- ✓ methylene chloride (dichloromethane)
- ✓ chloroform (trichloromethane)
- ✓ chloroform / methanol (90:10, v/v)
- ✓ chloroform / methanol (85:15, v/v)
- ✓ diethyl ether / ethanol (90:10, v/v)
- ✓ diethyl ether / ethanol (80:20, v/v)
- ✓ methylene chloride / 2-propanol (90:10, v/v)
- ✓ methylene chloride / 2-propanol (85:15, v/v)

Eluents with too high alcohol contents cause an increase in volume of the aqueous phase on the CHROMABOND® XTR. Here the column could be overloaded and the aqueous phase displaced from the column. In this case, a greater capacity column should be used.

Depending on the concentration of the analytes eluates can be analysed immediately, or the organic solvent is evaporated. The pH value of the aqueous solution can be altered on the column, which enables elution of different compounds of a sample under optimised conditions. Under certain circumstances, acidic, neutral, and basic compounds can be fractionated in this way.

General column parameters

CHROMABOND® XTR volume	amount of adsorbent	max. volume capacity of aq. solution	waiting period before elution	elution volume
1 ml	250 mg	0.25 ml	5 min	3 ml
3 ml	500 mg	0.5 ml	5 min	6 ml
6 ml	1 g	1 ml	5 – 10 min	8 ml
15 ml	3 g	3 ml	5 – 10 min	12 ml
30 ml	4.5 g	5 ml	5 – 10 min	16 ml
45 ml	8.3 g	10 ml	10 – 15 min	24 ml
70 ml	14.5 g	20 ml	10 – 15 min	40 ml
150 ml	37.5 g	50 ml	10 – 15 min	90 ml

Sample application

Spreading of the sample

Sample elution

Liquid–Liquid Extraction

Kieselguhr phase for liquid–liquid extraction

Determination of azo dyes and aromatic amines in coloured textile materials (with reference to § 35 German Law for Food and Consumer Goods/LMBG)

Sample pretreatment:
Weigh about 1 g cut-up textile sample (coloured textiles about 0.1 g) in a 100 ml threaded vial. (Degrease leather samples before processing: cover sample with technical purity *n*-hexane and put the vial in an ultrasonic bath for 20 min. After decanting the *n*-hexane rinse with little *n*-hexane and dry sample by gentle heating and blowing with air or N_2.)
Add 250 µl internal standard (IS: 1.2 mg/ml tetramethylbenzidine in methanol – ethyl acetate (1:1, v/v)), 17.0 ml citrate buffer (pH 6) (25.05 g citric acid and 12.64 g NaOH, fill up with deionized water to 2 l) and heat 30 min at 70 °C. Then add 3 ml of a freshly prepared solution of 0.2 g/ml sodium dithionite in water and heat for exactly 30 min to 70 °C while shaking occasionally.
Sample application:
cool the solution immediately (put vial in water – stopping of reductive cleavage). After 5 – 10 min pour it onto the CHROMABOND® XTR column (squeeze textile remains).

Elution:
allow solution to be soaked up by the adsorbent for 15 min. Then elute four times with 20 ml each of diethyl ether or diethyl ether – ethanol (90:10, v/v) (see recovery rates), using the first 40 ml to rinse the sample remains. Evaporate the eluates to 3 ml with a rotation evaporator and transfer the solution into a 10 ml measuring flask with the help of a pasteur pipette and by rinsing with methanol. Fill up to the marking with methanol, shake, and pipette about 1 ml into a vial.

Further analysis: Fast GC on OPTIMA® δ-3, 10 m, 0.1 mm ID, 0.1 µm film, REF 726 410.10 (application 210820) or HPLC on NUCLEOSIL® 100-5 C_{18} HD (application 110500 at *www.mn-net.com*)

MN Appl. No. 302100

Ordering information

column volume	1 ml	3 ml	6 ml	15 ml	30 ml	45 ml	70 ml	150 ml
adsorbent weight	250 mg	500 mg	1 g	3 g	4.5 g	8.3 g	14.5 g	37.5 g
max. volume capacity of aqeous solution	0.25 ml	0.5 ml	1 ml	3 ml	5 ml	10 ml	20 ml	50 ml
pack of	100	50	30	30	30	30	30	10
CHROMABOND® XTR polypropylene columns								
	730501	**730502**	**730487**	**730489**	**730505**	**730506**	**730507**	**730509**
CHROMABOND® XTR polypropylene columns · BIGpacks								
			730487.250 (250 col.)				**730507.100** (100 col.)	
CHROMABOND® MULTI 96 XTR								
96-well plates 96 x 150 mg, packs of 1 plate, for max. 96 x 0.2 ml aqueous solution								
				738131.150M				

CHROMABOND® XTR adsorbent				
50 bags of 14.5 g, for max. max. 20 ml aqueous solution each)				
for 70 ml PP columns with 100 PE filter elements	for NT20 with 50 PE filter elements (10 mm dia.)	500 g	1 kg	5 kg
730585	**730586**	**730595.500**	**730595.1000**	**730595.5000**

Accessories for liquid–liquid extraction with CHROMABOND® XTR	
variable polypropylene rack for 24 positions, incl. 24 PP stopcocks and 24 PP needles	**730508**

For parallel processing of up to 24 CHROMABOND® XTR columns 1 – 150 ml we recommend the polypropylene rack REF 730508 consisting of:
two side walls (1), middle part including stopcocks and needles (2), bottom part (3), top part for stabilising 45 ml, 70 ml and 150 ml CHROMABOND® XTR columns (4).

This rack can be adjusted to various heights depending on the CHROMABOND® XTR columns and the collection vials used. Each position of the middle part is equipped with a polypropylene stopcock on the top (REF 730185) and a polypropylene needle on the bottom (REF 730154).

For collection of the sample, vessels such as vials, test tubes, round bottom or tapered flasks, can be used. For our programme of sample vials, please see the chapter "Vials and accessories" from page 76.

Columns for gravity flow phase separation

CHROMABOND® PTS and PTL — columns for phase separation

- automatic separation of a two-phase mixture without separation funnel

  two-phase mixtures are completely applied to the column and the phase boundary is determined without further work. The special membrane stops automatically and the interesting phase is separated.

  columns **must not** be run with vacuum or pressure

- **PTS**

  for solvents **heavier** than water, e.g. for chloroform, dichloromethane etc.

  maximum size 150 ml

- **PTL**

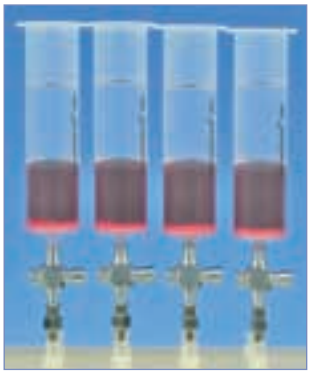
  for solvents **lighter** than water, e.g. for diethyl ether, hexane etc.

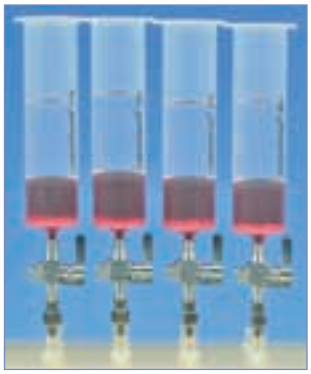
  maximum size 70 ml

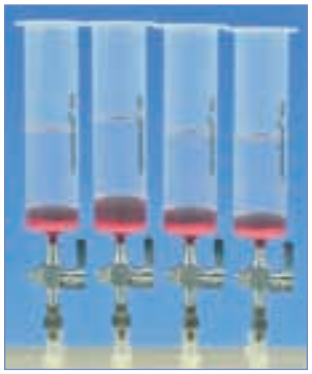
Ordering information

Column volume [ml]	Pack of [columns]	REF
CHROMABOND® PTS for solvents heavier than water		
1	100	**730710**
3	100	**730712**
6	100	**730714**
15	100	**730716**
30	100	**730718**
45	50	**730720**
70	50	**730722**
150	20	**730724**
CHROMABOND® PTL for solvents lighter than water		
1	100	**730730**
3	100	**730732**
6	100	**730734**
15	100	**730736**
30	100	**730738**
45	50	**730740**
70	50	**730742**

the ideal tool for breaking emulsions







CHROMABOND® PTL in action: organic upper phase (colourless), aqueous lower phase (red)

Glass columns and accessories for Flash chromatography

- economic low-tech method for the synthesis laboratory
  suited for the separation of compounds up to gram levels
  no expensive equipment required
- MN flash chromatography kits include a glass column, eluent reservoir, silica 60 and accessories.
  Glass columns of different sizes and accessories can be ordered separately.

  These columns are normally filled to a height of about 15 cm, working pressures are 1.5 to 2 bar.

  The most used adsorbent is silica 60 with particle size 40 – 63 µm (see page 179), however, you may also use our range of POLYGOPREP silica phases (see page 177 – 178). Particle sizes < 25 µm should only be used with very low-viscosity mobile phases, because otherwise flow rates will be very low.

  These columns are to be packed by the user.

Ordering information

Designation	Pack of	REF
Flash chromatography kits		
Flash chromatography kit I, consists of 1 glass column 20 mm ID x 400 mm, one 1-l eluent reservoir, 100 g silica 60 (40 – 63 µm), sea sand, silanised glass fibre wadding	1 kit	**727450**
Flash chromatography kit II, consists of 1 glass column 40 mm ID x 450 mm, one 2-l eluent reservoir, 100 g silica 60 (40 – 63 µm), sea sand, silanised glass fibre wadding	1 kit	**727451**
Flash chromatography columns		
complete with adaptor and PTFE tap, fitted with a polyethylene net to protect against bursting		
20 mm ID x 200 mm length	1 column	**727400**
20 mm ID x 400 mm length	1 column	**727401**
25 mm ID x 200 mm length	1 column	**727402**
25 mm ID x 400 mm length	1 column	**727403**
30 mm ID x 300 mm length	1 column	**727404**
30 mm ID x 400 mm length	1 column	**727405**
40 mm ID x 300 mm length	1 column	**727406**
40 mm ID x 450 mm length	1 column	**727407**
Accessories for flash chromatography glass columns		
Eluent reservoir 1 l with adaptor, covered with a protective plastic sleeve for burst protection; this also prevents build-up of UV-induced radicals in the eluent	1	**727420**
Eluent reservoir as above, however 2 l volume	1	**727421**
Pressure gauge for controlling flow rates	1	**727422**
Sea sand, acid washed and calcined	1000 g	**727423**
Glass fibre wadding, silanised	25 g	**718002**

CHROMABOND® Flash RS cartridges

ideal for Flash separations from 10 mg up to 160 g

- **for convenient operation and reliable upscaling**
  the complete program of ready-to-use Flash cartridges for the ISCO® Companion® and other Teledyne Isco CombiFlash® systems, or as stand-alone version for all pump/detector combinations, e.g. from Biotage®, Büchi®,
  from 4 g to 1600 g adsorbent from one of the leading companies in silica and TLC business
- **increases flexibility**
  considerable program of different phases and modifications
- **saves time and money**
  convenient prices, short delivery times
- **increases analytical safety**
  high pressure stability of 15 bar/220 psi (12 bar for cartridges > 200 g), excellent separation efficiency, good reproducibility

Technical features

- **Distribution of eluent stream via highly porous frits**
- **Cartridge material and geometry:**
  organic solvent resistant, low bleed polypropylene, thick column walls, one piece body, sophisticated length to diameter quotient for high plate numbers and excellent separation efficiencies
- **Cartridge/column connections**

CHROMABOND® RS cartridges are 100% compatible with the ISCO® Companion®, no additional hardware is needed for this type of purification systems.

CHROMABOND® RS cartridges (except RS 800 and RS 1600 with Maxi Luers) can also be used as stand alone system with any pump/detector/fraction collector combination using the CHROMABOND® Flash Starter Kit or the CHROMABOND® Flash Stand Alone Kit.

CHROMABOND® Flash Starter Kit

For the RS 800 and RS 1600 we offer stand alone adaptors Maxi Luer to ¼"-28 screws:

Column inlet:
Maxi Luer connector, male maxi luer to ¼"-28 inner screw, stainless steel, single use product

Column exit:
Aluminium bridge with stainless steel screw for Maxi Luer Output, female Maxi luer to ¼"-28 inner screw for RS 800 or RS 1600, respectively.

Accessories for CHROMABOND® Flash columns · Ordering information

Description	Pack of	REF
CHROMABOND® Flash Starter Kit		
consists of: 1/8" PTFE tubing, ID 1.5 mm, length 3 m; 5 x 1/4"-28 PP nuts; 5 x 1/8" ETFE ferrules; 5 x 1/4"-28 nylon unions; 2 x 1/4"-28 PP luer locks female; 1 x 1/4"-28 PP luer locks male; 1 x 1/4"-28 PP luer tip male	1 kit	**730798**
CHROMABOND® Flash Stand Alone Kit		
consists of: 1 x 1/4"-28 PP luer lock female; 1 x 1/4"-28 PP luer lock male; 2 x 1/8" ETFE ferrules; 2 x 1/4"-28 nylon unions; 2 x 1/4"-28 PP nuts	1 kit	**732903**
Accessories		
CHROMABOND® maxi luer connector for RS 800 and RS 1600 (inlet)	1	**732900**
CHROMABOND® Flash aluminium bridge with stainless steel screw for RS 800 (exit)	1	**732901**
CHROMABOND® Flash aluminium bridge with stainless steel screw for RS 1600 (exit)	1	**732902**

CHROMABOND® Flash solutions for specific Flash instruments

- product range designed for use in the Teledyne Isco CombiFlash® systems (Companion®, Rf etc.) and Flash systems of Biotage AB (FlashMaster™) without additional connectors or capillaries

  on request all column types listed below can be packed with any adsorbent as described on page 8 – 9 (please note that other packings often result in differing adsorbent weights)

Ordering information

Designation	Column length [cm]	ID [mm]	Adsorbent weight [g]	Pack of	REF
CHROMABOND® Flash RS columns for Teledyne Isco® systems					
All CHROMABOND® Flash RS types can be directly used in the Teledyne Isco Companion®, Rf, etc.					
CHROMABOND® Flash RS 4 SiOH	9.8	12.4	4	20	**732800**
CHROMABOND® Flash RS 15 SiOH	11.6	21.2	15	20	**732801**
CHROMABOND® Flash RS 25 SiOH	16.5	21.2	25	15	**732802**
CHROMABOND® Flash RS 40 SiOH	17.1	26.4	40	15	**732803**
CHROMABOND® Flash RS 80 SiOH	24.0	30.8	80	12	**732804**
CHROMABOND® Flash RS 120 SiOH	25.5	36.0	120	10	**732805**
CHROMABOND® Flash RS 200 SiOH	20.0	60.0	200	6	**732806**
CHROMABOND® Flash RS 330 SiOH	27.0	60.0	330	4	**732807**
CHROMABOND® Flash RS 800 SiOH	38.5	82.0	800	2	**732808**
CHROMABOND® Flash RS 1600 SiOH	43.0	104.0	1600	2	**732809**
CHROMABOND® Flash RS 4 C_{18} ec	9.8	12.4	4.3	2	**732810**
CHROMABOND® Flash RS 15 C_{18} ec	11.6	21.2	16.4	1	**732811**
CHROMABOND® Flash RS 25 C_{18} ec	16.5	21.2	26	1	**732812**
CHROMABOND® Flash RS 40 C_{18} ec	17.1	26.4	43	1	**732813**
CHROMABOND® Flash RS 80 C_{18} ec	24.0	30.8	86	1	**732814**
CHROMABOND® Flash RS 120 C_{18} ec	25.5	36.0	130	1	**732815**
CHROMABOND® Flash RS 200 C_{18} ec	20.0	60.0	220	1	**732816**
CHROMABOND® Flash RS 330 C_{18} ec	27.0	60.0	360	1	**732817**
CHROMABOND® Flash RS 800 C_{18} ec	38.5	82.0	880	1	**732818**
CHROMABOND® Flash RS 1600 C_{18} ec	43.0	104.0	1760	1	**732819**

CHROMABOND® Flash RS cartridges

Designation	Column length [cm]	ID [mm]	Adsorbent weight [g]	Pack of	REF
CHROMABOND® Flash RS 4 NH_2	9.8	12.4	4.3	2	**732820**
CHROMABOND® Flash RS 15 NH_2	11.6	21.2	16.4	1	**732821**
CHROMABOND® Flash RS 25 NH_2	16.5	21.2	26	1	**732822**
CHROMABOND® Flash RS 40 NH_2	17.1	26.4	43	1	**732823**
CHROMABOND® Flash RS 80 NH_2	24.0	30.8	86	1	**732824**
CHROMABOND® Flash RS 120 NH_2	25.5	36.0	130	1	**732825**
CHROMABOND® Flash RS 200 NH_2	20.0	60.0	220	1	**732826**
CHROMABOND® Flash RS 330 NH_2	27.0	60.0	360	1	**732827**
CHROMABOND® Flash RS 4 OH	9.8	12.4	4.3	2	**732830**
CHROMABOND® Flash RS 15 OH	11.6	21.2	16.4	1	**732831**
CHROMABOND® Flash RS 25 OH	16.5	21.2	26	1	**732832**
CHROMABOND® Flash RS 40 OH	17.1	26.4	43	1	**732833**
CHROMABOND® Flash RS 4 CN	9.8	12.4	4.3	2	**732840**
CHROMABOND® Flash RS 15 CN	11.6	21.2	16.4	1	**732841**
CHROMABOND® Flash RS 25 CN	16.5	21.2	26	1	**732842**
CHROMABOND® Flash RS 40 CN	17.1	26.4	43	1	**732843**
CHROMABOND® Flash RS 80 CN	24.0	30.8	86	1	**732844**
CHROMABOND® Flash RS 120 CN	25.5	36.0	130	1	**732845**
CHROMABOND® Flash RS 4 ALOX A	9.8	12.4	8	20	**732870**
CHROMABOND® Flash RS 4 ALOX N	9.8	12.4	8	20	**732871**
CHROMABOND® Flash RS 4 ALOX B	9.8	12.4	8	20	**732872**
CHROMABOND® Flash RS 15 ALOX A	11.6	21.2	30	20	**732874**
CHROMABOND® Flash RS 15 ALOX N	11.6	21.2	30	20	**732873**
CHROMABOND® Flash RS 15 ALOX B	11.6	21.2	30	20	**732875**
CHROMABOND® Flash RS 25 ALOX A	16.5	21.2	50	15	**732876**
CHROMABOND® Flash RS 25 ALOX N	16.5	21.2	50	15	**732877**
CHROMABOND® Flash RS 25 ALOX B	16.5	21.2	50	15	**732878**
CHROMABOND® Flash RS 40 ALOX A	17.1	26.4	80	15	**732879**
CHROMABOND® Flash RS 40 ALOX N	17.1	26.4	80	15	**732881**
CHROMABOND® Flash RS 40 ALOX B	17.1	26.4	80	15	**732880**
CHROMABOND® Flash RS cartridges for stand-alone operation incl. Maxi Luer connector at the top and bores for the aluminium bridge at the exit of the cartridges					
CHROMABOND® Flash RS 800 SiOH stand alone	38.5	82.0	800	2	**732808S**
CHROMABOND® Flash RS 1600 SiOH stand alone	43.0	104.0	1600	2	**732809S**
CHROMABOND® Flash columns for Biotage® FlashMaster™ systems					
CHROMABOND® Flash FM 15/2 SiOH	9.0	15.8	2.0	50	**730881**
CHROMABOND® Flash FM 25/5 SiOH	10.0	20.5	5.0	50	**730891**
CHROMABOND® Flash FM 25/10 SiOH	10.0	20.5	10.0	50	**730666**
CHROMABOND® Flash FM 70/10 SiOH	15.4	26.8	10.0	30	**730885**
CHROMABOND® Flash FM 70/20 SiOH	15.4	26.8	20.0	30	**730915**
CHROMABOND® Flash FM 70/25 SiOH	15.4	26.8	25.0	30	**730892**
CHROMABOND® Flash FM 150/25 SiOH	17.0	38.2	25.0	20	**730667**
CHROMABOND® Flash FM 150/50 SiOH	17.0	38.2	50.0	20	**730887**
CHROMABOND® Flash FM 150/70 SiOH	17.0	38.2	70.0	20	**730880**
CHROMABOND® Flash FM 15/2 C_{18} ec	9.0	15.8	2.0	50	**730890**
CHROMABOND® Flash FM 25/5 C_{18} ec	10.0	20.5	5.0	20	**730884**
CHROMABOND® Flash FM 70/10 C_{18} ec	15.4	26.8	10.0	20	**730886**
CHROMABOND® Flash FM 150/50 C_{18} ec	17.0	38.2	50.0	10	**730888**
CHROMABOND® Flash FM 70/10 NH_2	15.4	26.8	10.0	20	**730768**
CHROMABOND® Flash FM 70/20 NH_2	15.4	26.8	20.0	20	**730767**

Technical support

Loadability

Due to the narrow particle size distribution, the excellent packing quality and the optimised stationary phases (acid washed silica, reduced particulate matter) our cartridges can realize highest loadability at best possible separation efficiency. Additionally, the large range of different cartridge lengths and diameters eases to find the optimum in loadability for a given sample amount.

Rule of thumb for the loadability:

separation	loadability	g sample / g adsorbent
difficult	low	≤ 1 %
easy	high	≥ 10 %

Loadability table

SiOH cartridge	Average loadability per cartridge [g] difficult separation	easy separation
RS 4	0,04	0,4
RS 15	0,15	1,5
RS 25	0,25	2,5
RS 40	0,4	4
RS 80	0,8	8
RS 120	1,2	12
RS 200	2	20
RS 330	3,3	33
RS 800	8	80
RS 1600	16	160

Upscaling of the optimum flow rate

This depends on the eluent and the separation problem.

For RS cartridges the upscaling relation is easy:

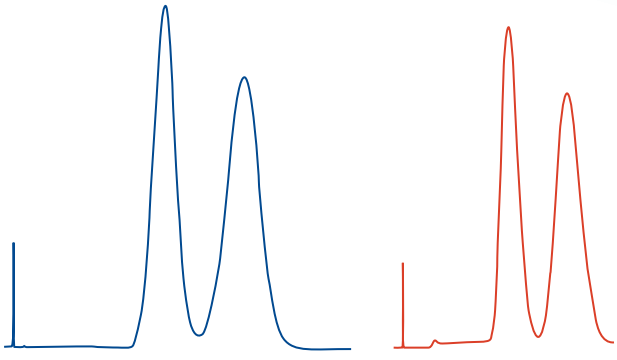
silica [g] to flow = 1:1 (for the same polarity of eluent)

e.g.

4 g silica → optimum flow: ~ 6 – 12 ml/min

40 g silica → optimum flow: ~ 60 – 120 ml/min

Upscaling of flow rate



Back pressure/pressure stability

The back pressure always depends on flow rate and viscosity of the eluent mixture, column length and diameter and particle size. The new ultra performance CHROMABOND® Flash RS cartridges up to 200 g silica are stable up to 15 bar (220 psi, > 200 g: 12 bar)

We recommend a pressure guard, because short time pressure peaks (viscosity of eluent or change in gradient) can exceed the pressure limit.

Back pressure of CHROMABOND® SiOH Flash RS cartridges for the eluent hexane – ethyl acetate 9:1 or 8:2

	Flow rate						
	20 ml/min	40 ml/min	80 ml/min	120 ml/min	160 ml/min	200 ml/min	240 ml/min
RS 4	0.75 bar	1.5 bar					
RS 15	0.25 bar	0.75 bar	1.5 bar	2.0 bar			
RS 25	0.5 bar	1.0 bar	1.75 bar	3.0 bar	4.0 bar	5.0 bar	
RS 40		0.75 bar	1.5 bar		3.0 bar		3.5 bar
RS 80			1.5 bar	2.5 bar	3.0 bar	3.5 bar	4.0 bar
RS 120			1.0 bar	1.5 bar	2.0 bar	2.5 bar	3.0 bar
RS 200			1.0 bar		2.0 bar		3.0 bar
RS 330			1.5 bar		3.0 bar		4.0 bar

Conditioning volumes for CHROMABOND® Flash RS cartridges (normally 1.5 column volumes of eluent)

Cartridge	Eluent volume for conditioning
RS 4	20 ml
RS 15	60 ml
RS 25	90 ml
RS 40	140 ml
RS 80	280 ml

Cartridge	Eluent volume for conditioning
RS 120	440 ml
RS 200	750 ml
RS 330	1100 ml
RS 800	2900 ml
RS 1600	5000 ml

CHROMABOND® Flash adsorbents

TLC upscaling

TLC is often used for the development of a selective and reproducible method in Flash chromatography, because it is often necessary to test a large number of eluent and/or adsorbent combinations. MN TLC plates and sheets are coated with the same base silica, which is used in our CHROMABOND® Flash cartridges. This is an important prerequisite for the reproducible transfer of a TLC separation to the Flash column, because the parameters are identical in both systems.

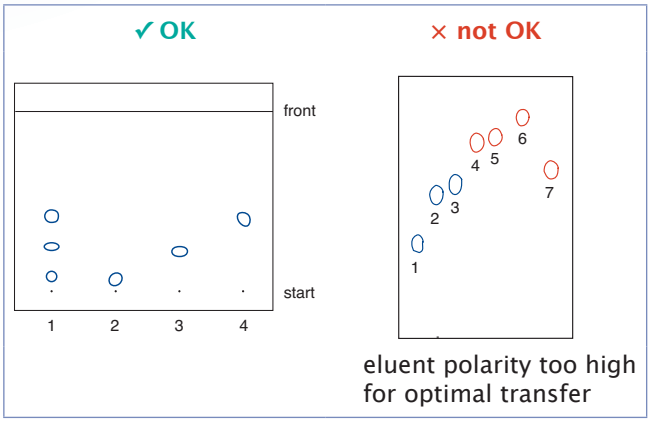
How can a successful TLC separation be transferred to a Flash column?

MN as a TLC manufacturer uses the same base material/silica on TLC plates as in Flash cartridges:

- same selectivities and easy upscaling from TLC to Flash is guaranteed
- saves time and money, because expensive optimisations are not necessary

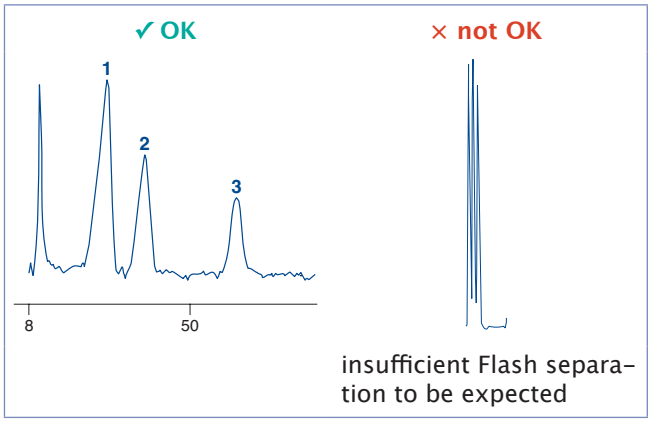
Examples:

R_f values of the TLC separation should be in the range of 0.1 – 0.4 (low height).



eluent polarity too high for optimal transfer

ΔR_f values on the TLC plate should be as high as possible.



insufficient Flash separation to be expected

During TLC optimisation always use solvents, which are well suited for the following Flash chromatography!

MN adsorbents — a unique variety of phases

- as with our SPE products, all Flash columns and cartridges from MN are available with our whole range of CHROMABOND® phases (more than 40, e.g. C_{18}, C_8, OH, Alox etc. as listed on page 8 – 9)

  Additionally you can choose from our range of POLYGOPREP silica packings in particle sizes from 20 to 130 µm and pore sizes from 60 to 4000 Å (see page 177 – 178).
- for high performance Flash separations you can order columns packed with spherical NUCLEODUR® featuring very high separation efficiency and extremely increased column lifetime (particle size > 20 µm as listed on page 172)

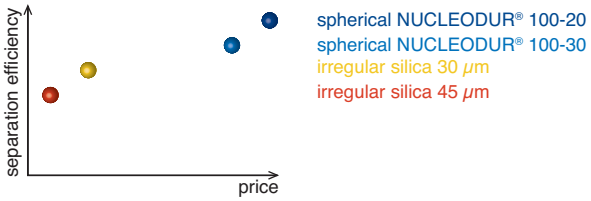
  For corresponding offers please contact your local MN distributor.

Technical silica information

Silica specifications:
acid-washed irregular silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2 – 8, for modified and plain silica

Additionally available silicas/particle sizes:

- irregular silica, 60 Å with a particle size of 30 µm
- spherical silica (NUCLEODUR®, 110 Å) with a particle size of 20 µm or 30 µm



separation efficiency and price of irregular versus spherical silica

CHROMABOND® Flash Safety System

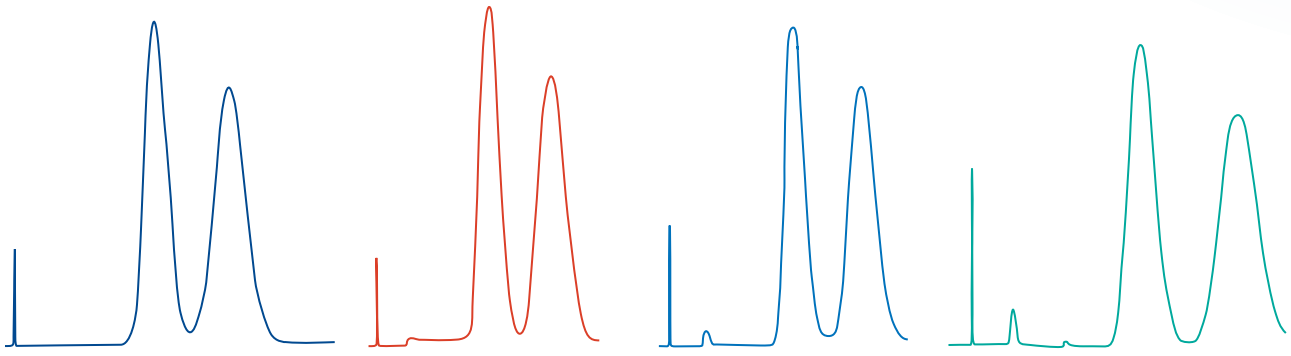
Separation efficiency and reproducibility tests

Our optimised automatic packing process leads to an excellent packing quality, irrespective of the phase or particle size distribution (normal phase or reversed phase, spherical or irregular particles).

MN, as a manufacturer of silicas, has decades of experience in the production of first class separation phases and columns. This leads to highest separation efficiencies of the columns, a constant back pressure (via controlled narrow particle size distribution) and good reproducibilities from cartridge to cartridge.

The separation efficieny is in the first step not influenced by the dimension or the geometry of the Flash RS cartridges. The chromatograms below show an identical resolution and peak form for different column dimensions, when flow and sample amount is adjusted correctly. This is positive for optimization and upscaling experiments.

Resolution and peak shape for different column dimensions



MN Flash Safety System

meeting today's customers' demands

- **features:**
  maximum safety during use under pressure
  increased column life time
  high separation efficiency
  excellent reproducibility
  high loadability
  easy and flexible installation, even with different instruments / hardware
- the **CHROMABOND® Flash Safety System**
  can be used as stand-alone system for any pump / detector / fraction collector combination with ¼"-28 fittings
  CHROMABOND® safety holder, available in 5 different sizes (90, 180, 240, 360, 750/1000 ml)
  holder can be equipped with either luer lock inlet, ¼"-28 threads or Swagelok® connection
  cartridges with luer lock exit for a safe and pressure stable tube connection
  maximum safety up to 9 bar

holders with cartridges

40 mm ID

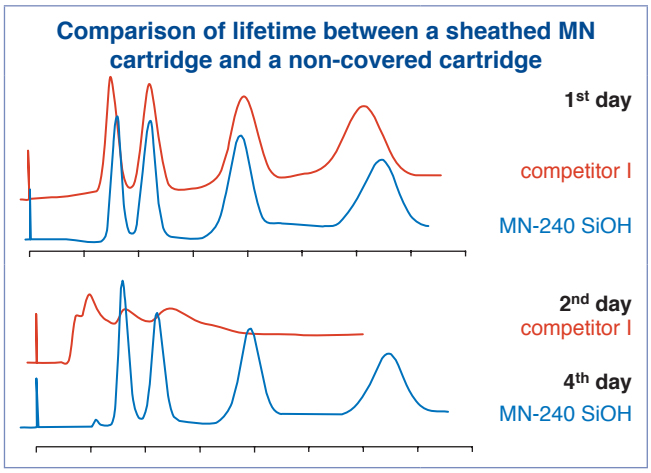
65 mm ID

CHROMABOND® Flash Safety System

Safety and column lifetime

Both points are closely connected for the CHROMABOND® Flash Safety System. The metal casing around the cartridge increases the security for the user compared to pure plastic cartridges without casing.

Our CHROMABOND® Flash Safety System is tested and proofed up to 9 bar. This increases the flexibility due to the use of a broader range of feasible solvents (i.e. with higher viscosity) and reduces the analysis time by higher possible flow rates. The metal casing inhibits the deformation or twisting of the cartridge and through this, avoids a damage of the packing by swelling or solvent effects. The increase in cartridge lifetime is now measured in days, not only in hours or a few runs.



CHROMABOND® Flash Safety System · Holders and replacement parts

Description	Dimension	Pack of	REF
CHROMABOND® Flash holder 90 (complete with cap (luer lock, female) and casing)	60 x 108 mm	1	**730896**
CHROMABOND® Flash holder 180 as above	60 x 187 mm	1	**730897**
CHROMABOND® Flash holder 240 as above	60 x 232 mm	1	**730899**
CHROMABOND® Flash holder 360 as above	60 x 318 mm	1	**730898**
CHROMABOND® Flash holder 750 (complete with cap, star-shaped distribution device, seal, retaining ring and casing)	95 x 300 mm	1	**730834**

CHROMABOND® Flash cartridges with luer lock · Ordering information

Description	Dimensions		Adsorbent SiOH			Adsorbent C18 ec		
	length [mm]	ID [mm]	adsorbent weight [g]	pack of	REF	adsorbent weight [g]	pack of	REF
CHROMABOND® Flash MN-90	114	40	40	10	**730810**	55	2	**730814**
CHROMABOND® Flash MN-180	194	40	90	10	**730811**	110	2	**730815**
CHROMABOND® Flash MN-240	240	40	130	10	**730784**	150	2	**730816**
CHROMABOND® Flash MN-360	325	40	180	5	**730813**	220	1	**730817**
CHROMABOND® Flash MN-750	270	65	330	5	**730835**	440	1	**730836**
CHROMABOND® Flash MN-1000	365	65	450	2	**730838**	620	1	**730837**
For operation of these cartridges the corresponding holder is required (see above)								

Injection accessories for CHROMABOND® Flash columns · Ordering information

Description	Dimension	Pack of	REF
Liquid injection accessories			
VALCO Cheminert® injection valve, 6 ways, 2 positions, manual, 1/4"-28		1	**724C226186**
CHROMABOND® Flash PP luer lock, female, 1/4"-28		5	**730805**
CHROMABOND® Flash PP luer lock, male, 1/4"-28		5	**730801**
CHROMABOND® Flash 3-way adaptor with valve, 1/4"-28 connections		1	**730895**
Solid injection system			
CHROMABOND® Flash solid injection adaptor 3 ml	3 ml	1	**730821**
CHROMABOND® Flash solid injection adaptor 6 ml	6 ml	1	**730822**
CHROMABOND® Flash solid injection adaptor 10 ml	10 ml	1	**730823**
CHROMABOND® Flash solid injection adaptor 30/55 ml	30 ml	1	**730831**

CHROMABOND® Flash injection systems

Description	Dimension	Pack of	REF
CHROMABOND® Flash solid injections cartridge with luer lock, incl. filter elements	3 ml	10	**730824**
CHROMABOND® Flash solid injections cartridge with luer lock, incl. filter elements	6 ml	10	**730825**
CHROMABOND® Flash solid injections cartridge with luer lock, incl. filter elements	10 ml	10	**730826**
CHROMABOND® Flash solid injections cartridge with luer lock, incl. filter elements	30 ml	10	**730833**
CHROMABOND® Flash solid injections cartridge with luer lock, incl. filter elements*	55 ml	10	**730927**
CHROMABOND® Flash solid injection filter elements for 3 ml cartridges	10 mm	20	**730827**
CHROMABOND® Flash solid injection filter elements for 6 ml cartridges	13 mm	20	**730828**
CHROMABOND® Flash solid injection filter elements for 10 ml cartridges *	16.5 mm	20	**730829**
CHROMABOND® Flash Viton® sealing ring for 10 ml solid injection adaptor *		5	**730925**
* other sizes on request			

Alternative injection systems and methods (in stand-alone mode)

- **liquid injection systems:** the sample is applied to the flash column e.g. via syringe and 3-way valve or with a VICI® medium pressure valve with sample loop (see figures below)
- **solid injection systems:** the sample is adsorbed to a suitable adsorbent (e.g. CHROMABOND® XTR), and the loaded adsorbent is filled into a solid injection cartridge fitted with the corresponding adaptor (right figures below)

The solid injection cartridges

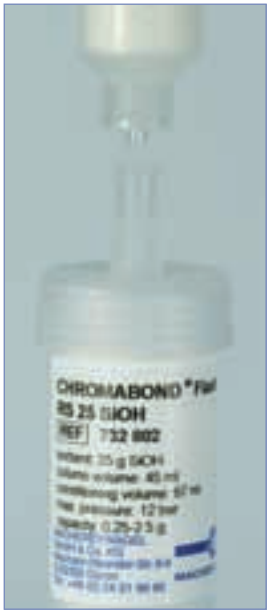
- can be connected directly to the upper luer lock of the cartridges for a pressure tight connection
- are available in 5 different dimensions, because different sample amounts always require adequate solutions
- can be filled easily and are reusable

Liquid injection via syringe and 3-way valve

VICI® medium pressure valve

Solid injection cartridges

Solid injection cartridge on Flash RS



Detail

Syringe filters CHROMAFIL®

Sample Clarification

Syringe filters are used for filtration of suspended matter from liquid samples or gases. With CHROMAFIL®, rapid purification and removal of particles is very simple: just place the filter on the syringe, and you are ready for filtration. Special manipulations are not required. Contamination of sensitive instrumentation by solid impurities can be avoided, thus increasing lifetime of chromatographic columns and equipment.

Advantages:

Polypropylene housing

The housing provides a considerably better solvent stability compared to acrylate and polystyrene filters, featuring a low content of extractable substances.

Lowest content of extractable substances

The the housing of every CHROMAFIL® filter is **ultrasonically sealed (welded), not glued,** because glue may have extractable ingredients. Welding leads to a tight connection between both parts, thus the filter can be used in both directions. No fluid can bypass the membrane. The special **thick rim** of the housing is ideal for use in laboratory robots (e. g. SOTAX®, Benchmate™).

Luer lock on the side of entry

For a safe connection on the high-pressure side every filter provides a luer lock on the side of entry.

Luer exit

For 25 and 3 mm filters: standard luer exit
For 15 mm filters: minispike · This luer configuration offers a low hold-up volume and easy filtration into autosampler vials and NMR tubes.

Filter inlet and filter exit can be fitted to all CHROMABOND® columns and accessories for selective sample preparation with the aid of a special adaptor.

No rupture of membrane due to the impact plate

The input solvent stream is broken and distributed by the impact plate, and does not directly hit the membrane: this prevents rupture of the membrane. The high pressure stream is diverted into four lanes.

Optimum flow geometry because of the star-shaped distribution device

The stream of liquid is broken into 4 lanes by the impact plate and then further distributed to 8 slots in the form of a star connected with 5 or 8 circular channels (for 15 mm and 25 mm filters, respectively). Thus, the fluid is able to penetrate the membrane on the whole surface, not only on a small region; the filter is not plugged up rapidly, which results in a high flow efficiency.

Colour coded filters

Filters with 0.2 µm pores have a yellow upper shell, that of filters with 0.45 µm pores is colourless; the different membrane types are distinguished by different colours of the lower shell.

Different pore sizes for versatile filtration applications

Standard **pore sizes** 0.2 and 0.45 µm (additionally: PET filters with 1.2 µm, glass fibre filters with 1 µm, PES filters with 5 µm). Filters with 0.45 µm pore size efficiently remove fine particles that can plug chromatography columns. Filters with 0.2 µm pore size are excellent for filtration of UHPLC samples or other techniques requiring high purity samples.

Filter sizes

25, 15 and 3 mm diameter: the small diameter filters are especially recommended for very small samples, which require extremely low dead volumes: 5 µl for 3 mm ∅, 35 µl for 15 mm ∅, 80 µl for 25 mm ∅

Recommended filter size depending on sample volume

sample volume	recommended filter diameter
≤ 1 ml	3 mm
1 – 5 ml	15 mm
5 – 100 ml	25 mm

Filters can be **autoclaved** at **121 °C / 1.1 bar** for 30 min.

All 25 mm CHROMAFIL® filters are designed to be 100% compatible and reliale for use with the SOTAX® AT70 smart fully automated dissolution testing systems.

Syringe filters CHROMAFIL®

Depending on your filtration task you can choose filter membranes made from different materials:

CHROMAFIL® BIG-BOXES

- 400 (25 mm) or 800 (15 mm) colour-coded quality syringe filters · 400 labelled Xtra syringe filters
- food safe PE box with screw cap
- economical prices

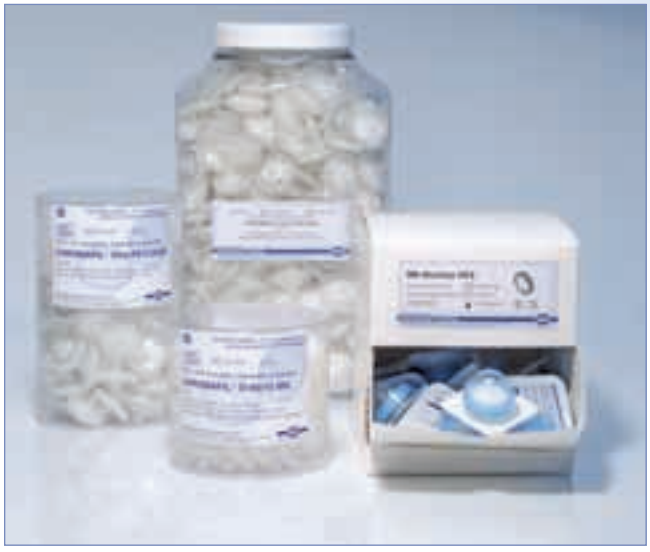
CHROMAFIL® Xtra

labelled for method validation and certification

Xtra: imprint for direct identification of the membrane type, diameter and pore size

Xtra: low bleeding PP housing

Xtra: colour-free plain polypropylene



CHROMAFIL® Combi Filters

Combi syringe filters with a coarse glass fibre prefilter and a small-pore membrane as main filter

User benefits:

- for solutions with a high load of particulate matter: lower back pressure, easy filtration
- for high yields of filtrate: more ml of pure filtrate per filter

The technology:

The glass fibre membrane (1.0 µm) removes coarse particles, before they can block the fine main membrane. This results in a better filtration efficiency, especially for highly contaminated samples.

Housing:	solvent-resistant, ultra low bleed polypropylene
Entry:	Luer lock
Exit:	Luer
Pore diameter:	1.0 / 0.20 µm or 1.0 / 0.45 µm
Filter diameter:	25 mm
Void volume:	< 80 µl
Packing unit:	100 filters / BigBoxes with 400 filters

Sample Clarification

CHROMAFIL® Combi filters

Polyester with glass fibre prefilter (GF/PET)

- hydrophilic multipurpose membrane
- for polar as well as nonpolar solvents
  the HPLC filter, especially suited for mixtures of water and organic solvents
- recommended for solutions with a high load of particulate matter or for highly viscous solutions

Ordering information

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
GF/PET-20/25	1.0/0.20	25	blue	orange	100	**729032**	400	**729032.400**
GF/PET-45/25	1.0/0.45	25	black	orange	100	**729033**	400	**729033.400**

Regenerated cellulose with glass fibre prefilter (GF/RC)

- hydrophilic membrane
- for aqueous and organic/aqueous liquids, i.e. polar and medium polar sample solutions
- recommended for solutions with a high load of particulate matter or for highly viscous aqueous solutions

NEW!

Ordering information

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
GF/RC-20/25	1.0/0.20	25	blue	blue	100	**729050**	400	**729050.400**
GF/RC-45/25	1.0/0.45	25	black	blue	100	**729051**	400	**729051.400**

Polyvinylidene difluoride with glass fibre prefilter (GF/PVDF)

- hydrophilic membrane
- recommended for filtration of biological samples with high particle loads. This filter features a high binding capacity for proteins.
- also suited for filtration of polar and nonpolar solutions

Ordering information

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
GF/P-45/25	1.0/0.45	25	black	white	100	**729039**	400	**729039.400**

Polyester (PET)

- hydrophilic multipurpose membrane
- for polar as well as nonpolar solvents

the HPLC filter, especially suited for mixtures of water and organic solvents

for TOC/DOC determination

not cytotoxic, does not inhibit the growth of microorganisms and higher cells

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]	Colourless top	Colourless bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PET-20/25	0.20	25	labelled	-	100	**729221**	400	**729221.400**
PET-45/25	0.45	25	labelled	-	100	**729220**	400	**729220.400**
PET-120/25	1.2	25	labelled	-	100	**729229**	400	**729229.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PET-20/15 MS	0.20	15	yellow	orange	100	**729022**	800	**729022.800**
PET-45/15 MS	0.45	15	colourless	orange	100	**729023**	800	**729023.800**
PET-20/25	0.20	25	yellow	orange	100	**729021**	400	**729021.400**
PET-45/25	0.45	25	colourless	orange	100	**729020**	400	**729020.400**

MS = minispike on filter exit

Regenerated cellulose (RC)

- hydrophilic membrane with very low adsorption
- for aqueous and organic/aqueous liquids, i.e. polar and medium polar sample solutions
- binding capacity for proteins 84 µg/filter

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]	Colourless top	Colourless bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
RC-20/25	0.20	25	labelled	-	100	**729230**	400	**729230.400**
RC-45/25	0.45	25	labelled	-	100	**729231**	400	**729231.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
RC-20/15 MS	0.20	15	yellow	blue	100	**729036**	800	**729036.800**
RC-45/15 MS	0.45	15	colourless	blue	100	**729037**	800	**729037.800**
RC-20/25	0.20	25	yellow	blue	100	**729030**	400	**729030.400**
RC-45/25	0.45	25	colourless	blue	100	**729031**	400	**729031.400**

MS = minispike on filter exit

Syringe filters CHROMAFIL®

Polytetrafluoroethylene (PTFE)

- hydrophobic membrane
- for nonpolar liquids and gases
- very resistant towards all kinds of solvents as well as acids and bases

  flushing with alcohol, followed by water, makes the originally hydrophobic membrane more hydrophilic

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]	Colourless top	Colourless bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PTFE-20/25	0.20	25	labelled	-	100	**729207**	400	**729207.400**
PTFE-45/25	0.45	25	labelled	-	100	**729205**	400	**729205.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
O-20/3	0.20	3	colourless	colourless	100	**729014**		
O-45/3	0.45	3	colourless	colourless	100	**729015**		
O-20/15 MS	0.20	15	yellow	colourless	100	**729008**	800	**729008.800**
O-45/15 MS	0.45	15	colourless	colourless	100	**729009**	800	**729009.800**
O-20/25	0.20	25	yellow	colourless	100	**729007**	400	**729007.400**

MS = minispike on filter exit

Cellulose mixed esters (MV)

- hydrophilic membrane with very low adsorption
- for aqueous or polar solutions

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]	Colourless top	Colourless bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
MV-20/25	0.20	25	labelled	-	100	**729206**	400	**729206.400**
MV-45/25	0.45	25	labelled	-	100	**729204**	400	**729204.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
A-20/25	0.20	25	yellow	yellow	100	**729006**	400	**729006.400**
A-45/25	0.45	25	colourless	yellow	100	**729004**	400	**729004.400**

Sample Clarification

Cellulose acetate (CA)

- hydrophilic membrane
- for filtration of water-soluble oligomers and polymers, especially suited for biological macromolecules
- very high shape stability in aqueous solutions
- extremely low binding capacity for proteins (21 µg/filter)

- also available in a sterile package (S) for filtration under sterile conditions (each filter individually sealed)

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]	Colourless top	Colourless bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
CA-20/25	0.20	25	labelled	-	100	**729226**	400	**729226.400**
CA-45/25	0.45	25	labelled	-	100	**729227**	400	**729227.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
CA-20/25	0.20	25	yellow	red	100	**729026**	400	**729026.400**
CA-45/25	0.45	25	colourless	red	100	**729027**	400	**729027.400**
Sterile filters								
CA-20/25 S	0.20	25	yellow	red	50	**729024**		
CA-45/25 S	0.45	25	colourless	red	50	**729025**		

Polyamide (PA) = Nylon

- rather hydrophilic membrane
- for aqueous and organic/aqueous medium polar liquids

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]	Colourless top	Colourless bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PA-20/25	0.20	25	labelled	-	100	**729212**	400	**729212.400**
PA-45/25	0.45	25	labelled	-	100	**729213**	400	**729213.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
AO-20/3	0.20	3	light beige	light beige	100	**729010**		
AO-45/3	0.45	3	light beige	light beige	100	**729011**		
AO-20/25	0.20	25	yellow	green	100	**729012**	400	**729012.400**
AO-45/25	0.45	25	colourless	green	100	**729013**	400	**729013.400**

Syringe filters CHROMAFIL®

Polyethersulfone (PES)

- hydrophilic membrane
- for aqueous liquids and aqueous liquids with low organic contents
- very low adsorption for pharmaceuticals and proteins
- good stability against acids and bases
- for sterile filtration of non-sterile solutions we recommend the CHROMAFIL® Sterilizer PES (each filter individually sealed)
- binding capacity for proteins 29 µg/filter

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]	Colourless top	Colourless bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PES-20/25	0.20	25	labelled	-	100	**729240**	400	**729240.400**
PES-45/25	0.45	25	labelled	-	100	**729241**	400	**729241.400**
PES-500/25	5.0	25	labelled	-	100	**729242**	400	**729242.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PES-20/25	0.20	25	yellow	amber	100	**729040**	400	**729040.400**
Sterile filters for sterilisation								
Sterilizer PES	0.20	25	blue rim		50	**729401**		

Polyvinylidene difluoride (PVDF)

- hydrophilic membrane
- for polar and nonpolar solutions, water-soluble oligomers and polymers like proteins
- binding capacity for proteins 82 µg/filter

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]	Colourless top	Colourless bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PVDF-20/25	0.20	25	labelled	-	100	**729218**	400	**729218.400**
PVDF-45/25	0.45	25	labelled	-	100	**729219**	400	**729219.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF
PVDF-20/15 MS	0.20	15	yellow	white	100	**729043**
PVDF-45/15 MS	0.45	15	colourless	white	100	**729044**

MS = minispike on filter exit

NEW!

Glass fibre (GF)

- inert filter, nominal pore size 1 µm, allows higher flow rates than small pore filters
- for solutions with high loads of particulate matter or for highly viscous solutions (e.g. soil samples, fermentation broths)
- as prefilters for other CHROMAFIL® filters, they prevent plugging of the membrane

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]	Colourless top	Colourless bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
GF-100/25	nom. 1.0	25	labelled	-	100	**729228**	400	**729228.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Colour code top	Colour code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
GF-100/15 MS	nom. 1.0	15	blue	colourless	100	**729034**		
GF-100/25	nom. 1.0	25	yellow	black	100	**729028**	400	**729028.400**
MS = minispike on filter exit								

Syringe filters CHROMAFIL®

Chemical compatibility of filter materials

The following table lists the chemical compatibility of our CHROMAFIL® materials. The chemical compatibility depends on several parameters such as time, pressure, temperature and concentration. In most cases, CHROMAFIL® filters will have only short contact with a solvent. In these cases they may be used despite of limited compatibility.

For example, a PTFE filter with PP housing does not liberate any UV-detectable substances during filtration of 5 ml THF, although PP shows only limited resistance towards THF.

Solvent	Material									
	MV	CA	RC	PA	PTFE	PVDF	PES	PET	GF	PP
Acetaldehyde	⊖	⊖	⊕	○	⊕	⊕		⊕	⊕	○
Acetic acid, 100 %	⊖	⊖	⊖	⊖	⊕	⊕	⊕	⊕	⊕	⊕
Acetone	⊖	⊖	⊕	⊕	⊕	⊖	⊖	⊕	⊕	⊕
Acetonitrile	⊖	⊖	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Ammonia, 25 %	⊖	⊖	○	⊖	⊕	⊕	⊕	○	⊕	⊕
Benzene	⊕	⊕	⊕	⊕	⊕	○		⊕	⊕	○
n-Butanol	⊕	⊕	⊕	○	⊕	⊕	⊕	⊕	⊕	⊕
Cyclohexane	⊕	⊕	⊕	○	⊕	⊕	⊕	⊕	⊕	⊕
Dichloromethane	⊕	⊖	⊕	⊖	⊕	⊕	⊖	⊕	⊕	⊖
Diethyl ether	○	○	⊕	⊕	⊕	⊕	⊕	⊕	⊕	○
Dimethylformamide	⊖	⊖	○	⊕	⊕	⊖	⊖	⊕	⊕	⊕
1,4-Dioxane	⊖	⊖	⊕	⊕	⊕	○	⊖	⊕	⊕	○
Ethanol	⊖	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Ethyl acetate	⊖	⊖	⊕	⊕	⊕	⊕	⊕	⊕	⊕	○
Ethylene glycol	○	○	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Formic acid, 100 %	⊕	⊖	○	⊖	⊕	⊕	⊕	○	⊕	⊕
Hydrochloric acid, 30 %	⊖	⊖	⊖	⊖	⊕	⊕	⊕	⊖	⊕	⊕
Methanol	⊖	⊖	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Nitric acid, 65 %	⊖	⊖	⊖	⊖	○	○		○	⊕	⊖
Oxalic acid, 10 % aqueous	⊕	⊖	⊕	⊖	⊕	⊕		⊕	⊕	⊕
Petroleum ether	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Phosphoric acid, 80 %	⊖	⊖	○	⊖	⊕	○		⊕	⊕	⊕
Potassium hydroxide, 1 mol/l	⊖	⊖	○	⊕	⊕	○	⊕	○	⊕	⊕
2-Propanol	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Sodium hydroxide, 1 mol/l	⊖	⊖	○	⊕	⊕	○	○	○	○	⊕
Tetrachloromethane	⊕	⊖	⊕	⊕	⊕	○		⊕	⊕	○
Tetrahydrofuran	⊖	⊖	⊕	○	⊕	⊕	⊖	⊕	⊕	○
Toluene	⊕	⊖	⊕	⊕	⊕	⊕	⊕	⊕	⊕	○
Trichloroethene	⊕	⊕	⊕	○	⊕	⊕		⊕	⊕	○
Trichloromethane	⊕	⊖	⊕	⊖	⊕	⊕	⊖	⊕	⊕	⊖
Urea	⊕	⊕	⊕	⊕	⊕	⊕		⊕	⊕	⊕
Water	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Xylene	⊕	⊕	⊕	⊕	⊕	○		⊕	⊕	○

Data not guaranteed.

⊕ resistant, ⊖ not resistant, ○ limited resistance

MV = cellulose mixed esters, CA = cellulose acetate, RC = regenerated cellulose, PA = polyamide, PTFE = polytetrafluoroethylene, PVDF = polyvinylidene difluoride, PES = polyethersulfone, PET = polyester, GF = glass fibre, PP = polypropylene (housing material)

CHROMABOND® MULTI 96 filter plates

- 96-well polypropylene plates for simultaneous filtration of 96 samples
- advantages of this high-throughput system are:
  - economical by saving time and solvent
  - use of multi-channel pipettors facilitates liquid transfer steps
  - readily adaptable to all common automated / robotic handling systems
  - minimised dead volume (≤ 40 µl)
- membrane materials correspond to the respective CHROMAFIL® filters

Ordering information

Description	Pack of	REF
Filter plates with cellulose mixed ester filter elements (0.20 µm)	1	**738770.M**
Filter plates with cellulose mixed ester filter elements (0.45 µm)	1	**738771.M**
Filter plates with cellulose mixed ester filter elements (3.0 µm)	1	**738772.M**
Filter plates with RC filter elements (regenerated cellulose, 0.2 µm)	1	**738656.M**
Filter plates with RC filter elements (regenerated cellulose, 0.45 µm)	1	**738657.M**
Filter plates with PTFE filter elements (0.2 µm)	1	**738660.M**
Filter plates with PTFE filter elements (0.45 µm)	1	**738661.M**
Filter plates with PTFE filter elements (1.0 µm)	1	**738662.M**
Filter plates with PTFE filter elements (3.0 µm)	1	**738663.M**
Filter plates with PE filter elements (20 µm)	1	**738655.M**
Filter plates with PE filter elements (50 µm)	1	**738659.M**
Filter plates with glass fibre filter elements (nominal 1 µm)	1	**738655.2M**
Filter plates with glass fibre filter elements (nominal 3 µm)	1	**738658.M**
CHROMABOND® MULTI 96 vacuum manifold for monoblocks, with reservoir tank, vacuum gauge, and control valve, required for filtration with 96-well filter plates	1	**738630.M**

Disposable syringes with luer tip (body and piston made from polypropylene)

Sample volume	Pack of	REF
2 ml	100	**729100**
5 ml	100	**729101**
10 ml	100	**729102**

General material information · vials and caps

Materials

According to the high requirements of chemical analyses, especially with regard to reproducibility combined with high detection sensitivity, the container material for the respective samples is of great importance. In general, for this purpose vials made from glass are used. The hydrolytic resistance of the glass can be taken as a measure for its chemical inertness. Determination of the hydrolytic resistance and the resulting classification of a glass grade are governed by the German and international industrial standard DIN 12111 / ISO 719. Glass grades are classified in hydrolytic classes. We supply vials from the following classes:

1st hydrolytic class

Glass grades made from borosilicate, such as Duran®, Pyrex®, Fiolax® and others belong to this group. Glass of this class, which is often called neutral glass, has a very good chemical resistance towards acid and neutral solutions. The relatively low alkali content permits good values for the resistance towards alkaline solutions, too. If nothing else is stated, the vials of our programme are made from glass of the 1st hydrolytic class (manufactured in accordance with Eu.Ph. VI Ed., U.S.P. XXXI Ed., DAB-2008, Ph. Jap. 13).

3rd hydrolytic class, AR glass

Glass of this class, also called soft glass or lime soda glass, has a medium hydrolytic resistance. For long-time storage of aqueous and especially alkaline-aqueous samples (for example to use them repeatedly) it is not recommended. Nevertheless, it can be used for many analytical applications.

Physical properties of glass grades

Parameter	1st hydrolytic class	3rd hydrolytic class
density	2.64	2.5
thermal coefficient of linear expansion (K^{-1})	$60 \cdot 10^{-7}$	$85 \cdot 10^{-7}$
quenching stability (Δ T in K) according to DIN 52321	60	42
internal pressure resistance (bar) according to DIN 52320	at least 6	at least 6

We supply the following types of sample bottles:

- vials with crimp top and corresponding caps (page 77)
- special vials with special caps (page 87)
- screw thread vials and screw caps (page 88)
- sealing disks for individual combinations of cap and seal

Except for a few frequently used combi packs, vials and caps can be ordered separately, thus allowing a wide range of possible combinations.

Advantages of the DIN crimp top:

Crimp top vials are available with 3 different rim heights: 3 mm, DIN crimp top with 3.6 mm and 4 mm. When using only one crimper, tedious adjustments for the different heights are necessary. The standardized DIN crimp top avoids this problem. The rim height acc. to DIN 58366 should be 3.6 ± 0.2 mm. We supply vials with DIN crimp top for volumes above 5 ml.

Temperature stability of sealing disks and plastic caps

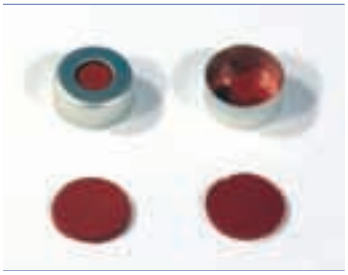
shaped butyl rubber disks, centre coated with PTFE	120 °C (-40 °C)
butyl rubber	190 °C (-30 °C)
red rubber	110 °C (-40 °C)
silicone rubber	200 °C (-60 °C)
PTFE	250 °C
PE (polyethylene)	80 °C
PP (polypropylene)	120 - 130 °C

Allowable variation for the thickness of sealing disks is ± 0.25 mm.

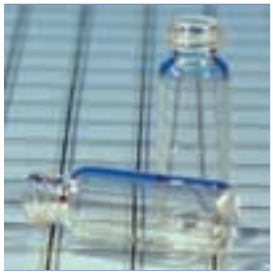
Except where explicitly mentioned, caps with sealing disks are supplied assembled, i.e. ready-to-use. Seals below the caps are shown for illustration purposes only, and they are pictured upside down.

All drawings in this chapter are scale 1:2.

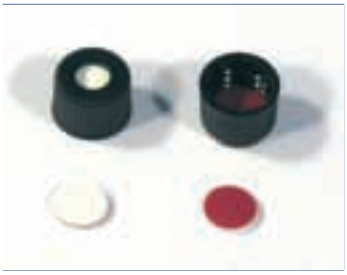
Crimp top vials N 11-1



Crimp caps N 11



Screw thread vials N 8-1



Screw caps N 8 with sealing disks

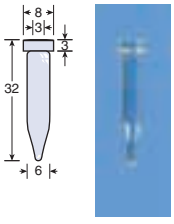
Crimp top vials and caps

- **Vials with crimp top** are injection bottles with rim diameters of 8, 11, 13 or 20 mm which can be closed with crimp caps or PE caps (PE caps only for 11 and 20 mm rim diameter).
- **Vials with snap ring design** with 11 mm rim diameter may be closed with PE snap-on caps or crimp caps.
- **Conic vials** are vials with tapered inner shape for small sample volumes, which can be closed with crimp caps or PE caps.
- **Micro inserts** are used to reduce the volume of standard sample vials for application with very small sample volumes. Vials are closed as usual. As an alternative for small volumes you may use the sample vials with conic inner shape (conic vials).
- **Crimp caps** can be used for crimp top vials or vials with snap ring design. They are available with or without sealing disks, with centre hole, tear-off middle seal and as tear-off caps. Caps with centre hole are made from aluminium, aluminium with steel insert or steel. The two latter are magnetic.
- **PE caps** are also used for crimp top vials, while **snap-on caps** are used for vials with snap ring design.
- Additionally we offer a versatile range of **sealing disks** for crimp caps, PE caps and snap-on caps.

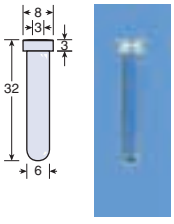
Ordering information

Vials N 8 with crimp top

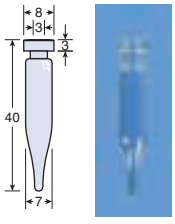
Designation	net volume	rim diameter	height	OD x height	Pack of	REF
N 8-02, conic, clear	0.3 ml	8 mm	3 mm	6 x 32 mm	100	**70286**
N 8-03, clear, round bottom	0.3 ml	8 mm	3 mm	6 x 32 mm	100	**70282**
N 8-07, conic, clear	0.7 ml	8 mm	3 mm	7 x 40 mm	100	**70212**
N 8-07, conic, amber	0.7 ml	8 mm	3 mm	7 x 40 mm	100	**70212.1**
N 8-08, clear	0.8 ml	8 mm	3 mm	8.2 x 30 mm	100	**70251**



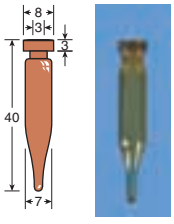
N 8-02 **70286**



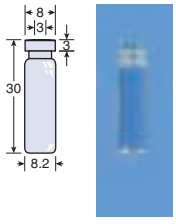
N 8-03 **70282**



N 8-07 **70212**



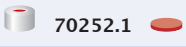
N 8-07 **70212.1**

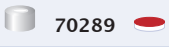


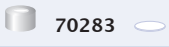
N 8-08 **70251**

Aluminium crimp caps N 8 with centre hole, with or without sealing disks

	hole diameter	sealing disk material	thickness	hardness		
N 8 TB/oA-4 aluminium coloured	4 mm	natural rubber red / PTFE colourless	0.9 mm	45 shore	100	**70252.1**
N 8 TS/oA aluminium coloured	4 mm	silicone rubber white / PTFE red	1.3 mm	45 shore	100	**70289**
N 8 T/oA aluminium coloured	4 mm	PTFE white	0.25 mm	53 shore	100	**70283**
N 8 aluminium coloured	4 mm	without sealing disk	-	-	100	**702800**


70252.1


70289


70283

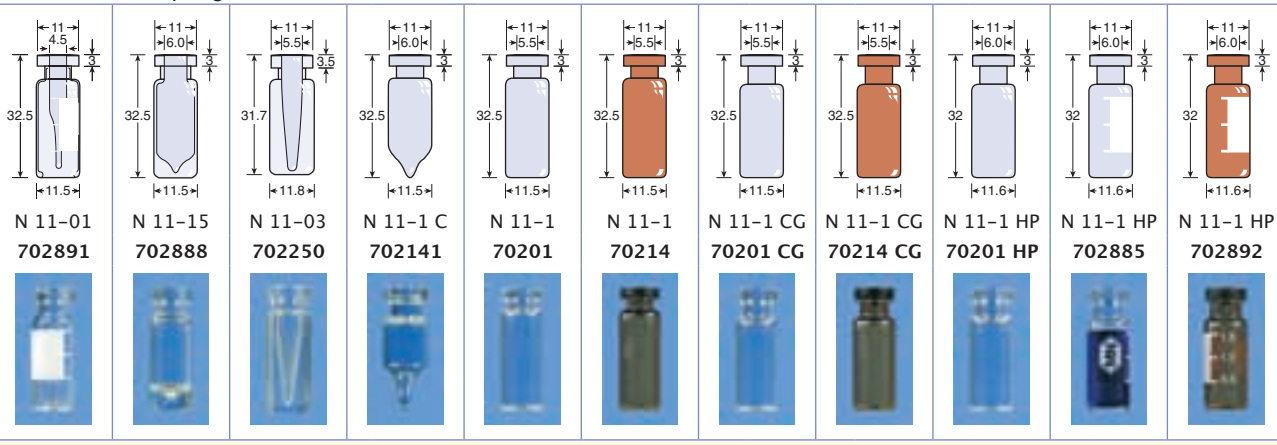

702800

Sealing disks N 8

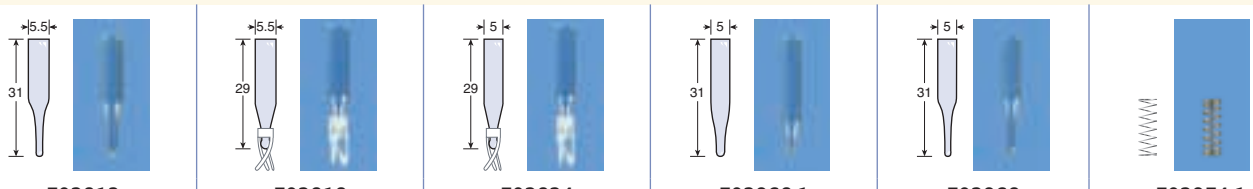
material	drawing	OD	thickness	hardness		
N 8 natural rubber red / PTFE colourless		8 mm	1.3 mm	60 shore	100	**70246**
N 8 butyl rubber beige / PTFE grey		8 mm	1.3 mm	55 shore	100	**70247**
N 8 silicone rubber white / PTFE red		8 mm	1.3 mm	35 shore	100	**70248**
N 8 silicone rubber white / PTFE blue, slotted		8 mm	1.0 mm	55 shore	100	**702481**
N 8 PTFE white		8 mm	0.25 mm	53 shore	100	**70261**

Crimp top vials and caps N 11

Designation	net volume	rim diameter	height	OD x height	Pack of	REF
Vials N 11 with crimp top for nearly all autosamplers, for detailed compatibility see pages 94 – 97						
N 11-01, integrated micro insert with label area and scale	0.2 ml	11 mm	3 mm	11.5 x 32.5 mm	1	**702891**
N 11-15, integrated micro insert 15 µl / 1 ml, wide opening	0.015 / 1 ml	11 mm	3 mm	11.5 x 32.5 mm	100	**702888**
N 11-03 conic, clear, reaction vial	0.15 ml	11 mm	3.5 mm	11.8 x 31.7 mm	1	**702250**
N 11-1 C, conic, clear	1 ml	11 mm	3 mm	11.5 x 32.5 mm	100	**702141**
N 11-1, clear	1.5 ml	11 mm	3 mm	11.5 x 32.5 mm	100	**70201**
N 11-1, amber	1.5 ml	11 mm	3 mm	11.5 x 32.5 mm	100	**70214**
N 11-1 CG, clear	1.5 ml	11 mm	3 mm	11.5 x 32.5 mm	100	**70201 CG**
N 11-1 CG, amber	1.5 ml	11 mm	3 mm	11.5 x 32.5 mm	100	**70214 CG**
Micro inserts for N 11-1 and N 11-1 CG, with mounted PP springs	0.25 ml	–	–	5 x 29 mm	100	**702824**
Micro inserts for N 11-1 standard, clear	0.25 ml	–	–	5 x 31 mm	100	**702968.1**
Micro inserts for N 11-1, strongly tapered	0.2 ml	–	–	5 x 31 mm	100	**702968**
Springs for micro inserts 5 x 31 mm	–	–	–	–	100	**702974.1**
N 11-1 HP, clear, wide opening	1.5 ml	11 mm	3 mm	11.6 x 32 mm	100	**70201 HP**
N 11-1 HP, clear, with label area and scale, wide opening	1.5 ml	11 mm	3 mm	11.6 x 32 mm	100	**702885**
N 11-1 HP, amber, with label area and scale, wide opening	1.5 ml	11 mm	3 mm	11.6 x 32 mm	100	**702892**
Micro inserts for N 11-1 HP, strongly tapered	0.2 ml	–	–	5.5 x 31 mm	100	**702813**
Micro inserts for N 11-1 HP, with mounted PP springs	0.25 ml	–	–	5.5 x 29 mm	100	**702818**



Micro inserts for vials N 11-1



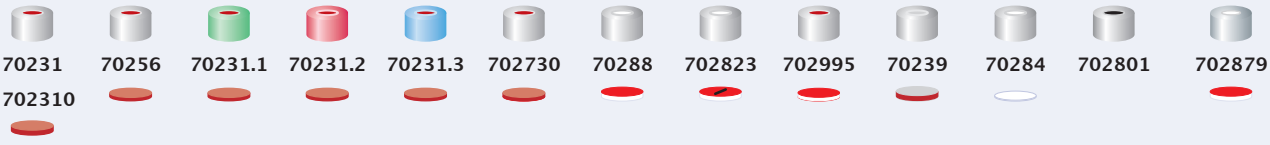
For more crimpable vials with micro insert also see Vials with snap ring design page 80.

Crimp top vials and caps N 11

Designation	Dimensions (all drawings scale 1:2)	Pack of	REF
Combi packs of crimp top vials and caps N 11, with sealing disks assembled for all common autosamplers			
Combi pack vials N 11-1 HP, clear + aluminium crimp caps N 11 TB/oA-1.0 with centre hole, sealing disks butyl rubber red / PTFE colourless		1000 each	**702842**
Combi pack vials N 11-1 HP, clear + aluminium crimp caps N 11 TS/oA with centre hole, sealing disks silicone rubber white / PTFE red		1000 each	**702843**
Combi pack vials N 11-1 HP, clear + aluminium crimp caps N 11 TB/oA-1.3 with centre hole, sealing disks natural rubber red / PTFE colourless; suited for HPLC and GC *NEW!*		1000 each	**702851**
Combi pack vials N 11-1, clear + aluminium crimp caps N 11 TB/oA-1.0 with centre hole, sealing disks natural rubber red / PTFE colourless; recommended for HPLC *NEW!*		1000 each	**702852**
Combi pack vials N 11-1 HP, clear + aluminium crimp caps N 11 RR/oA-1.0 with centre hole, sealing disks red rubber red / FEP colourless *NEW!*		1000 each	**702854**

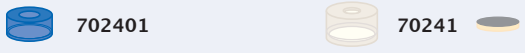
Crimp caps N 11 with centre hole

	hole diameter	sealing disk material	thickness	hardness		
Aluminium crimp caps with or without sealing disks (caps with sealing disks are assembled)						
N 11 TB/oA aluminium coloured	5.6 mm	natural rubber red / PTFE colourless	1.3 mm	60 shore	100	**70231**
N 11 TB/oA-1,3 aluminium coloured *NEW!*	5,6 mm	natural rubber red / PTFE colourless	1.3 mm	60 Shore	100	**702310**
N 11 TB/oA-0.9 aluminium coloured	5.6 mm	butyl rubber red / PTFE colourless	0.9 mm	45 shore	100	**70256**
N 11 TB/oA green	5.6 mm	butyl rubber red / PTFE colourless	0.9 mm	45 shore	100	**70231.1**
N 11 TB/oA red	5.6 mm	natural rubber red / PTFE colourless	0.9 mm	45 shore	100	**70231.2**
N 11 TB/oA blue	5.6 mm	butyl rubber red / PTFE colourless	0.9 mm	45 shore	100	**70231.3**
N 11 RR/oA aluminium col. *NEW!*	5.6 mm	red rubber red / FEP colourless	1.0 mm	45 shore	100	**702730**
N 11 TS/oA aluminium coloured	5.6 mm	silicone rubber white / PTFE red	1.3 mm	35 shore	100	**70288**
N 11 TS/oAKS aluminium coloured	5.6 mm	silicone rubber white / PTFE red, slotted	1.3 mm	55 shore	100	**702823**
N 11 TST/oA aluminium coloured	5.6 mm	PTFE red / silicone rubber white / PTFE red	1.0 mm	45 shore	100	**702995**
N 11 TBT/oA aluminium coloured	5.6 mm	PTFE light grey / butyl rubber red / PTFE light grey	1.3 mm	55 shore	100	**70239**
N 11 T/oA aluminium coloured	5.6 mm	PTFE white	0.25 mm	53 shore	100	**70284**
N 11 aluminium coloured	5.6 mm	without sealing disk	–	–	100	**702801**
Steel crimp caps with sealing disks, assembled						
N 11 TS/oA-M magnetic	5 mm	silicone rubber white / PTFE red	1.3 mm	45 shore	100	**702879**



PE caps (caps with sealing disks are **not assembled**)

without centre hole, blue, thin piercing area, for N 11 crimp top vials						
N 11	–	–	–		100	**702401**
with centre hole for vials N 11 with 3 mm rim						
N 11 TB/oA	4.5 mm	butyl rubber beige / PTFE grey	1.3 mm	55 shore	100	**70241**
N 11	4.5 mm	–	–	–	100	**70265**



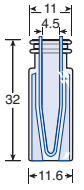
Snap ring vials and caps N 11

Sealing disks N 11

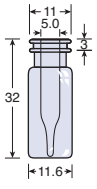
Designation	Dimensions (all drawings scale 1:2)				Pack of	REF
material	drawing	OD	thickness	hardness		
N 11 natural rubber red / PTFE colourless		11 mm	1.3 mm	60 shore	100	**702903**
N 11 butyl rubber beige / PTFE grey		11 mm	1.3 mm	55 shore	100	**70268**
N 11 silicone rubber white / PTFE red		11 mm	1.3 mm	35 shore	100	**70263**
N 11 PTFE red / silicone rubber white / PTFE red		11 mm	1.3 mm	45 shore	100	**70264**
N 11 PTFE white		11 mm	0.25 mm	53 shore	100	**70262**

Vials N 11 with snap ring design

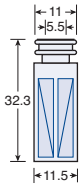
	net volume	rim diameter	height	OD x height		
N 11-1, TPX with glass micro insert 0.2 ml, clear	0.2 ml	11 mm	–	11.6 x 32 mm	100	**702708**
N 11-01, clear, with integrated glass micro insert	0.2 ml	11 mm	–	11.6 x 32 mm	100	**702709**
N 11-03 PP with integrated micro insert, polypropylene	0.3 ml	11 mm	–	11.5 x 32.3 mm	100	**702809**
N 11-1, clear, wide opening	1.5 ml	11 mm	–	11.5 x 32.5 mm	100	**702714**
N 11-1, clear, wide opening, with label area	1.5 ml	11 mm	–	11.5 x 32.5 mm	100	**702713**
N 11-1, amber, wide opening, with label area	1.5 ml	11 mm	–	11.5 x 32.5 mm	100	**702712**
Micro inserts for snap ring vials N 11, with mounted PP springs	0.25 ml	–	–	5.5 x 29 mm	100	**702818**
Micro inserts for snap ring vials 15 mm tip, strongly tapered	0.2 ml	–	–	5.5 x 31 mm	100	**702715**
Micro inserts for snap ring vials, 12 mm tip	0.25 ml	–	–	5.5 x 31 mm	100	**702716**



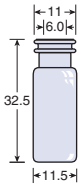
N 11-1 TPX
702708



N 11-01
702709

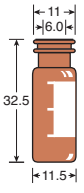


N 11-03 PP
702809

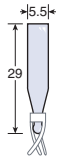


N 11-1
702714

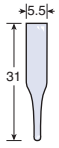
N 11-1
702713



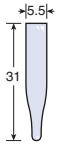
N 11-1
702712



micro insert
702818



micro insert
702715



micro insert
702716

All vials N 11 with snap ring design can also be used with N 11 crimp caps (see previous page)

Snap ring caps with centre hole

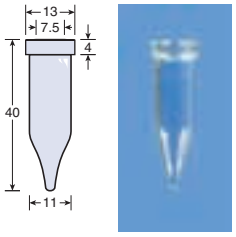
		hole diameter	sealing disk material	thickness	hardness		
N 11, transparent		6 mm	natural rubber orange red / PTFE colourless	1.0 mm	60 shore	100	**702711**
N 11, transparent	*NEW!*	6 mm	red rubber red / FEP colourless	1.0 mm	45 shore	100	**702731**
N 11, transparent		6 mm	silicone rubber white / PTFE red	1.3 mm	45 shore	100	**702710**
N 11, blue		6 mm	silicone rubber white / PTFE red	1.3 mm	45 shore	100	**702710.1**
N 11, transparent		6 mm	PTFE red / silicone rubber white / PTFE red	1.0 mm	45 shore	100	**702718**
N 11, blue		6 mm	PTFE red / silicone rubber white / PTFE red	1.0 mm	45 shore	100	**702718.1**

Crimp top vials and caps N 13

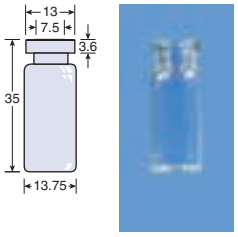
Designation	Dimensions (all drawings scale 1:2)				Pack of	REF
N 11, transparent	6 mm	silicone rubber white / PTFE blue, slotted	1.0 mm	55 shore	100	**702717**
N 11, blue	6 mm	as above	1.0 mm	55 shore	100	**702717.1**
N 11, blue	6 mm	as above, but cross-slotted	1.0 mm	55 shore	100	**702717.2**

Vials N 13 with crimp top

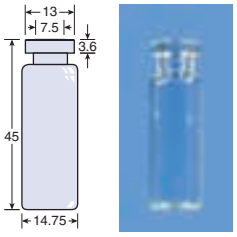
	net volume	rim diameter	height	OD x height		
N 13-1 TK, clear	1 ml	13 mm	4 mm	11 x 40 mm	100	**70255**
N 13-2, clear	2 ml	13 mm	3.6 mm	13.75 x 35 mm	100	**70203**
N 13-4, clear	4 ml	13 mm	3.6 mm	14.75 x 45 mm	100	**70253**
N 13-4 TK, clear	2 ml	13 mm	4 mm	11 x 43 mm	100	**70258**



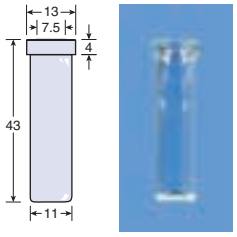
N 13-1 TK
70255



N 13-2
70203



N 13-4
70253



N 13-4 TK
70258

Crimp caps N 13

	hole diameter	material	sealing disk thickness	hardness		
Aluminium crimp caps with centre hole, with or without sealing disks						
N 13 TB/oA aluminium coloured	6 mm	shaped butyl rubber disk dark grey / centre coated with PTFE light grey	2 mm	50 shore	100	**70257**
N 13 aluminium coloured	6 mm	without sealing disk · use sealing disks N 12	-	-	100	**702802**
Aluminium crimp caps with tear-off middle seal						
N 13 TB gold coloured	-	shaped butyl rubber disk dark grey / centre coated with PTFE light grey	2 mm	50 shore	100	**70232**
N 13 gold coloured	-	without sealing disk · use sealing disks N 12	-	-	100	**702803**

Stoppers N 13

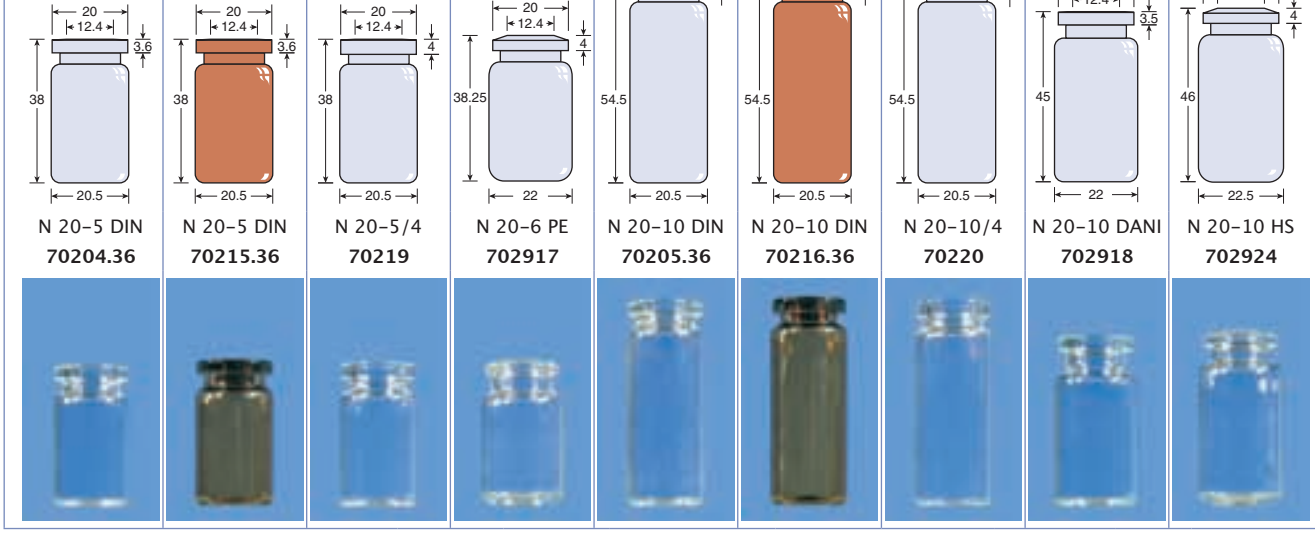
Bromobutyl rubber stoppers N 13 grey				45 shore	100	**702820**

Sealing disks for crimp caps N 13

material	drawing	OD	thickness	hardness		
N 12 PTFE white		12 mm	0.25 mm	53 shore	100	**70260**
N 12 natural rubber orange red / PTFE colourless		12 mm	1.3 mm	60 shore	100	**702967**

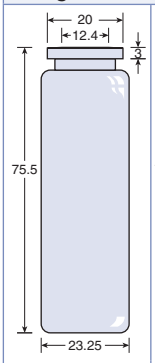
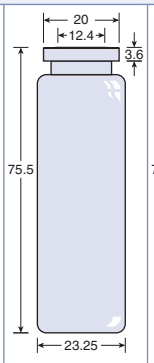
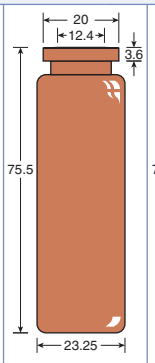
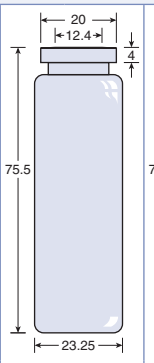
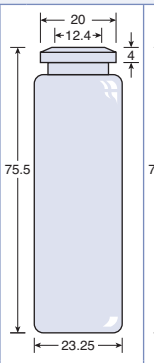
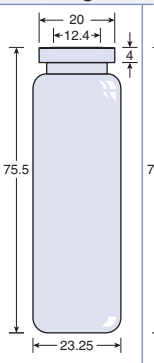
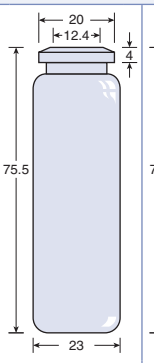
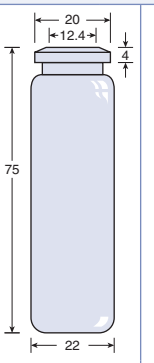
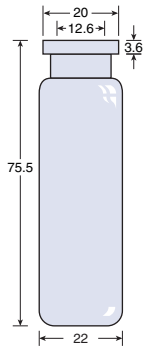
Crimp top vials N 20

Designation	net volume	rim diameter	height	OD x height	Pack of	REF
Vials N 20 with crimp top (volume 5, 6 and 10 ml)						
N 20-5 DIN, clear	5 ml	20 mm	3.6 mm	20.5 x 38 mm	100	**70204.36**
N 20-5 DIN, amber	5 ml	20 mm	3.6 mm	20.5 x 38 mm	100	**70215.36**
N 20-5/4, clear	5 ml	20 mm	4 mm	20.5 x 38 mm	100	**70219**
N 20-6 PE, clear, conic rim, rounded bottom edges	6 ml	20 mm	4 mm	22 x 38.25 mm	100	**702917**
N 20-10 DIN, clear	10 ml	20 mm	3.6 mm	20.5 x 54.5 mm	100	**70205.36**
N 20-10 DIN, amber	10 ml	20 mm	3.6 mm	20.5 x 54.5 mm	100	**70216.36**
N 20-10/4, clear	10 ml	20 mm	4 mm	20.5 x 54.5 mm	100	**70220**
N 20-10 DANI, clear	10 ml	20 mm	3.5 mm	22 x 45 mm	100	**702918**
N 20-10 HS, conic rim, rounded bottom edges, wall 1.3 mm thick	10 ml	20 mm	4 mm	22.5 x 46 mm	100	**702924**



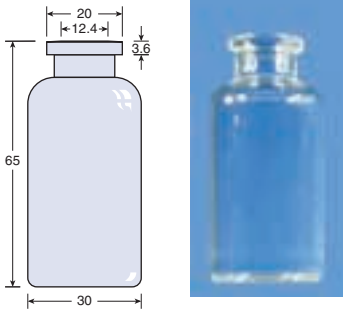
Designation	net volume	rim diameter	height	OD x height	Pack of	REF
Vials N 20 with crimp top (volume 20 ml)						
N 20-20, clear	20 ml	20 mm	3 mm	23.25 x 75.5 mm	100	**70206**
N 20-20 DIN, clear	20 ml	20 mm	3.6 mm	23.25 x 75.5 mm	100	**70206.36**
N 20-20 DIN, amber	20 ml	20 mm	3.6 mm	23.25 x 75.5 mm	100	**70217.36**
N 20-20/4, clear	20 ml	20 mm	4 mm	23.25 x 75.5 mm	100	**70226**
N 20-20 HS, clear, conic rim, wall 0.95 mm thick	20 ml	20 mm	4 mm	23.25 x 75.5 mm	100	**70207**
N 20-20 R, clear, rounded bottom edges, wall 1.0 mm thick	20 ml	20 mm	4 mm	23.25 x 75.5 mm	100	**70218**
N 20-20 PE, clear, conic rim, rounded bottom edges for PE autosamplers, wall 1.2 mm thick	20 ml	20 mm	4 mm	23 x 75.5 mm	100	**70254**
N 20-20 DANI, clear, conic rim, rounded bottom for PE / CTC autosamplers, wall 1.2 mm thick	20 ml	20 mm	4 mm	22 x 75 mm	100	**702261**
N 20-20 HP / CTC, clear, flat crimp top, long neck, rounded bottom for PE / CTC and HP autosamplers, wall 1.2 mm thick	20 ml	20 mm	3.6 mm	22 x 75.5 mm	100	**702263**

Crimp top vials N 20

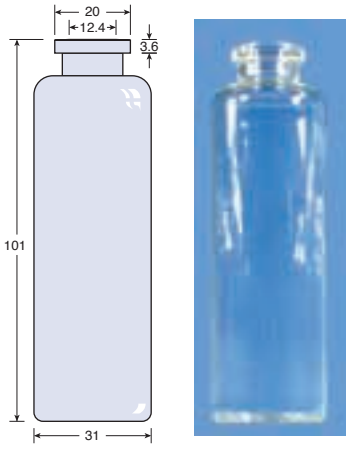
Designation	Dimensions (all drawings scale 1:2)	Pack of	REF
N 20-20			**70206**
N 20-20 DIN			**70206.36**
N 20-20 DIN			**70217.36**
N 20-20/4			**70226**
N 20-20 HS			**70207**
N 20-20 R			**70218**
N 20-20 PE			**70254**
N 20-20 DANI			**702261**
N 20-20 HP / CTC			**702263**

Vials N 20 with crimp top (volume 25, 50 and 100 ml)

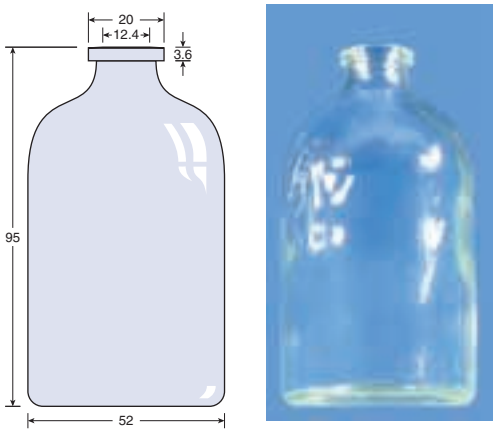
	net volume	rim diameter	height	OD x height		
N 20-25 DIN, clear	25 ml	20 mm	3.6 mm	30 x 65 mm	100	**70210.36**
N 20-50 DIN, clear	50 ml	20 mm	3.6 mm	31 x 101 mm	100	**70208.36**
N 20-100 DIN, clear (3rd hydrolytic class)	100 ml	20 mm	3.6 mm	52 x 95 mm	88	**70209.1**



N 2025 DIN
70210.36



N 20-50 DIN
70208.36

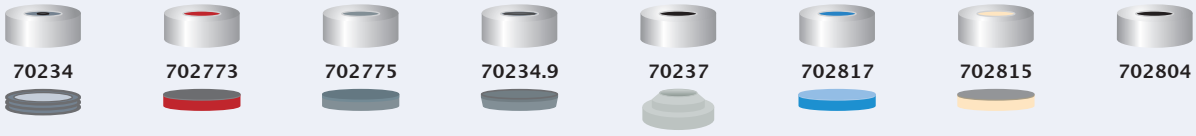


N 20-100 DIN
70209.1

Vials and Accessories

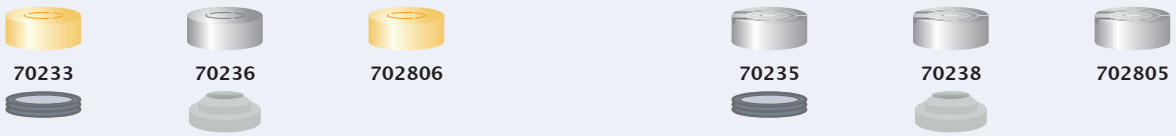
Crimp caps N 20

Designation	Dimensions (all drawings scale 1:2)				Pack of	REF
Crimp caps N 20						
	hole diameter	sealing disk material	thickness	hardness		
Aluminium crimp caps with centre hole, with or without sealing disks						
N 20 TB/oA aluminium coloured	10 mm	shaped butyl rubber disk dark grey / centre coated with PTFE light grey	3 mm	50 shore	100	**70234**
N 20 TB/oA aluminium coloured	10 mm	butyl rubber red / PTFE grey	3 mm	55 shore	100	**702773**
N 20 TB/oA aluminium coloured *NEW!*	10 mm	butyl rubber light grey / PTFE dark grey	3 mm	50 shore	100	**702775**
N 20 TB/oA-F aluminium coloured	10 mm	shaped butyl rubber disk grey / PTFE dark grey	3 mm	50 shore	100	**70234.9**
N 20 B/oA aluminium coloured	10 mm	butyl rubber stopper grey, **not assembled**	–	37 shore	100	**70237**
N 20 TS/oA aluminium coloured	10 mm	silicone rubber blue / PTFE colourless	3 mm	40 shore	100	**702817**
N 20 TS/oA aluminium coloured	10 mm	silicone rubber cream / PTFE grey	3 mm	60 shore	100	**702815**
N 20 aluminium coloured	10 mm	without sealing disk	–	–	100	**702804**



Aluminium crimp caps with centre hole, special perforation for burst protection, with sealing disks						
N 20 TB/HS aluminium coloured	8 mm	shaped butyl rubber disk grey / PTFE grey	3 mm	50 shore	100	**70234.8**
N 20 TB/HS aluminium coloured	8 mm	butyl rubber red / PTFE grey	3 mm	55 shore	100	**702836**
N 20 TB/HS aluminium coloured *NEW!*	8 mm	butyl rubber light grey / PTFE dark grey	3 mm	50 shore	100	**702829**
N 20 TS/HS aluminium coloured	8 mm	silicone rubber blue / PTFE colourless	3 mm	40 shore	100	**702927**
N 20 TS/HS aluminium coloured	8 mm	silicone rubber cream / PTFE grey	3 mm	60 shore	100	**702835**

Aluminium crimp caps with tear-off middle seal, with or without sealing disks						
N 20 TB gold coloured	–	shaped butyl rubber disk dark grey / centre coated with PTFE light grey	3 mm	50 shore	100	**70233**
N 20 B aluminium coloured	–	butyl rubber stopper grey, **not assembled**	–	37 shore	100	**70236**
N 20 gold coloured	–	without sealing disk	–	–	100	**702806**
Aluminium tear-off crimp caps, with or without sealing disks						
N 20 TB/mE aluminium coloured	–	shaped butyl rubber disk dark grey / centre coated with PTFE light grey	3 mm	50 shore	100	**70235**
N 20 B/mE aluminium coloured	–	butyl rubber stopper grey, **not assembled**	–	37 shore	100	**70238**
N 20 aluminium coloured	–	without sealing disk	–	–	100	**702805**



Caps and stoppers N 20

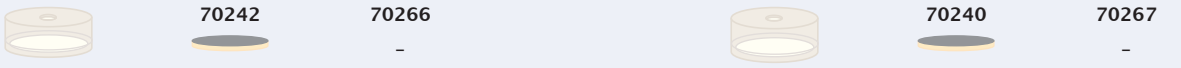
Designation	Dimensions (all drawings scale 1:2)				Pack of	REF
	hole diameter	sealing disk material	thickness	hardness		
Aluminium crimp caps with centre hole, blue, with steel insert, magnetic, with sealing disks						
N 20 TB/oA ASM bimetal, magnetic	8 mm	butyl rubber grey / PTFE grey	3 mm	50 shore	100	**702838**
N 20 TS/oA ASM bimetal, magnetic	8 mm	silicone rubber cream / PTFE grey	3 mm	60 shore	100	**702837**
N 20 TS/oA ASM bimetal, magnetic	8 mm	silicone rubber blue / PTFE colourless	3 mm	40 shore	100	**702834**
Steel crimp caps N 20 with centre hole, magnetic, with sealing disks						
N 20 TB/oA-M magnetic	8 mm	shaped butyl rubber disk grey / PTFE grey	3 mm	50 shore	100	**702928**
N 20 TB/oA-M magnetic	8 mm	shaped butyl rubber disk dark grey / centre coated with PTFE light grey	3 mm	50 shore	100	**702928.9**
N 20 TB/oA-M magnetic	8 mm	butyl rubber red / PTFE grey	3 mm	55 shore	100	**702774**
N 20 TS/oA-M magnetic	8 mm	silicone rubber blue / PTFE colourless	3 mm	40 shore	100	**702929**

Sealing disks for crimp caps N 20

Material	Drawing	OD	Thickness	Hardness		
N 20 B, butyl rubber red		20 mm	3 mm	55 shore	100	**70276**
N 20 B/PTFE, butyl rubber red / PTFE grey		20 mm	3 mm	55 shore	100	**70277**
N 20 S/PTFE, silicone rubber cream / PTFE grey		20 mm	3 mm	60 shore	100	**70278**
N 20 S/ALU, silicone rubber white, aluminium coated		20 mm	3 mm	50 shore	100	**70279**
N 20 TB, shaped butyl rubber disk dark grey, centre coated with PTFE light grey		20 mm	3 mm	50 shore	100	**702D20TB**

PE caps N 20 (for caps with sealing disks: disks are **not assembled**)

	Hole diameter	Material	Sealing disk Thickness	Hardness		
with centre hole for vials N 20 with 3 mm rim						
N 20 TB/oA	4.3 mm	butyl rubber beige / PTFE grey	1.3 mm	55 shore	100	**70242**
N 20	4.3 mm	–	–	–	100	**70266**
with centre hole for vials N 20 with 4 mm rim						
N 20 TB/oA-4	4.3 mm	butyl rubber beige / PTFE grey	1.3 mm	55 shore	100	**70240**
N 20-4	4.3 mm	–	–	–	100	**70267**



Sealing disks for PE caps N 20

material	drawing	OD	thickness	hardness		
N 20 butyl rubber beige / PTFE grey		20 mm	1.3 mm	55 shore	100	**70269**
N 20 natural rubber red / PTFE colourless		20 mm	1.3 mm	45 shore	100	**702904**

Stoppers N 20

Rubber stoppers N 20 light grey	37 shore	100	**702931**
Bromobutyl rubber stoppers N 20 red	45 shore	100	**702931.1**
Rubber stoppers N 20, for freeze-drying	37 shore	100	**702N20 GT**

Crimpers and opening pliers

Manual crimpers and opening pliers

For tightly closing crimp top vials manually, you need an appropriate crimper, for opening the corresponding opening pliers are used. If you have e.g. sample vials with 20 mm rim diameter and the proper crimp caps (e.g. N 20 TB/oA), you can use crimpers N 20 and opening pliers N 20 OE. The crimpers listed below can be adjusted to the respective rim height with the aid of a hexagonal key (except for the N8 crimper).

Ordering information

Designation	Pack of	REF
Hand crimpers for crimp top vials		
N 8 for crimp caps with 8 mm ID	1	**735126**
N 11 for crimp caps with 11 mm ID	1	**735111**
N 13 for crimp caps with 13 mm ID	1	**735113**
N 20 for crimp caps with 20 mm ID	1	**735120**

Designation	Pack of	REF
Opening pliers for crimp top vials		
N 8 OE for crimp caps with 8 mm ID	1	**735408**
N 11 OE for crimp caps with 11 mm ID	1	**735911**
N 13 OE for crimp caps with 13 mm ID	1	**735913**
N 20 OE for crimp caps with 20 mm ID	1	**735920**

Pneumatic crimpers and opening devices

- for more convenient operation
- available for manual or pedal operation

Pneumatic crimpers consist of a pneumatic unit, for either manual or pedal operation, and a crimping head or opening head. Connection to pressurized air or gas (6 bar min.) is accomplished via DN-5 quick-connects for 4 x 6 mm tubing. The type of crimping or opening head depends on the diameter of the crimp caps. Crimping and opening heads are exchangeable, both pneumatic units and crimping / opening heads can be ordered separately.

Ordering information

Designation	Pack of	REF
Pneumatic crimpers with crimping head for crimp top vials		
N 11 H, complete, for manual control	1	**735114**
N 20 H, complete, for manual control	1	**735116**
N 11 F, complete, for pedal control	1	**735117**
N 20 F, complete, for pedal control	1	**735119**

Designation	Pack of	REF
Crimping heads without pneumatic unit		
N 11	1	**735121**
N 20	1	**735123**

Designation	Pack of	REF
Opening heads without pneumatic unit		
N 8 OE	1	**735308.1**
N 11 OE	1	**735434.1**
N 20 OE	1	**735139**

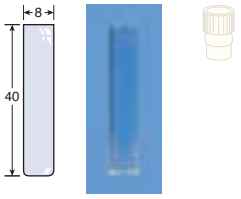
Designation	Pack of	REF	Designation	Pack of	REF
Pneumatic units without crimping heads					
for manual control	1	**735124**	for pedal control	1	**735125**

Special vials

- **Vials without crimp top, not threaded**, which are closed with special plastic stoppers (for Waters WISP autosamplers)
- **Vials for snap-on caps** are sample vials made from clear AR glass (3rd hydrolytic class), which may be closed with polyethylene snap-on caps
- The corresponding **polyethylene snap-on caps** and **plastic stoppers** do not require sealing disks.

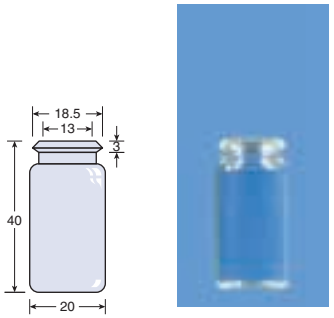
Ordering information

Designation	Dimensions		Pack of	REF
Vials N 8 without crimp top				
	Net volume	OD x height		
N 8-1.2 W, clear	1.2 ml	8.2 x 40 mm	100	**70202.1**
Plastic stoppers N 8				
Plastic stopper N 8 – colourless for N 8-1.2 W			100	**702807**

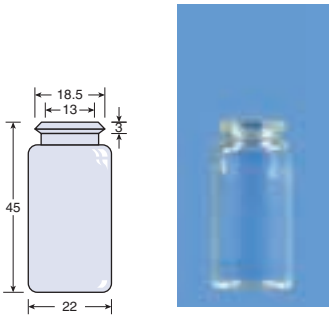


N 8-1.2 W
70202.1 **702807**

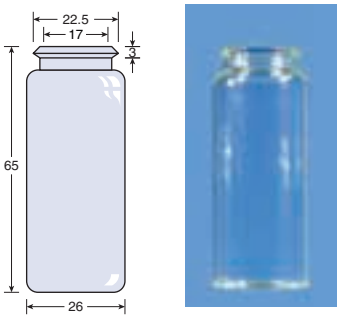
Vials for snap-on caps (AR glass)				
	Net volume	OD x height		
N 18-5, clear	7.5 ml	20 x 40 mm	100	**70271**
N 18-10, clear	10 ml	22 x 45 mm	100	**70272**
N 22-25, clear	25 ml	26 x 65 mm	100	**70273**



N 18-5
70271



N 18-10
70272



N 22-25
70273

Polyethylene snap-on caps		
N 18 for vials N 18-5 and 18-10	100	**70274**
N 22 for vials N 22-25	100	**70275**

70274

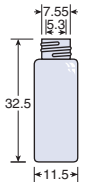
70275

Screw thread vials and screw caps

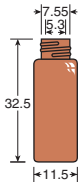
- **Vials with screw threads** (threaded vials) are available in sizes N 8, N 9, N 12, N 13 and N 18. They feature a threaded rim for screw caps.
- **Conic vials with screw threads and thick glass walls** are micro reaction vials with tapered inner shape for small sample volumes, which are also closed with screw caps.
- **Micro inserts** are used to reduce the volume of standard sample vials for application with very small sample volumes. Vials are closed as usual. As an alternative for small volumes you may use the sample vials with conic inner shape (conic vials).
- **Screw caps** for threaded vials are available with or without sealing disks and with or without centre hole.
- Additionally we offer a versatile range of **sealing disks** for screw caps.

Ordering information

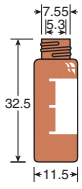
Designation	Dimensions		Pack of	REF
Vials N 8, threaded (8-425 threads) e.g. for autosamplers of CTC, VWR (Merck) / Hitachi, Shimadzu, Spark, Thermo, Varian				
	Net volume	OD x height		
N 8-1, clear	1.5 ml	11.5 x 32.5 mm	100	**70213**
N 8-1, amber	1.5 ml	11.5 x 32.5 mm	100	**70213.2**
N 8-1, amber, with label area and scale	1.5 ml	11.5 x 32.5 mm	100	**702893**
Micro inserts for N 8-1, with mounted PP springs	0.25 ml	5 x 29 mm	100	**702824**
Micro inserts for N 8-1, standard, clear	0.25 ml	5 x 31 mm	100	**702968.1**
Micro inserts for N 8-1, strongly tapered	0.2 ml	5 x 31 mm	100	**702968**
Springs for micro inserts 5 x 31 mm	-	-	100	**702974.1**
N 8-1 C, conic, clear	1.0 ml	11.5 x 32.5 mm	100	**702860**



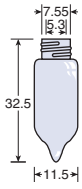
N 8-1
70213



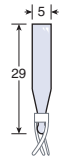
N 8-1
70213.2



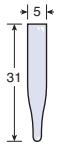
N 8-1
702893



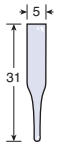
N 8-1 C
702860



702824



702968.1



702968


702974.1

Combi packs of screw thread vials and screw caps N 8 with sealing disks assembled

Combi pack vials N 8-1, clear + screw caps N 8, sealing disks natural rubber red/ PTFE colourless	1000 each	**702844**
Combi pack vials N 8-1, clear + screw caps N 8, sealing disks silicone rubber white / PTFE red	1000 each	**702845**

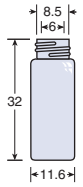
Screw thread vials and screw caps

Designation	Dimensions				Pack of	REF
Screw caps N 8 (8–425 threads) with or without sealing disks						
	hole diameter	sealing disk material	thickness	hardness		
N 8 with centre hole	5.5 mm	natural rubber orange red / PTFE colourless	1.3 mm	60 shore	100	**702431**
N 8 with centre hole	5.5 mm	natural rubber red / PTFE colourless, **not assembled**	1.3 mm	60 shore	100	**70243**
N 8 with centre hole	5.5 mm	butyl rubber beige / PTFE grey	1.3 mm	55 shore	100	**70244.1**
N 8 with centre hole	5.5 mm	silicone rubber white / PTFE red, slotted	1.3 mm	35 shore	100	**702437**
N 8 with centre hole	5.5 mm	silicone rubber white / PTFE red	1.3 mm	35 shore	100	**70245**
N 8 with centre hole	5.5 mm	without sealing disk	–	–	100	**70249**
N 8 without centre hole	–	without sealing disk	–	–	100	**70250**

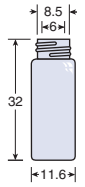
Sealing disks N 8						
material	drawing	OD	thickness	hardness		
N 8 natural rubber red / PTFE colourless		8 mm	1.3 mm	60 shore	100	**70246**
N 8 butyl rubber beige / PTFE grey		8 mm	1.3 mm	55 shore	100	**70247**
N 8 silicone rubber white / PTFE red		8 mm	1.3 mm	35 shore	100	**70248**
N 8 silicone rubber white / PTFE blue, slotted		8 mm	1.0 mm	55 shore	100	**702481**
N 8 PTFE white		8 mm	0.25 mm	53 shore	100	**70261**

Screw thread vials and screw caps

Designation		Dimensions		Pack of	REF
Vials N 9, threaded (short scale screw) e.g. for autosamplers of Agilent, Waters, CTC, Dionex, Thermo, Varian		net volume	OD x height		
N 9-1, clear, wide opening		1.5 ml	11.6 x 32 mm	100	**702282**
N 9-1, clear, silanised, wide opening		1.5 ml	11.6 x 32 mm	100	**702266**
N 9-1, clear, with label area and scale, wide opening		1.5 ml	11.6 x 32 mm	100	**702283**
N 9-1, amber, wide opening	*NEW!*	1.5 ml	11.6 x 32 mm	100	**702293**
N 9-1, amber, with label area and scale, wide opening		1.5 ml	11.6 x 32 mm	100	**702284**
Micro inserts for N 9-1, strongly tapered		0.2 ml	5.5 x 31 mm	100	**702813**
Micro inserts for N 9-1, with mounted PP springs		0.25 ml	5.5 x 29 mm	100	**702818**

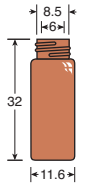


N 9-1
702282



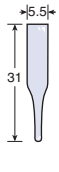
N 9-1
702266

N 9-1
702283

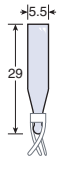


N 9-1
702293

N 9-1
702284



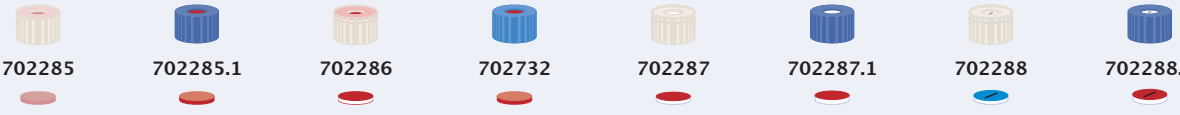
702813



702818

Screw caps N 9 (short scale screw) with centre hole and sealing disks, assembled

		hole diameter	sealing disk material	thickness	hardness		
N 9, transparent		5.5 mm	natural rubber orange red / PTFE colourless	1.0 mm	60 shore	100	**702285**
N 9, blue		5.5 mm	natural rubber red / PTFE colourless	1.0 mm	45 shore	100	**702285.1**
N 9, transparent		5.5 mm	PTFE red / silicone rubber white / PTFE red	1.0 mm	45 shore	100	**702286**
N 9, blue	*NEW!*	5.5 mm	red rubber red / FEP colourless	1.0 mm	45 shore	100	**702732**
N 9, transparent		5.5 mm	silicone rubber white / PTFE red	1.0 mm	55 shore	100	**702287**
N 9, blue		5.5 mm	silicone rubber white / PTFE red	1.3 mm	35 shore	100	**702287.1**
N 9, transparent		5.5 mm	silicone rubber white / PTFE blue, slotted	1.0 mm	55 shore	100	**702288**
N 9, blue		5.5 mm	silicone rubber white / PTFE red, slotted	1.3 mm	35 shore	100	**702288.1**



702285 **702285.1** **702286** **702732** **702287** **702287.1** **702288** **702288.1**

Sealing disks N 9 acc. to VDI 3482, sheet 3

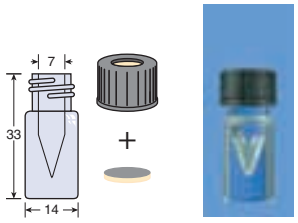
Material	Drawing	OD	Thickness	Hardness		
N 9 butyl rubber red / PTFE colourless		9	1.3	60 shore	100	**70270**

Micro reaction vials

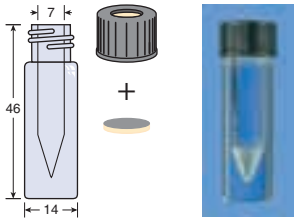
Vials N 12 with conic inner shape, threaded, with screw caps (phenolic resin) and sealing disks

	Net volume	OD x height		
N 12-03 conic, clear	0.25 ml	14 x 33 mm	1	**702210**
N 12-1 conic, clear	0.75 ml	14 x 46 mm	1	**702220**

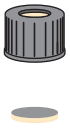
Designation	Dimensions			Pack of	REF
Screw caps N 12 for vials N 12-03 conic and N 12-1 conic, with sealing disks, not assembled					
	Hole diameter	Sealing disk Material	Thickness	Hardness		
N 12-SD	8.5 mm	butyl rubber beige / PTFE grey, **not assembled**	1.3 mm	55 shore	48	**702270**



N 12-03 conic
702210



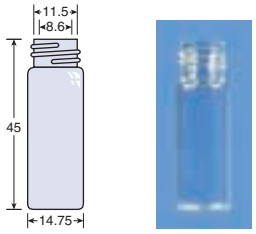
N 12-1 conic
702220



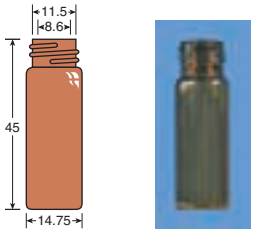
N 12-SD
702270

Sealing disks N 12 for screw caps N 12-SD						
Material	Drawing	OD	Thickness	Hardness		
N 12 butyl rubber beige / PTFE grey		12 mm	1.3 mm	55 shore	48	**702290**

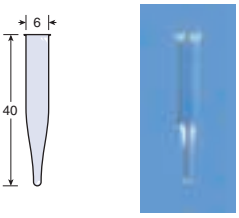
Vials N 13, threaded				
	Net volume	OD x height		
N 13-4 G, clear	4 ml	14.75 x 45 mm	100	**702962**
N 13-4 G, amber	4 ml	14.75 x 45 mm	100	**702973**
Micro inserts for vials N 13-4 G	0.3 ml	6 x 40 mm	100	**702972**
Springs for micro inserts 702972	-	-	100	**702974**



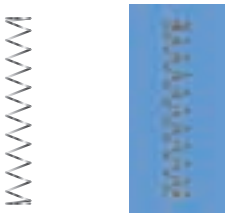
N 13-4 G
702962



N 13-4 G
702973

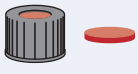


micro insert
702972



spring
702974

Screw caps N 13 (13-425 threads) with or without sealing disks							
	hole diameter	sealing disk material		thickness	hardness		
N 13 with centre hole	8.5 mm	natural rubber red / PTFE colourless	*NEW!*	1.3 mm	60 shore	100	**702926.1**
N 13 with centre hole	8.5 mm	silicone rubber white / PTFE red		1.3 mm	35 shore	100	**702926**
N 13 with centre hole	8.5 mm	without sealing disks		-	-	100	**702963**
N 13 without centre hole	-	use sealing disks N 12 PTFE		-	-	100	**702966**



702926.1

702926

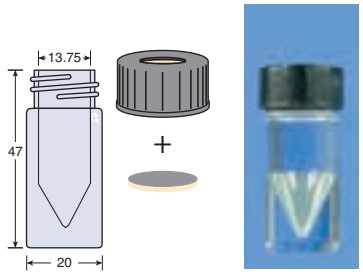
702963

702966

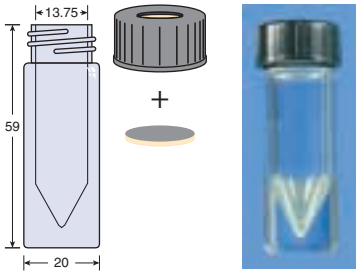
Sealing disks for screw caps N 13						
material	drawing	OD	thickness	hardness		
N 12 PTFE white		12 mm	0.25 mm	53 shore	100	**70260**
N 12 natural rubber orange red / PTFE colourless		12 mm	1.3 mm	60 shore	100	**702967**

Screw thread vials and screw caps

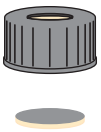
Designation	Dimensions		Pack of	REF
Micro reaction vials				
Vials N 18 with conic inner shape, threaded, with screw caps (phenolic resin) and sealing disks				
	Net volume	OD x height		
N 18-3 conic, clear	3 ml	20 x 47 mm	1	**702230**
N 18-5 conic, clear	4.5 ml	20 x 59 mm	1	**702240**
Screw caps N 18 for vials N 18-3 conic and N 18-5 conic, with sealing disks, not assembled				
	hole diameter	sealing disk material	thickness	hardness		
N 18-SD	12 mm	butyl rubber beige / PTFE grey	1.3 mm	55 shore	48	**702280**



N 18-3 conic
702230



N 18-5 conic
702240



702280

Sealing disks N 18 for screw caps N 18-SD						
Material	Drawing	OD	Thickness	Hardness		
N 18 butyl rubber beige / PTFE grey		18 mm	1.3 mm	55 shore	48	**702300**

Containers for vials

- available in 3 different sizes for small (N 8 to N 11), medium size (N 13) and large (N 20) sample vials
- suited for freezers
- stackable

Ordering information

Designation	Pack of	REF
81 positions, for vials N 8, N 9 and N 11, with integrated insert; size 130 x 130 x 45 mm, coded, incl. lid	1	**702514**
49 positions, for vials N 13, with integrated insert; size 130 x 130 x 50 mm, incl. lid	1	**702515**
25 positions, for vials N 20, with removable insert; size 130 x 130 x 80 mm, incl. lid	1	**702516**

Vials and crimp caps for doping control

- available in a polystyrene box with 12 sets or as separate units (vials, caps and boxes)
- allow protection from manipulation of doping samples

Ordering information

Designation	Pack of	REF
Vials N 20–100 with crimp top	88	**70209.1**
Safety crimp caps N 20 TB/Ü (tear-up), aluminium, without hole, sealing disks lined with PTFE	100	**70280**
Vials N 20–100 with safety crimp caps N 20 TB/Ü and sealing disks lined with PTFE, sealed with UP caps	88 each	**702V 005 UP**
Polystyrene box for 12 vials N 20–100, empty	1 Box	**702V leer 01**
Polystyrene box with 12 vials N 20–100 and 12 safety crimp caps N 20 TB/Ü with sealing disks lined with PTFE	1 Box	**702V 001**
Polystyrene box with 12 vials N 20–100 and 12 safety crimp caps N 20 TB/Ü with sealing disks lined with PTFE, sealed with UP caps	1 Box	**702V 001 UP**

Autosampler compatibility of MN vials

A large number of our vials can also be used in automatic samplers. The table below shows, which types are suited for a given instrument. The list of autosamplers is by no means complete. At the same time we cannot consider technical changes recently introduced by the manufacturers of these instruments.

Vial size [mm]	6 x 32	7 x 40	8.2 x 30	8 x 40
Designation	N 8-03	N 8-07	N 8-08	N 8-1.2 W
REF				
Crimp top vials	70282	70212 70212.1	70251	
Screw thread vials				
Vials with snap-on caps				70202.1
Autosampler type				
Altex / Antek / A.I. 42 / AIM / Alcott 718, 719, 738				
Agilent 1100, 1048, 1090	✘			
Agilent 1050, 1090, 1100, 1200, 5880, 5890, 6850, 6890, 7670A, 7671A, 7672, 7673A, 7673B, 7683				
Agilent Headspace, 19395 A, G 1888				
Agilent HS 7694				
Beckman 501, 502, 507	✘			
Beckman 504		✘		
Bruker LC 51				
Carlo Erba AS-V 42, 60, 105	✘			
Carlo Erba A 200 / CTC AS 200 S		✘		
Carlo Erba 60 tray AS-V 60			✘	
Carlo Erba AS-V 42, 105, 550, 8000				
Carlo Erba Headspace HS 250, 500, 800, 850				
Carlo Erba Headspace CTC 500				
CTC CombiPal		✘		
CTC LC PAL / GC PAL / HTC PAL / HTS PAL / AS 200				
Dani, Dynatech PS 411 (42-tray)				
Dani HS 39.50, 86.50				
Dionex Gina 50, AS 50, ASI 100				
Dynatech (60-tray), LC 2000			✘	
Finnigan A200S		✘	✘	
Fisons AS 800				
Fisons HS 500				
Fisons HS 800, 850				
Gerstel MPS 2	✘	✘		
Gilson 231 / 232 / 401	✘	✘	✘	
Gilson 231 / 232 / 235 / 401 / 402, Aspec				
Gynkotek Gina 50				
Hitachi / Merck AS2000, AS4000, AS6000, Lachrom L-2200, L-7200	✘		✘	
ICI LC 1600				
Infochroma / Jasco AS 2055 / 2057 / 2059				

Autosampler compatibility of MN vials

11.5 x 32.5 N 8–1, N 11–1 regular	11.5 x 32.5 N 9–1, N 11–1 wide neck	11 x 40 N 13–1 TK	14.75 x 45 N 13–4	22 x 38.5 N 20–6 PE	22.5 x 45 N 20–10 DANI	22.5 x 46 N 20–10 HS	23 x 75.5 N 20–20 PE	22 x 75.5 N 20–20 DANI + HP / CTC	23.25 x 75.5 N 20–20 R
70201 / CG 70214 702891 702809 702250	70201 HP 702885 702892 702888	70255	70253	702917	702918	702924	70254	702261 702263	70218
70213 70213.2 702893	702282 702283 702284		702962 702973						
	702712 702713 702714 702708 702266								
✘	✘								
✘	✘								
	✘								
				✘		✘		✘	
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✘	✘								
✘									
✘	✘								
✘	✘								

Autosampler compatibility of MN vials

Vial size [mm]	6 x 32	7 x 40	8.2 x 30	8 x 40
Designation	N 8-03	N 8-07	N 8-08	N 8-1.2 W
REF				
Crimp top vials	70282	70212 70212.1	70251	
Screw thread vials				
Vials with snap-on caps				70202.1
Autosampler type				
Knauer Platinblue AS-1				
Kontron 360, 460				
Kontron MSI 660, Promis				
LDC 713-60			✘	
LDC Marathon				
Perkin-Elmer ISS-100, 200, Autosystem GC	✘			
Perkin Elmer AS 100/300/2000B			✘	
Perkin-Elmer AI-1, ISS-100, 200, LC 600 (42-tray), 420, 420B, 600, AS 100, 300, 2000B, 8300, 4710, 4900				
Perkin-Elmer Autosystem GC, Clarus 500				
Perkin Elmer Headspace HS 6, 40, ISS 100/200, Autosystem GC, Integral 4000				
Perkin Elmer Headspace F 40/45, HS 100, HS 110				
Pharmacia LKB 2157-010, 020		✘		
Sedere				
Shimadzu SIL-2 AS, SIL-6A	✘			
Shimadzu AOC 9/14/1400, SIL-6 A/6 B/9 A, SIL-6 B, LC-10A, LC-2010, AOC-14/1400				
Shimadzu AOC-5000	✘	✘		
Spark Promise/Midas/Triathlon/Marathon / Spectra Physics / Talbot				
Thermo AS 100, 1000, 2000, 3000, 3500, A 200LC				
Thermo HS 250, 500, 800, 850, 2000				
Unicam LC-XP				
Varian Prostar 400, 410, 420, 430,				
Varian 8000, 8035, 8100, 8200, 8400, 8410				
Varian CP-910 / 911 / 912 / 940 / 941				
Varian LC 9090 / 9095 / 9100				
Varian Vista 8000				
Waters Acquity™				
Waters Alliance® 2690/2695, 2790/2795, HT				
Waters WISP™ (96-tray)				✘
Waters WISP™ (48-tray)				

Autosampler compatibility of MN vials

11.5 x 32.5	11.5 x 32.5	11 x 40	14.75 x 45	22 x 38.5	22.5 x 45	22.5 x 46	23 x 75.5	22 x 75.5	23.25 x 75.5
N 8-1, N 11-1 regular	N 9-1, N 11-1 wide neck	N 13-1 TK	N 13-4	N 20-6 PE	N 20-10 DANI	N 20-10 HS	N 20-20 PE	N 20-20 DANI + HP / CTC	N 20-20 R
70201 / CG 70214 702891 702809 702250	70201 HP 702885 702892 702888	70255	70253	702917	702918	702924	70254	702261 702263	70218
70213 70213.2 702893	702282 702283 702284		702962 702973						
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Vials for every lab

Columns for HPLC

Adsorbents for liquid chromatography

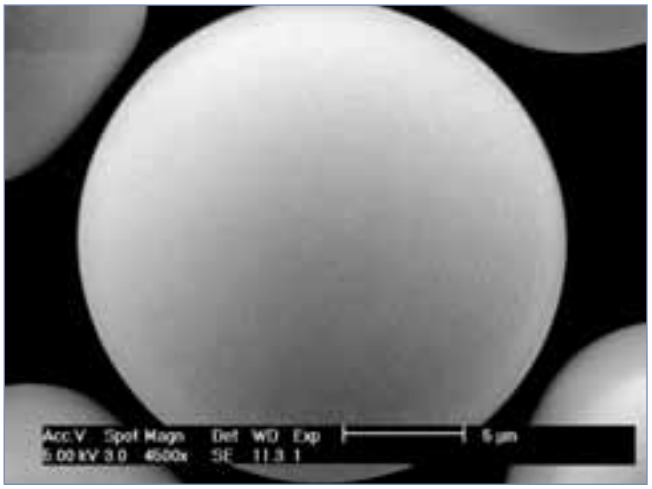
NUCLEODUR® high purity silica for HPLC

NUCLEODUR® is a fully synthetical type B silica (silica of 3rd generation) offering highly advanced physical properties like **totally spherical** particle shape, outstanding **surface microstructure**, high **pressure stability** and **low metal content**.

NUCLEODUR® as a state-of-the-art silica is the ideal base material for modern HPLC phases. It is the result of MACHEREY-NAGEL's pioneering research in chromatography for more than 40 years and succeeds MN's famous NUCLEOSIL® silica.

In RP liquid chromatography the efficiency of the packing is strongly affected by the quality of the base silica itself. Shortcomings in the surface geometry of the particles or metal contaminants are the main reasons for inadequate coverage with the covalently bonded alkylsilanes in the subsequent derivatization steps. It is well known, that poor surface coverage and, in consequence, high activity of residual free silanols often results in peak tailing or adsorption, particularly with basic compounds.

Particle shape and surface symmetry



NUCLEODUR® silicas are synthesized in a unique and carefully controlled manufacturing process which provides silica particles, which are totally spherical. The picture shows the outstanding smoothness of the NUCLEODUR® surface.

Purity

As already mentioned above, a highly pure silica is required for achieving symmetric peak shapes and maximum resolution. Inclusions of e.g. iron or alkaline earth metal ions on the silica surface are largely responsible for the unwanted interactions with ionizable analytes, e.g. amines or phenolic compounds.

NUCLEODUR® is virtually free of metal impurities and low acidic surface silanols. Elemental analysis data of NUCLEODUR® 5 µm measured by AAS are listed below.

Elementary analysis (metal ions) of NUCLEODUR® 100-5

Aluminium	<	5	ppm
Iron	<	5	ppm
Sodium	<	5	ppm
Calcium	<	10	ppm
Titanium	<	1	ppm
Zirconium	<	1	ppm
Arsenic	<	0.5	ppm
Mercury	<	0.05	ppm

Pressure stability

The totally spherical and 100% synthetic silica gel exhibits an outstanding mechanical stability, even at high pressures up to 800 bar and elevated eluent flow rates.

In addition, after several cycles of repeated packing, no significant drop in pressure can be observed. The latter is of prime importance for preparative and process-scale applications.

Physical data of NUCLEODUR®

Surface area (BET)	340 m^2/g
Pore size	110 Å
Pore volume	0.9 ml/g

NUCLEODUR® modifications

Several different surface modifications based on NUCLEODUR® silica have been developed over the last years providing a full range of specified HPLC phases and an ideal tool for every separation:

- NUCLEODUR® C_{18} Gravity and C_8 Gravity
- NUCLEODUR® C_{18} Isis
- NUCLEODUR® C_{18} Pyramid
- NUCLEODUR® Sphinx RP
- NUCLEODUR® C_{18} HTec *NEW!*
- NUCLEODUR® C_{18} ec and C_8 ec
- NUCLEODUR® HILIC *NEW!*
- NUCLEODUR® CN and CN-RP
- NUCLEODUR® NH_2 and NH_2-RP *NEW!*

For a summary of important properties of our NUCLEODUR® phases please see page 102.

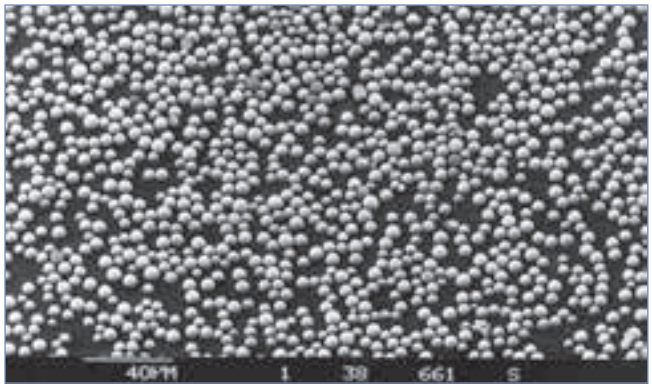
NUCLEOSIL® standard silica for HPLC

NUCLEOSIL® is a family of totally porous spherical silicas. They feature a very pure and uniform SiO_2 structure and have gained wide acceptance as routine chromatographic packings for very different fields of modern chromatography.

- one of the first spherical silicas used in HPLC
- developed in the early seventies, it became a world-renowned HPLC packing
- still found in many analytical and preparative applications, it is an absolutely reliable choice in HPLC
- the largest variety of modified HPLC silicas available

Due to its particle sizes NUCLEOSIL® finds application in analytical as well as in preparative columns. It allows

- high bed stability due to spherical particles
- high efficiency due to narrow particle size distribution
- high separation performance due to optimized binding techniques
- high chemical and mechanical stability
- high load capacity and recovery rates
- high reproducibility from lot to lot



Physical properties of NUCLEOSIL® silicas

NUCLEOSIL® is manufactured with different pore diameters (50, 100, 120, 300, 500, 1000 and 4000 Å) and particle sizes from 3 µm (only NUCLEOSIL® 50, 100 and 120) to 10 µm with very narrow fractionation.

All narrow-pore NUCLEOSIL® packings are stable up to 600 bar (8 500 psi), for NUCLEOSIL® 120 even pressures of up to 800 bar (11 500 psi) can be applied. The wide-pore NUCLEOSIL® silicas are stable up to 300 or 400 bar (4 200 or 5 600 psi).

For a summary of physical properties of unmodified NUCLEOSIL® silica see page 140.

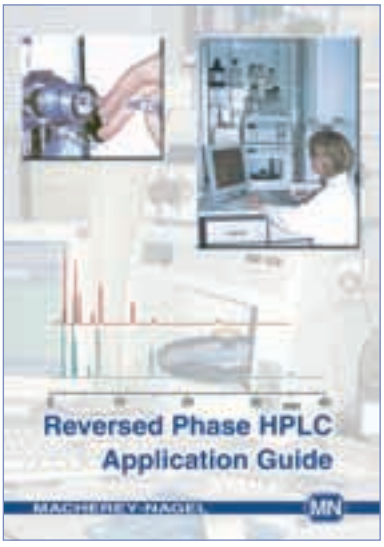
NUCLEOSIL® modifications

NUCLEOSIL® packings are available as unmodified silica or with numerous chemically bonded phases:

- RP phases like C_{18} AB, C_{18} HD, C_{18} Nautilus, C_{18} endcapped, Protect I, C_8 HD, C_8 ec, C_8, C_4, C_2 and Phenyl) separate mainly by hydrophobic interactions (van der Waals forces).
  The less polar the sample molecules, the more they are retained – the more polar the sample, the weaker are the hydrophobic interactions and consequently the shorter are retention times.
- Phases with chemically bonded polar groups such as CN, NO_2, NH_2, $N(CH_3)_2$, OH show selective separation properties.
  Due to the availability of different functional groups it is possible to vary the chemical characteristics of the surface and consequently the adsorption characteristics of the stationary phase.
- Silica-based ion exchangers (NUCLEOSIL® SA and SB) are stable from pH 2 to 8 and do not swell. Compared to resin-based ion exchangers they offer the advantage of constant permeability, even when the ionic strength and/or pH of the eluent are changed. The separation can be influenced by
  – the **type of buffer**
  – the **ionic strength** and
  – the **pH value.**

For a summary of our NUCLEOSIL® phases please refer to page 130.

For basic information on RP chromatography and numerous applications with our NUCLEODUR® and NUCLEOSIL® phases please ask for our Reversed Phase HPLC Application Guide.



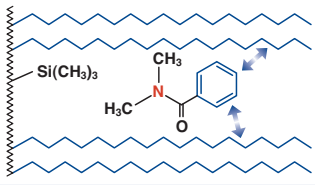
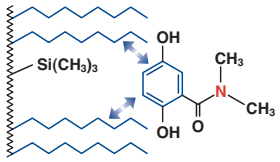
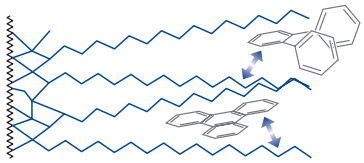
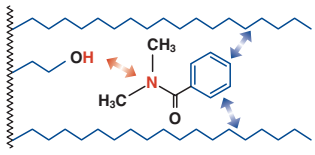
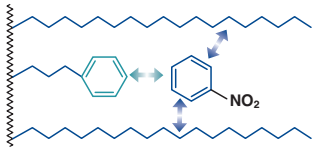
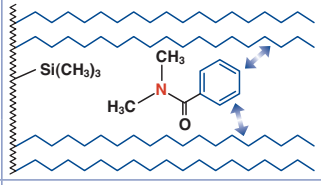
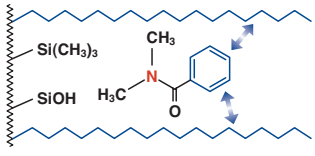
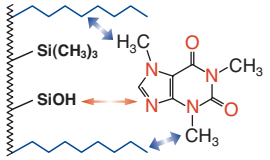
Overview of NUCLEODUR® RP phases

Columns for HPLC

Phase	Specification	Characteristics*	Stability	Structure
C_{18} Gravity	octadecyl phase, high density coating multi-endcapping 18 % C · USP **L1**	A B C	pH stability 1 – 11, suitable for LC/MS	NUCLEODUR® $(Si\text{-}O_2)_n$
C_8 Gravity	octyl phase, high density coating multi-endcapping 11 % C · USP **L7**	A B C	pH stability 1 – 11, suitable for LC/MS	NUCLEODUR® $(Si\text{-}O_2)_n$
C_{18} Isis	octadecyl phase with specially crosslinked surface modification endcapping 20 % C · USP **L1**	A B C	pH stability 1 – 10, suitable for LC/MS	NUCLEODUR® $(Si\text{-}O_2)_n$
C_{18} Pyramid	C_{18} modification with polar endcapping 14 % C · USP **L1**	A B C	stable against 100 % aqueous eluents, pH stability 1 – 9, suitable for LC/MS	NUCLEODUR® $(Si\text{-}O_2)_n$ OH OH
Sphinx RP	bifunctional RP phase, propylphenyl and C_{18} ligands; endcapping 15 % C; USP **L1** and **L11**	A B C	pH stability 1 – 10, suitable for LC/MS	NUCLEODUR® $(Si\text{-}O_2)_n$
C_{18} HTec	octadecyl phase with high capacity, high density coating, multi-endcapping 18 % C · USP **L1**	A B B	pH stability 1 – 11, suitable for LC/MS	NUCLEODUR® $(Si\text{-}O_2)_n$
C_{18} ec	octadecyl / octyl phase, medium density coating endcapping 17.5 % C · USP **L1**	A B C	pH stability 1 – 9	NUCLEODUR® $(Si\text{-}O_2)_n$ Si–OH $Si\text{-}O\text{-}Si(CH_3)_3$
C_8 ec	octadecyl / octyl phase, medium density coating endcapping 10.5 % C · USP **L7**	A B C	pH stability 1 – 9	NUCLEODUR® $(Si\text{-}O_2)_n$ Si–OH $Si\text{-}O\text{-}Si(CH_3)_3$

* A = hydrophobic selectivity, B = polar/ionic selectivity, C = steric selectivity

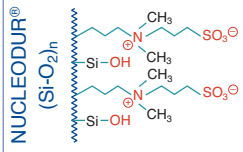
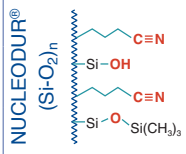
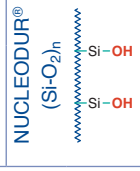
An optimised phase for every separation

	Application	Similar phases**	Separation principle · Retention mechanism		Page
	in general compounds with ionizable functional groups such as basic pharmaceuticals and pesticides	**NUCLEOSIL® C_{18} HD** Waters Xterra® RP_{18} / MS C_{18}; Phenomenex Luna® C18 (2), Gemini®, Synergi™ and Max RP; Zorbax Extend C18; Inertsil ODS III; Purospher RP-18; Star RP-18	**only hydrophobic interactions** (van der Waals interactions)		108 – 111
	like C_{18} Gravity, however generally shorter retention times for nonpolar compounds	**NUCLEOSIL® C_8 HD** Waters Xterra® RP_8 / MS C_8; Phenomenex Luna C8; Zorbax Eclipse; XDB-C8			
	high steric selectivity, thus suited for separation of positional and structural isomers, planar/nonplanar molecules	**NUCLEOSIL® C_{18} AB** Inertsil ODS-P; YMC Pro C18RS, Zorbax SB	**steric interactions** and **hydrophobic interactions**		112 – 113
	basic pharmaceutical ingredients, very polar compounds, organic acids	Phenomenex Aqua; YMC AQ; Waters Atlantis® dC18	**hydrophobic interactions** and **polar interactions** (H bonds)		114 – 115
	compounds with aromatic and multiple bond systems	no similar phases	**π-π interactions** and **hydrophobic interactions**		116 – 117
	robust and well base deactivated C_{18} phase; all separation tasks with preparative potential	Waters Xterra® RP_{18} / MS C_{18} / SunFire™ C_{18}; Phenomenex Luna® C18 (2), Gemini®, Synergi™ and Max RP; Zorbax Extend C18; Inertsil ODS III; Purospher RP-18; Star RP-18	**only hydrophobic interactions** (van der Waals interactions)		118 – 119
	robust C_{18} phase for routine analyses	**NUCLEOSIL® C_{18}** Spherisorb® ODS II; Hypersil ODS; Waters Symmetry® C18; Inertsil ODS II; Kromasil C18; LiChrospher RP 18	**only hydrophobic interactions** (van der Waals interactions) some residual silanol interactions		120 – 122
	robust C_8 phase for routine analyses	**NUCLEOSIL® C_8 ec / C_8** Spherisorb® C8; Hypersil MOS; Waters Symmetry® C8; Kromasil C8; LiChrospher RP 8			

** phases which provide a similar selectivity based on chemical and physical properties

Columns for HPLC

Overview of polar NUCLEODUR® phases

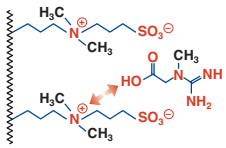
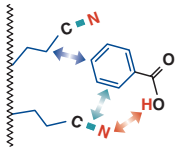
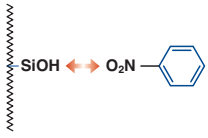
Phase	Specification	Characteristics*		Stability	Structure
HILIC	zwitterionic ammonium sulfonic acid modification 7 % C	A	⬢	pH stability 2 – 8.5, suitable for LC/MS	
		B	⬢⬢⬢⬢⬢		
		C	–		
CN / CN-RP	cyano (nitrile) phase for NP and RP separations 7 % C · USP **L10**	A	⬢	pH stability 1 – 8, stable towards highly aqueous mobile phases	
		B	⬢⬢⬢⬢		
		C	–		
NH_2 / NH_2-RP	amino phase for NP and RP separations 2.5 % C · USP **L8**	A	⬢	pH stability 1 – 8, stable towards highly aqueous mobile phases	
		B	⬢⬢⬢⬢		
		C	–		
SiOH	unmodified high purity silica USP **L3**	A	–	pH stability 2 – 8	
		B	n.a.		
		C	–		

* A = ⬢ hydrophobic selectivity, B = ⬢ polar/ionic selectivity, C = ⬢ steric selectivity

Columns for HPLC

NUCLEODUR® high purity silica

Special selectivities for special separations

	Application	Similar phases**	Separation principle · Retention mechanism		Page
	hydrophilic compounds such as organic polar acids and bases, polar natural compounds	Merck Sequant ZIC®-HILIC; Sielc Obelisc™	**ionic / hydrophilic interactions, electrostatic interactions**		124 – 125
	polar organic compounds (basic drugs), molecules containing π electron systems	**NUCLEOSIL® CN / CN-RP**	**π-π** and **polar interactions** (H bonds), **hydrophobic interactions**		126 – 127
	sugars, sugar alcohols and other hydroxy compounds, DNA bases, polar compounds in general	**NUCLEOSIL® NH_2 / NH_2-RP**	**polar /ionic interactions, hydrophobic interactions**		128 – 129
	polar compounds in general	**unmodified NUCLEOSIL®**	**polar /ionic interactions**		123
		** phases which provide a similar selectivity based on chemical and physical properties			

An optimised phase for every field of application

Particle size and separation efficiency

1.8 µm particles for increased separation efficiency

- **key features**
  - decrease of analysis time (ultra fast HPLC)
  - shorter columns with high separation efficiency
  - significant improvement of resolution and detection sensitivity
  - suitable for **LC/MS** due to low bleeding characteristics
- NUCLEODUR® 1.8 µm particles are fractionated to limit the increase in back pressure

- **NUCLEODUR® phases available in 1.8 µm:**
  C_{18} Gravity
  C_8 Gravity
  C_{18} Isis
  C_{18} Pyramid
  Sphinx RP
  HILIC

Advantages of 1.8 µm particle size

Miniaturization in HPLC has a long history. It started in the early stage of HPLC development with the reduction of particle size from 10 µm via 7 µm to standard 5 µm – which is still the most widely used particle diameter in analytical HPLC – to 3 µm spherical particles which so far was the smallest particle size available for gaining higher theoretical plates and efficiencies. With the introduction of the new 1.8 µm NUCLEODUR® particles now researchers have turned over a new leaf in HPLC column technology. Columns packed with these sub-2 micron particles show extraordinary improvements in terms of plate numbers, column efficiencies and resolution compared with their 3 µm counterparts.

Features of 1.8 µm NUCLEODUR® silica particles

- **Increase of separation efficiency by higher number of theoretical plates (N):**
  50 x 4.6 mm NUCLEODUR® C_{18} Gravity
  3 µm: N ≥ 100 000 plates/m (h value ≤ 10)
  1.8 µm: N ≥ 166 667 plates/m (h value ≤ 6)

  Increase of the plate number by ~67% offers the possibility of using shorter columns with equal plate numbers resulting in a decrease of analysis time.

- **Significant improvement in resolution**

  Use of 1.8 µm instead of 3 µm particles leads to an increase of resolution by a factor 1.29 (29%) since the resolution is inversely proportional to the square root of the particle size:

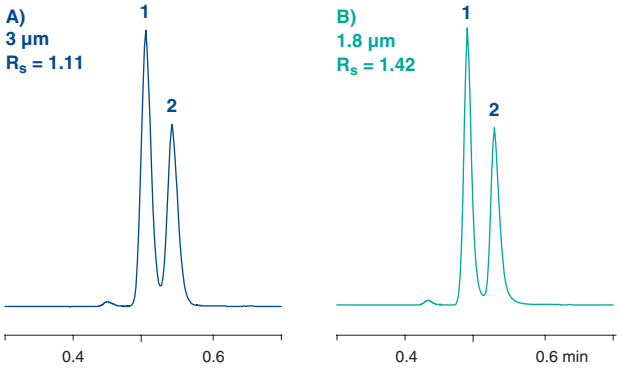
$$R_s = \frac{\sqrt{N}}{4}\left(\frac{\alpha-1}{\alpha}\right)\left(\frac{k_i'}{k_i'+1}\right)$$

R_s = resolution
α = selectivity (separation factor)
k_i' = retention
N = plate number with $N \propto 1/d_P$
d_P = particle size

Resolution as a function of particle size

Column: 50 x 4 mm NUCLEODUR® C_{18} Gravity
A) 3 µm, B) 1.8 µm
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 2 ml/min
Pressure: A) 80 bar, B) 160 bar
Detection: UV, 254 nm

Peaks:
1. Naphthalene
2. Ethylbenzene



- **Column back pressure**

  Due to the smaller particle size the back pressure will increase according to

$$\Delta_P = \frac{\Phi \cdot L_C \cdot \eta \cdot u}{d_P^2}$$

Δ_P = pressure drop
Φ = flow resistance (nondimensional)
L_C = column length
η = viscosity
u = linear velocity
d_P = particle diameter

Because of the high sphericity of the NUCLEODUR® particles and the very narrow particle size distribution we were able to keep the back pressure on a moderate level. Nevertheless the use of columns packed with sub 2 µm particles generally makes special demands on the HPLC equipment. Pumps should be designed for pressures of 250 – 1000 bar and the entire system should feature the lowest possible dead volume.

Particle size and separation efficiency

Comparison of back pressures:		
Eluent:	100 % methanol	
Flow rate:	1.5 ml/min	
Temperature:	22 °C	
Column dimension:	50 x 4.6 mm	
	NUCLEODUR® C_{18} Gravity	Competitor A
3 µm	70 bar	–
1.8 µm	130 bar	170 bar

Technical requirements

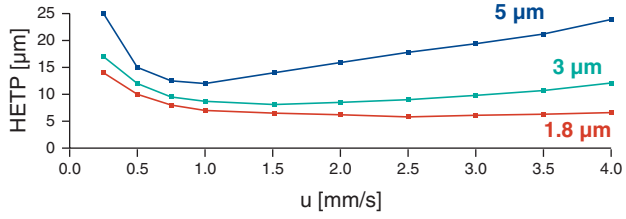
To gain the best result in ultra fast HPLC based on 1.8 µm particles certain technical demands on the instrument are made. Pumps for pressures of 250 – 1000 bar realizing a flow rate of 2 – 3 ml are required. The dead volume of the LC system has to be reduced to a minimum. In addition, fast data recording is necessary for an optimum chromatographic result.

Higher flow rates and shorter run times

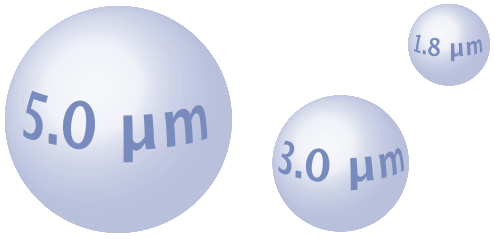
optimal flow rate for 1.8 µm particles is higher than for 3 and 5 µm particles (see figures – the flow rate should be at the van-Deemter minimum)

Van-Deemter plot

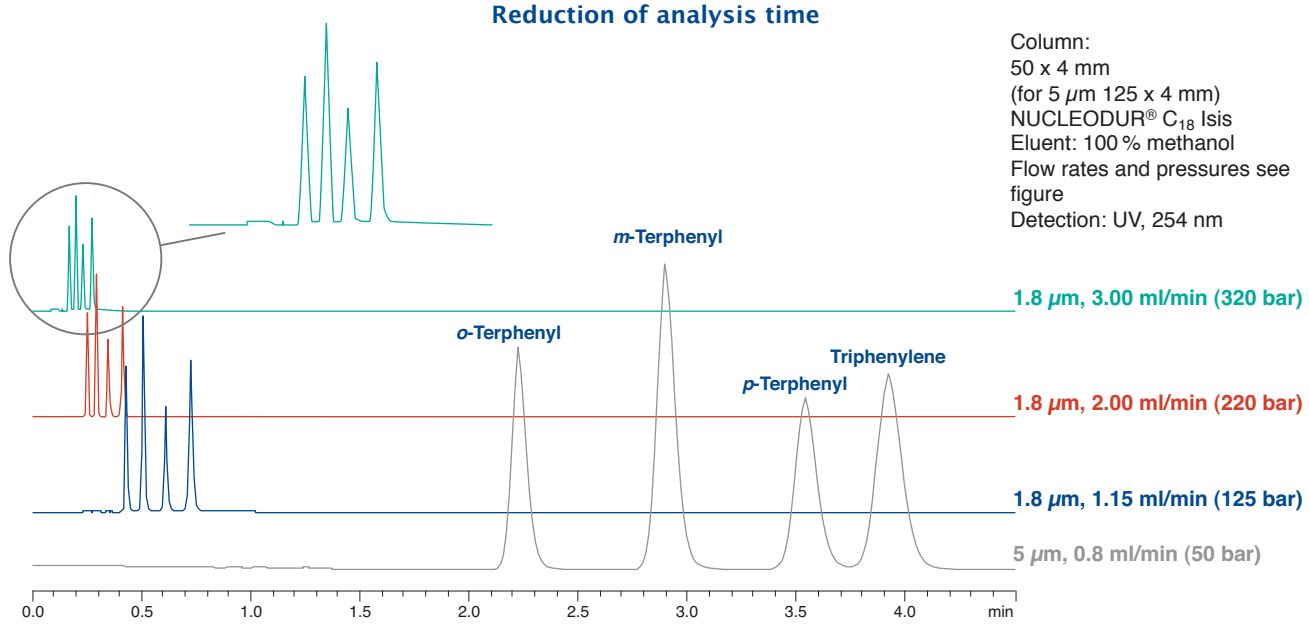
column 50 x 4.6 mm, acetonitrile – water (50:50, v/v), analyte toluene



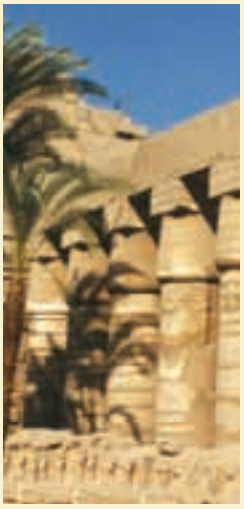
Currently all NUCLEODUR® premium phases (C_{18} Gravity, C_8 Gravity, C_{18} Isis, C_{18} Pyramid, Sphinx RP, HILIC) are available in 1.8 µm. The description of each phase and its selectivity can be found in the individual chapters.



Reduction of analysis time



NUCLEODUR® C_{18} Gravity · C_8 Gravity — nonpolar high density phases



- **key features:**
  - suitable for **LC/MS** and HPLC at pH extremes (pH 1 – 11)
  - superior base deactivation
  - ideal for method development
- **technical characteristics:**
  available as octadecyl (C_{18}) and octyl (C_8)
  pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm for C_{18}, 1.8 and 5 µm for C_8; 7, 10, 12 and 16 µm particles for preparative purposes on request
  carbon content 18% for C_{18}, 11% for C_8
- **recommended application:**
  overall sophisticated analytical separations
  compound classes separated so far: pharmaceuticals, e.g. analgesics, antiinflammatory drugs, antidepressants; herbicides; phytopharmaceuticals; immunosuppressants
  USP L1 (C_{18}) / USP L7 (C_8)

Base deactivation

NUCLEODUR® C_{18} Gravity and NUCLEODUR® C_8 Gravity are based on the ultrapure NUCLEODUR® silica, which is described above.

A unique derivatization process generates a homogeneous surface with a high density of bonded silanes (carbon content ~18% for C_{18}, ~11% for C_8). The following thorough endcapping suppresses any unwanted polar interactions between the silica surface and the sample, which makes "Gravity" particularly suitable for the separation of basic and other ionizable analytes. Even strongly basic pharmaceuticals like amitriptyline are eluted without tailing under isocratic conditions. For a discussion of the different retention behaviour of octadecyl phases compared to octyl phases see page 121.

Enhanced pH stability

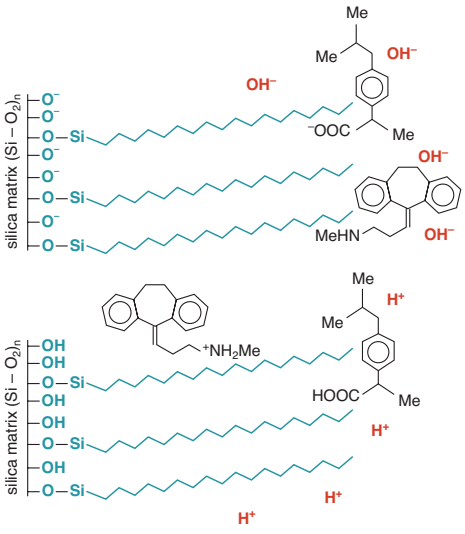
One major disadvantage of using silica stationary phases is the limited stability at strongly acidic or basic pH ranges. Cleavage of the siloxane bonding by hydrolysis, or dissolution of the silica will rapidly lead to a considerable loss in column performance. Therefore conventional RP phases are usually not recommended to be run with mobile phases at pH > 8 or pH < 2 for extended periods of time. The special surface bonding technology and the low concentration of trace elements of NUCLEODUR® C_8 and C_{18} Gravity allow for use at an expanded pH range from pH 1 to 11.

When is enhanced pH stability beneficial?

The option to work at an expanded pH range is often required in method development. Many nitrogen containing compounds like basic drugs are protonated at acidic or neutral pH and exhibit poor retention on a standard C_{18} phase.

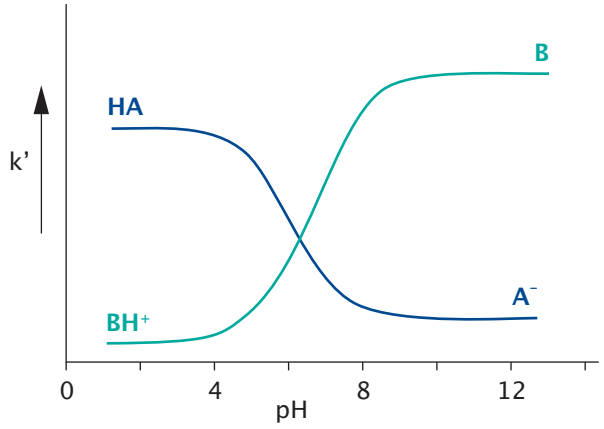
The retention behaviour can be improved by working at a higher pH, where the analyte is no longer protonated, but formally neutrally charged, as a rule between pH 9 – 10. For acidic analytes it is exactly in inverse proportion, maximum retention can be attained at low pH.

Surface silanols at different pH values



The figure above shows the extent of protonation of surface silanols and of two exemplary analytes at acidic and alkaline pH. The following graph explains the general correlation between retention and pH.

Correlation between retention and pH for basic and acidic compounds

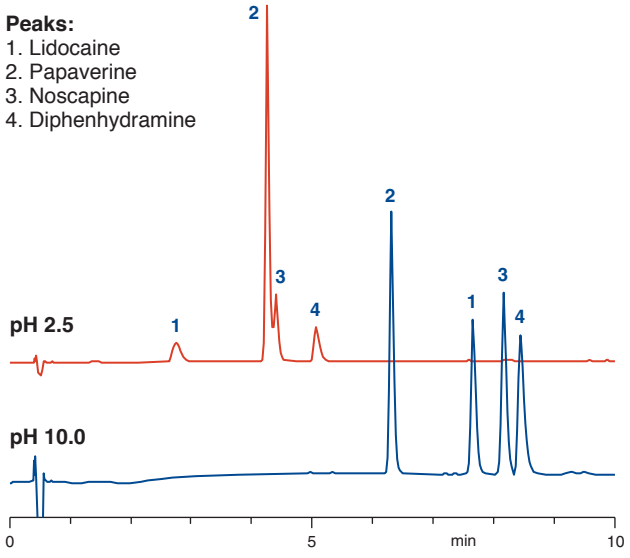


As it was previously mentioned, pH stability of the stationary phase can be helpful for improving selectivity in method development. The figure below shows the separation of 4 basic drugs under acidic and basic conditions.

Separation of basic alkaloids

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluents: A) acetonitrile
B) 20 mM $(NH_4)_2HPO_4$, pH 2.5 / 10.0
Gradient: 10% A (1 min) → 75% A in 10 min
Flow rate: 1.0 ml/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 2 µl

Peaks:
1. Lidocaine
2. Papaverine
3. Noscapine
4. Diphenhydramine



MN Appl. No. 118010

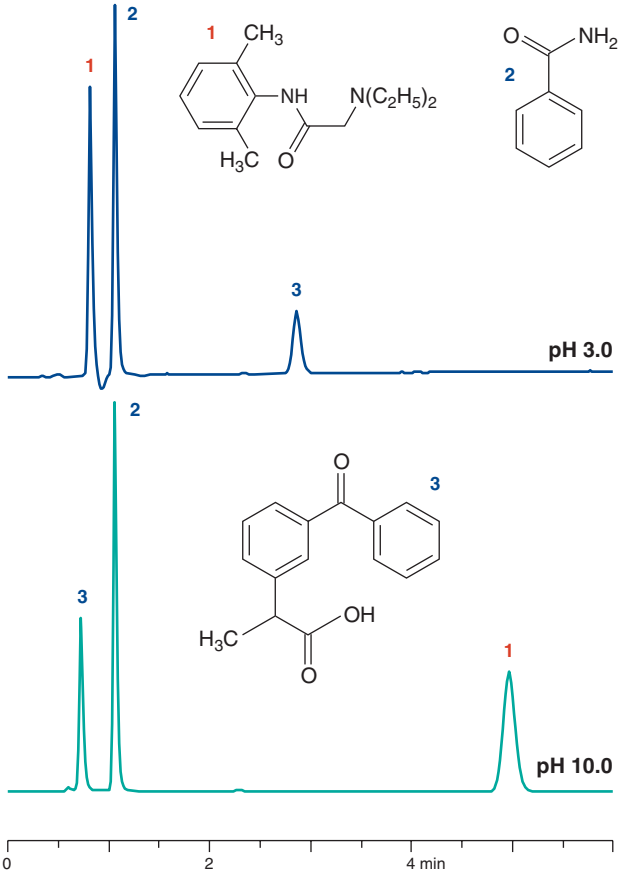
At pH 2.5 the protonated analytes exhibit poor retention (early elution) and in addition an inadequate resolution for papaverine and noscapine, whilst the formally non ionized molecules can be baseline separated due to the better retention pattern at alkaline pH.

A further example how selectivity can be controlled by the pH value is demonstrated below. The sample mixture consists of an acid (ketoprofen), a base (lidocaine) and benzamide. Under acidic conditions the protonated lidocaine is eluted very fast due to lack of sufficiently strong hydrophobic interactions between analyte and C_{18} chains, in contrary to the formally neutral ketoprofen, which is eluted after about 3 minutes. However at pH 10 a reversal of the elution order, with a visibly longer retention time for the basic lidocaine, can be achieved.

Influence of the pH value on selectivity

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluents: A) acetonitrile – 10 mM ammonium formate, pH 3.0 (50:50, v/v)
B) acetonitrile – 10 mM ammonium bicarbonate, pH 10.0 (50:50, v/v)
Flow rate: 1.0 ml/min
Temperature: 30 °C
Detection: UV, 230 nm
Injection volume: 2 µl

Peaks:
1. Lidocaine
2. Benzamide
3. Ketoprofen



MN Appl. No. 120860

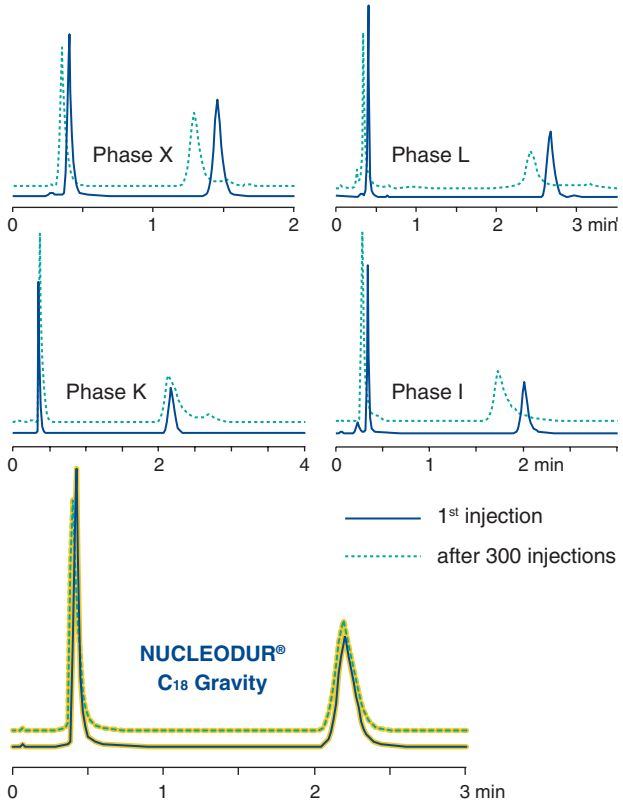
Columns with NUCLEODUR® phases

The following chromatograms demonstrate the stability of NUCLEODUR® C_{18} Gravity under alkaline conditions in comparison with four commercially available modern RP18 phases. Again, the ultrapure Gravity with its unique high density surface bonding technology withstands strong alkaline mobile phase conditions.

Stability of NUCLEODUR® C_{18} Gravity at alkaline pH compared with different C_{18} phases

Columns: 50 x 4.6 mm
Eluent: methanol – water – ammonia (20:80:0.5, v/v/v), pH 11
Flow rate: 1.3 ml/min
Temperature: 30 °C
Detection: UV, 254 nm
Injection volume: 2.0 µl

Peaks: 1. theophylline, 2. caffeine



MN Appl. No. 120850

Even after 300 injections no loss of column efficiency, identified e.g. by peak broadening or decrease in retention times, could be observed.

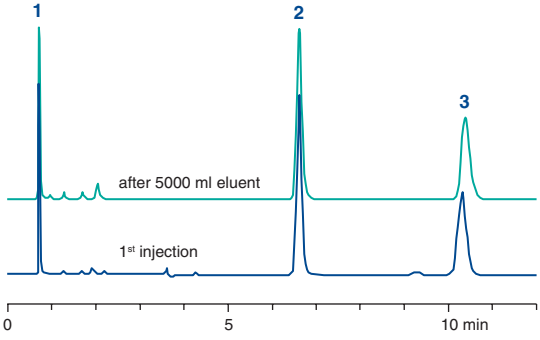
The pH stability of silica under alkaline conditions is mainly a kinetic effect and based on the velocity of the dissolution of the silica support. It is worth mentioning, that this phenomenon also depends on type and concentration of buffers, as well as on the temperature. It is well known that the use of phosphate buffers, particularly at elevated temperatures, can reduce column lifetime even at moderate pH. If possible, phosphate buffers should be replaced by less harmful alternatives.

The following chromatograms show the excellent column stability of NUCLEODUR® C_{18} Gravity in acidic conditions. The retention time of all three compounds in the column performance test remains consistent and virtually unchanged, even after the column is run with 5000 ml eluent. Due to the extremely stable surface modification, no cleavage of the Si-O-Si bonding occurs, column deterioration is therefore successfully prevented.

Stability of NUCLEODUR® C_{18} Gravity at pH 1.5

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: acetonitrile – 1% TFA in water (50:50, v/v), pH 1.5
Flow rate: 1.0 ml/min
Temperature: 30 °C,
Detection: UV, 230 nm
Injection volume: 5 µl

Peaks: 1. pyridine, 2. toluene, 3. ethylbenzene



MN Appl. No. 120840

Ordering information

eluent in column acetonitrile / water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEODUR® C_{18} Gravity, 1,8 µm						octadecyl phase, particle size 1.8 µm, 18 % C		
EC columns								
2 mm ID	**760078.20**	**760079.20**	**760071.20**	**760076.20**		**760075.20**		
3 mm ID	**760078.30**	**760079.30**						
4 mm ID	**760078.40**	**760079.40**						
4.6 mm ID	**760078.46**	**760079.46**						

Columns with NUCLEODUR® phases

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEODUR® C_{18} Gravity, 3 µm					octadecyl phase, particle size 3 µm, 18 % C			
Microbore columns								
1 mm ID				717714.10	717715.10	717716.10	717717.10	
EC columns								
2 mm ID		760080.20			760081.20	760083.20	760082.20	761124.30
3 mm ID		760080.30			760081.30	760083.30	760082.30	761124.30
4 mm ID		760080.40			760081.40	760083.40	760082.40	761124.40
4.6 mm ID		760080.46	760086.46	760084.46	760081.46	760083.46	760082.46	761124.40
NUCLEODUR® C_{18} Gravity, 5 µm					octadecyl phase, particle size 5 µm, 18 % C			
Microbore columns								
1 mm ID				717706.10	717707.10	717708.10	717705.10	
EC columns								
2 mm ID		760102.20			760100.20	760103.20	760101.20	761125.30
3 mm ID		760102.30			760100.30	760103.30	760101.30	761125.30
4 mm ID		760102.40			760100.40	760103.40	760101.40	761125.40
4.6 mm ID		760102.46	760106.46	760104.46	760100.46	760103.46	760101.46	761125.40
VarioPrep columns								
10 mm ID		762103.100			762109.100		762113.100	762160.80
21 mm ID		762103.210			762109.210		762113.210	762161.160
32 mm ID							762113.320	762163.320
40 mm ID						762100.400	762113.400	762163.320
NUCLEODUR® C_{18} Gravity, 10 µm					octadecyl phase, particle size 10 µm, 18 % C			
VarioPrep columns								
21 mm ID							762250.210	762161.160
40 mm ID							762250.400	762163.320
NUCLEODUR® C_8 Gravity, 1.8 µm					octyl phase, particle size 1.8 µm, 11 % C			
EC columns								
2 mm ID	760756.20	760755.20	760760.20	760757.20		760759.20		
3 mm ID	760756.30	760755.30						
4 mm ID	760756.40	760755.40						
4.6 mm ID	760756.46	760755.46						
NUCLEODUR® C_8 Gravity, 5 µm					octyl phase, particle size 5 µm, 11 % C			
EC columns								
2 mm ID		760750.20			760751.20	760752.20	760753.20	761754.30
3 mm ID		760750.30			760751.30	760752.30	760753.30	761754.30
4 mm ID		760750.40			760751.40	760752.40	760753.40	761754.40
4.6 mm ID		760750.46	760749.46	760754.46	760751.46	760752.46	760753.46	761754.40
VarioPrep columns								
10 mm ID		762081.100			762071.100		762070.100	762097.80
21 mm ID		762081.210			762071.210	762082.210	762070.210	762089.160

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, analytical and preparative main columns in packs of 1.
Other Microbore and VarioPrep columns on request; for available dimensions see page 168/169.

VP guard column cartridge	pack of	for VP column	required holder (see page 168)
VP 10/8, 10 x 8 mm ID	2	10 mm ID	8 mm (REF 718251)
VP 20/16, 20 x 16 mm ID	2	21 mm ID	16 mm (REF 718250)
VP 15/32, 15 x 32 mm ID	1	32 to 40 mm ID	32 mm (REF 718253)

NUCLEODUR® C_{18} Isis — phase with high steric selectivity

- **key features:**
  - exceptional steric selectivity
  - outstanding surface deactivation
  - suitable for **LC/MS** and HPLC at pH 1 – 10
- **technical characteristics:**
  C_{18} phase with special polymeric, crosslinked surface modification; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 20%
- **recommended application:**
  steroids, (*o,p,m*–) substituted aromatics, fat-soluble vitamins
  USP L1

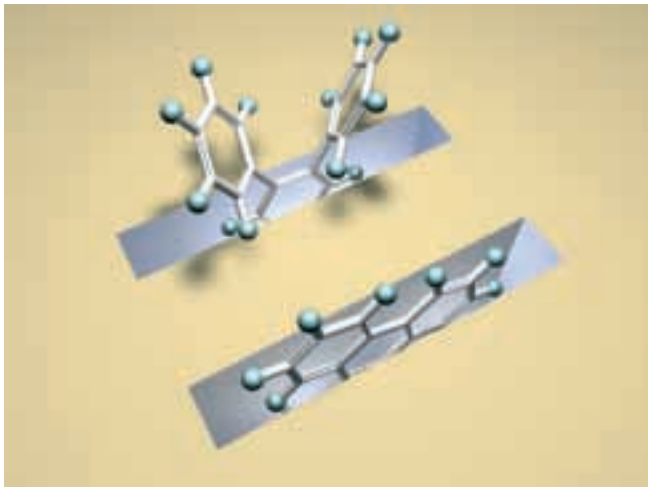
Surface modification

By use of specific C_{18} silanes and appropriate polymeric bonding technologies a dense shield of alkyl chains protects the subjacent silica matrix. Elemental analysis of NUCLEODUR® C_{18} Isis shows a carbon load of 20%.

The target crosslinking of the C_{18} chains on the surface enables the separation of compounds with similar molecular structure but different stereochemical properties. The technical term for this feature is steric selectivity. The chromatograms on the right reveal the improved resolution for positional isomers in a test mixture of aromatic compounds on NUCLEODUR® C_{18} Isis (1) in direct comparison with monomerically coated (2) and polar endcapped (3) C_{18} columns.

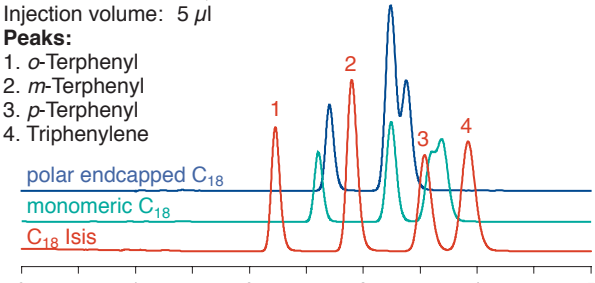
Sander and Wise [LCGC 8 (1990) 378 – 390] proposed a model for the retention of aromatic compounds based on molecular shape, which is referred to as "Slot Model". This model pictures the bonded C_{18} phase on the silica surface with slots which the analytes have to penetrate during retention. Planar molecules are able to penetrate these slots deeper than non-planar molecules of similar molecular weight and length-to-breadth ratio. Thus triphenylene is longer retained than *o*-terphenyl.

Slot model



Steric selectivity of NUCLEODUR® C_{18} Isis

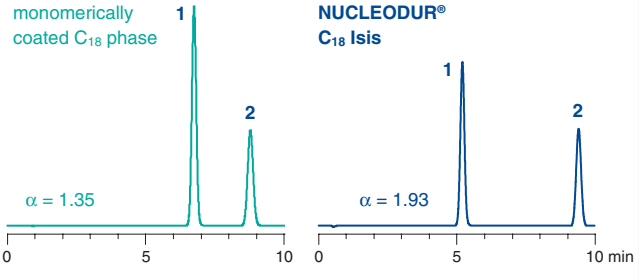
Columns: 125 x 4 mm; **NUCLEODUR® C_{18} Isis**, **monomerically coated C_{18} phase**, **polar endcapped phase**
Eluent: methanol – water (90:10, v/v)
Flow rate: 1 ml/min, temperature: 35 °C
Detection: UV, 254 nm
Injection volume: 5 µl
Peaks:
1. *o*-Terphenyl
2. *m*-Terphenyl
3. *p*-Terphenyl
4. Triphenylene



The separation of *o*-terphenyl and triphenylene is a concrete example to evaluate the selectivity potential of a reversed phase column in terms of the different shape of two molecules. The phenyl rings of *o*-terphenyl are twisted out of plane while triphenylene has a planar geometry. The separation factor (α value) is a measure for the steric selectivity. As is shown in the following chromatograms the α value is considerable larger on NUCLEODUR® C_{18} Isis compared to a conventional C_{18} column.

Steric selectivity of NUCLEODUR® C_{18} Isis

Columns: 125 x 4 mm
Eluent: methanol – water (80:20, v/v)
Flow rate: 1 ml/min, temperature: 40 °C
Detection: UV, 254 nm, injection volume: 1 µl
Peaks: 1. *o*-terphenyl, 2. triphenylene



Columns with NUCLEODUR® phases

Surface deactivation

The chromatography of basic analytes requires a high density of surface-bonded C_{18} silanes combined with a thorough endcapping procedure to keep silanol activity at a minimum. This ensures tailing-free elution of even strongly basic amino-containing compounds (see Appl. 121210 at *www.mn-net.com*).

Stability

The applied special surface bonding technology also provides improved stability features for the NUCLEODUR® C_{18} Isis phase.

Ordering information

eluent in column acetonitrile / water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEODUR® C_{18} Isis, 1.8 µm								particle size 1.8 µm
EC columns								
2 mm ID	**760406.20**	**760405.20**	**760396.20**	**760407.20**		**760409.20**		
3 mm ID	**760406.30**	**760405.30**						
4 mm ID	**760406.40**	**760405.40**						
4.6 mm ID	**760406.46**	**760405.46**						
NUCLEODUR® C_{18} Isis, 3 µm								particle size 3 µm
Microbore columns								
1 mm ID		**717760.10**		**717761.10**	**717762.10**			
EC columns								
2 mm ID		**760400.20**			**760402.20**	**760403.20**	**760404.20**	**761300.30**
3 mm ID		**760400.30**			**760402.30**	**760403.30**	**760404.30**	**761300.30**
4 mm ID		**760400.40**			**760402.40**	**760403.40**	**760404.40**	**761300.40**
4.6 mm ID		**760400.46**	**760397.46**	**760401.46**	**760402.46**	**760403.46**	**760404.46**	**761300.40**
NUCLEODUR® C_{18} Isis, 5 µm								particle size 5 µm
Microbore columns								
1 mm ID		**717770.10**		**717771.10**	**717772.10**			
EC columns								
2 mm ID		**760410.20**			**760412.20**	**760413.20**	**760414.20**	**761310.30**
3 mm ID		**760410.30**			**760412.30**	**760413.30**	**760414.30**	**761310.30**
4 mm ID		**760410.40**			**760412.40**	**760413.40**	**760414.40**	**761310.40**
4.6 mm ID		**760410.46**	**760416.46**	**760415.46**	**760412.46**	**760413.46**	**760414.46**	**761310.40**
VarioPrep columns								
10 mm ID		**762404.100**			**762405.100**		**762403.100**	**762420.80**
21 mm ID		**762404.210**			**762405.210**		**762403.210**	**762421.160**
32 mm ID							**762403.320**	**762422.320**
40 mm ID						**762406.400**	**762403.400**	**762422.320**

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, analytical and preparative main columns in packs of 1.
Other Microbore and VarioPrep columns on request; for available dimensions see page 168/169.

VP guard column cartridge	pack of	for VP column	required holder (see page 168)
VP 10/8, 10 x 8 mm ID	2	10 mm ID	8 mm (REF 718251)
VP 20/16, 20 x 16 mm ID	2	21 mm ID	16 mm (REF 718250)
VP 15/32, 15 x 32 mm ID	1	32 to 40 mm ID	32 mm (REF 718253)

NUCLEODUR® C_{18} Pyramid — phase for highly aqueous eluents

- **key features:**
  - stable in 100 % aqueous mobile phase systems
  - interesting polar selectivity features
  - excellent base deactivation; suitable for **LC/MS** due to low bleeding characteristics
- **technical characteristics:**

  special phase with polar endcapping; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm (7 and 10 µm particles for preparative purposes on request); carbon content 14 %; pH stability 1 – 9
- **recommended application:** analgesics, penicillin antibiotics, nucleic acid bases, water-soluble vitamins, complexing agents, organic acids

  USP L1

RP-HPLC with highly aqueous mobile phases

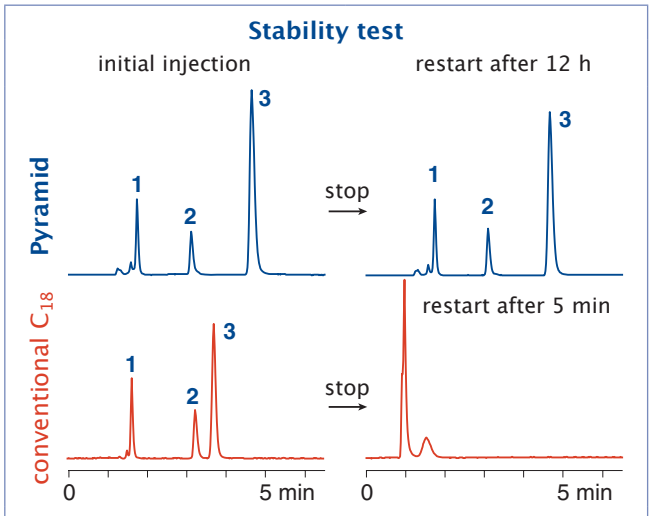
The efforts to neutralize unwanted activity of unreacted surface silanol groups often results in well base-deactivated phases with high carbon load, but a limited scope of selectivity beyond non-polar interactions. In particular polar compounds like carboxylic acids, drug metabolites, etc. show only weak retention on densely bonded reversed phase columns due to distinct hydrophobic properties but low polar interactions. Very polar analytes require highly aqueous mobile phases for solubility and retention. Conventional reversed phase columns often display stability problems in eluent systems with high percentage of water (> 95%) as evidenced by a sudden decrease of retention time and overall poor reproducibility. This phenomenon is described as phase collapse caused by the mobile phase expelled from the pores due to the fact, that hydrophobic RP phases are incompletely wetted with the mobile phase [U. D. Neue et al., Chromatographia 54 (2001) 169 – 177].

Different approaches can be used to increase column stability with highly aqueous mobile phase systems. The most promising concepts are incorporating a polar group in the hydrophobic alkyl chain, or using hydrophilic endcapping procedures to improve the wettability of the reversed phase modification. NUCLEOSIL® Nautilus may be taken as an example for the embedded polar group strategy, in which a C_{18} silane with a polar function is successfully linked to the silica surface [D. Rieger, H. Riering, Int. Laboratory Aug. 2000, Vol. 30 (4A), 12].

Stability features

NUCLEODUR® C_{18} Pyramid is a silica phase with hydrophilic endcapping, designed especially for use in eluent systems of up to 100 % water. The upper figure shows the retention behaviour of tartaric, acetic and maleic acid under purely aqueous conditions on NUCLEODUR® C_{18} Pyramid in comparison with a conventionally bonded RP phase.

It can be shown that the retention times for NUCLEODUR® C_{18} Pyramid remain nearly unchanged between initial injection and restart after the flow has been stopped for 12 hours, whilst the performance of the conventional RP column already collapsed totally 5 min.



Both columns: 125 x 4 mm
Eluent: 50 mM KH_2PO_4 pH 2.5
Flow rate: 0.7 ml/min, temperature 25 °C
Detection: UV, 210 nm
Injection volume: 1 µl.
Peaks: 1. tartaric acid, 2. acetic acid, 3. maleic acid

MN Appl. No. 120870

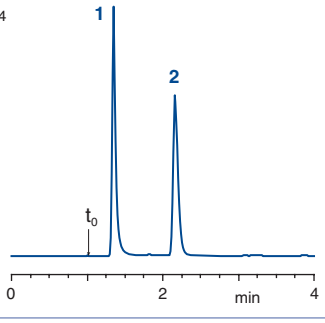
Retention characteristics

The polar surface derivatization exhibits retention characteristics, which differentiate the "Pyramid" from conventional C_{18} stationary phases. The chromatogram below shows the improved retention behaviour of very polar compounds such as short chain organic acids, which are insufficiently retained on RP columns with predominantly hydrophobic surface properties.

Separation of very polar compounds

Column: 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: 0.2 % H_3PO_4
Flow rate: 1.0 ml/min
Temperature: 22 °C
Detection: UV, 202 nm
Injection volume: 2 µl

Peaks:
1. Formic acid
2. Acetic acid



MN Appl. No. 119170

In addition to the exceptional polar selectivity NUCLEODUR® C_{18} Pyramid also provides adequate hydrophobic retention (see application No. 119180 at *www.mn-net.com*). The capacity factors of the non-polar, alkyl-substituted benzenes toluene and ethylbenzene do not go too far in comparison with standard C_{18} phases.

Base deactivation

The perceptible increase in polarity has no impact on the retention behaviour of ionizable analytes. Even with the strongly basic compounds of the tricyclic antidepressant drug test mixture, no unwanted interactions or a so-called lack in base deactivation are observed (see application 119200 at *www.mn-net.com*).

Ordering information

eluent in column acetonitrile / water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEODUR® C_{18} Pyramid, 1.8 µm								particle size 1.8 µm
EC columns								
2 mm ID	**760271.20**	**760272.20**	**760275.20**	**760273.20**		**760274.20**		
3 mm ID	**760271.30**	**760272.30**						
4 mm ID	**760271.40**	**760272.40**						
4.6 mm ID	**760271.46**	**760272.46**						
NUCLEODUR® C_{18} Pyramid, 3 µm								particle size 3 µm
Microbore columns								
1 mm ID		**717740.10**		**717741.10**	**717742.10**	**717743.10**	**717744.10**	
EC columns								
2 mm ID		**760263.20**			**760260.20**	**760261.20**	**760262.20**	**761854.30**
3 mm ID		**760263.30**			**760260.30**	**760261.30**	**760262.30**	**761854.30**
4 mm ID		**760263.40**			**760260.40**	**760261.40**	**760262.40**	**761854.40**
4.6 mm ID		**760263.46**	**760259.46**	**760264.46**	**760260.46**	**760261.46**	**760262.46**	**761854.40**
NUCLEODUR® C_{18} Pyramid, 5 µm								particle size 5 µm
Microbore columns								
1 mm ID				**717722.10**	**717723.10**	**717724.10**	**717725.10**	
EC columns								
2 mm ID		**760200.20**			**760201.20**	**760203.20**	**760202.20**	**761800.30**
3 mm ID		**760200.30**			**760201.30**	**760203.30**	**760202.30**	**761800.30**
4 mm ID		**760200.40**			**760201.40**	**760203.40**	**760202.40**	**761800.40**
4.6 mm ID		**760200.46**	**760205.46**	**760204.46**	**760201.46**	**760203.46**	**760202.46**	**761800.40**
VarioPrep columns								
10 mm ID		**762271.100**			**762273.100**		**762272.100**	**762291.80**
21 mm ID		**762271.210**			**762273.210**		**762272.210**	**762292.160**
32 mm ID							**762272.320**	**762293.320**
40 mm ID						**762269.400**	**762272.400**	**762293.320**

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, analytical and preparative main columns in packs of 1.
Other Microbore and VarioPrep columns on request; for available dimensions see page 168/169.

VP guard column cartridge	pack of	for VP column	required holder (see page 168)
VP 10/8, 10 x 8 mm ID	2	10 mm ID	8 mm (REF 718251)
VP 20/16, 20 x 16 mm ID	2	21 mm ID	16 mm (REF 718250)
VP 15/32, 15 x 32 mm ID	1	32 to 40 mm ID	32 mm (REF 718253)

Columns with NUCLEODUR® phases

NUCLEODUR® Sphinx RP — bifunctional RP phase

key features:

- distinct selectivity based on well-balanced bifunctional surface coverage
- widens the scope for method development based on additional π–π interactions
- suitable for **LC/MS** due to low bleeding characteristics

technical characteristics:

octadecyl and propylphenyl modified silica; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 15 %;
pH stability 1 – 10; high reproducibility and consistent quality

recommended application:

quinolone antibiotics, sulfonamides, xanthines, substituted aromatics

USP L1 and L11

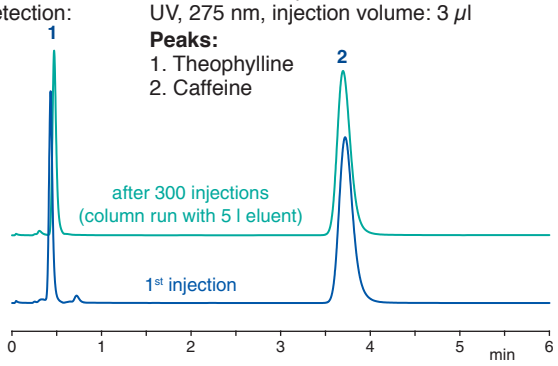
Alternative RP selectivity

NUCLEODUR® Sphinx RP is characterized by exceptional selectivity features generated by a well-balanced ratio of covalently bonded octadecyl and phenyl groups. The combination of classical hydrophobic with π–π interactions (aromatic ring system) expands the scope of selectivity in comparison with conventional reversed phase packings. NUCLEODUR® Sphinx RP is particularly suited for the separation of molecules containing aromatic and multiple bonds. For the separation of polar compounds NUCLEODUR® Sphinx RP can be especially recommended and can also outperform many customary C_{18} phases. In addition, exhaustive endcapping steps minimize unwanted surface silanol activity and guarantee excellent peak shapes even for strong basic analytes.

Stability of NUCLEODUR® Sphinx RP at pH 10

Column: 50 x 4.6 mm NUCLEODUR® Sphinx RP, 5 µm
Eluent: methanol – dil. NH_3, pH 10 (20:80, v/v)
Flow rate: 1.0 ml/min, temperature 30 °C
Detection: UV, 275 nm, injection volume: 3 µl

Peaks:
1. Theophylline
2. Caffeine



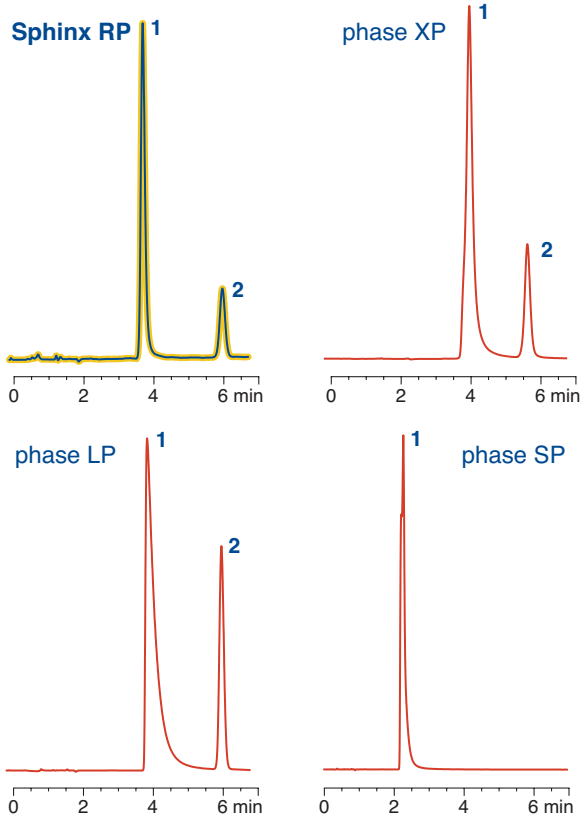
MN Appl. No. 120900

Different from standard phenyl phases, NUCLEODUR® Sphinx RP is far more stable towards hydrolysis and is also suggested for LC/MS applications. Due to the additional intermolecular interactions NUCLEODUR® Sphinx RP is an interesting replenishment to the high density bonded phases NUCLEODUR® C_8/C_{18} Gravity and the polar endcapped NUCLEODUR® C_{18} Pyramid.

Comparison of surface deactivation of different phenyl modified RP phases

Columns: 150 x 4.6 mm, A) NUCLEODUR® Sphinx RP, 5 µm
B) competitor 1 (column XP), C) competitor 2 (column LP)
D) competitor 3 (column SP)
Eluent: methanol – water (30:70, v/v)
Flow rate: 1 ml/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection volume: 2 µl

Peaks:
1. Pyridine
2. Phenol

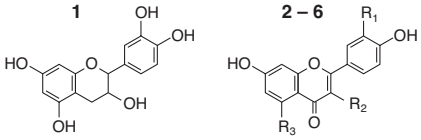


MN Appl. No. 120910

Separation of flavonoids on 3 different NUCLEODUR® phases

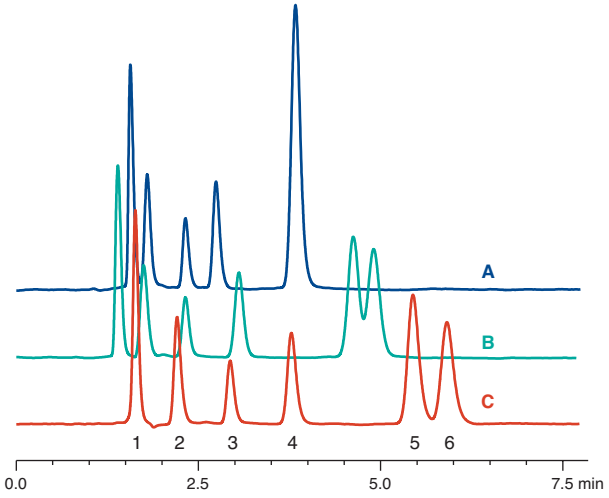
Columns: 150 x 4.6 mm: **A) NUCLEODUR® C_8 Gravity, 5 µm**
B) NUCLEODUR® C_{18} Gravity, 5 µm
C) NUCLEODUR® Sphinx RP, 5 µm
Eluent: water – methanol (40:60, v/v), flow rate 1 ml/min
Temperature: 30 °C, detection: UV, 270 nm
Injection volume: 3 µl

Peaks:



1. Catechin
2. Rutin — $R_1 = R_3 = OH$, R_2 = O-rutinose
3. Fisetin — $R_1 = R_2 = OH$, $R_3 = H$
4. Quercetin — $R_1 = R_2 = R_3 = OH$
5. Kaempferol — $R_1 = H$, $R_2 = R_3 = OH$
6. Isorhamnetin — $R_1 = OCH_3$, $R_2 = R_3 = OH$

MN Appl. No. 119830



Ordering information

eluent in column acetonitrile / water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEODUR® Sphinx RP, 1.8 µm								particle size 1.8 µm
EC columns								
2 mm ID	760821.20	760822.20	760825.20	760823.20		760824.20		
3 mm ID	760821.30	760822.30						
4 mm ID	760821.40	760822.40						
4.6 mm ID	760821.46	760822.46						
NUCLEODUR® Sphinx RP, 3 µm								particle size 3 µm
Microbore columns								
1 mm ID		717686.10		717685.10		717687.10		
EC columns								
2 mm ID		760806.20			760807.20	760805.20	760808.20	761557.30
3 mm ID		760806.30			760807.30	760805.30	760808.30	761557.30
4 mm ID		760806.40			760807.40	760805.40	760808.40	761557.40
4.6 mm ID		760806.46	760813.46	760812.46	760807.46	760805.46	760808.46	761557.40
NUCLEODUR® Sphinx RP, 5 µm								particle size 5 µm
Microbore columns								
1 mm ID		717680.10		717681.10	717682.10	717683.10	717684.10	
EC columns								
2 mm ID		760800.20			760801.20	760802.20	760803.20	761550.30
3 mm ID		760800.30			760801.30	760802.30	760803.30	761550.30
4 mm ID		760800.40			760801.40	760802.40	760803.40	761550.40
4.6 mm ID		760800.46	760815.46	760809.46	760801.46	760802.46	760803.46	761550.40
VarioPrep columns								
10 mm ID		762372.100			762375.100		762373.100	762390.80
21 mm ID		762372.210			762375.210		762373.210	762391.160
32 mm ID							762373.320	762392.320
40 mm ID						762371.400	762373.400	762392.320

NUCLEODUR® C_{18} HTec — base-deactivated preparative octadecyl phase

key features:

- reliable and durable standard RP phase for up-scaling to preparative scale, suited for **LC/MS**
- high loadability and excellent stability
- outstanding base deactivation

technical characteristics:

high density octadecyl modification (C_{18})
pore size 110 Å; particle sizes 5 µm, 7 µm and 10 µm for analytical and preparative separations
carbon content 18 %, pH stability 1 – 11

recommended application:

sophisticated analytical and preparative separations of basic, neutral and acidic pharmaceuticals, derivatised amino acids, pesticides, fat-soluble vitamins, aldehydes, ketones and phenolic compounds

USP L1

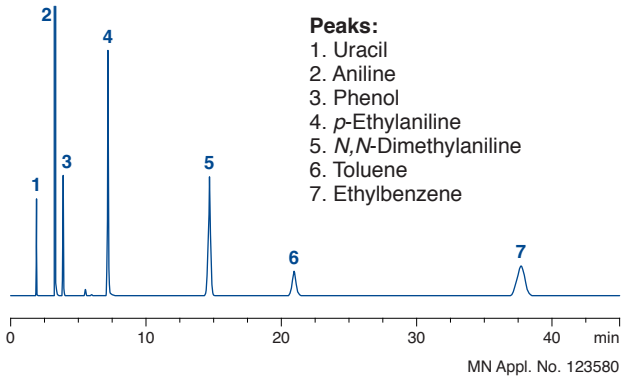
Preparative separations place high demands on silica based HPLC materials. Apart from excellent selectivity and base deactivation, robustness (pH, pressure stability, ...) and capacity are vital criteria for optimal and efficient separation at the preparative scale.

Selectivity and base deactivation

The innovative and special endcapping procedure leads to exceptionally good base deactivation – the Engelhardt test demonstrates superb selectivity, peak symmetry and peak shape over the entire polarity range. In addition NUCLEODUR® C_{18} HTec scores in low bleed characteristics and is therefore highly suitable for LC/MS.

Engelhardt test

Column:	250 x 4 mm NUCLEODUR® 100-5 C_{18} HTec
Eluent:	methanol – water (49:51, v/v)
Flow rate:	1 ml/min
Temperature:	40 °C
Detection:	UV, 254 nm
Injection volume:	5 µl



Peaks:
1. Uracil
2. Aniline
3. Phenol
4. *p*-Ethylaniline
5. *N,N*-Dimethylaniline
6. Toluene
7. Ethylbenzene

MN Appl. No. 123580

Stability and lifetime

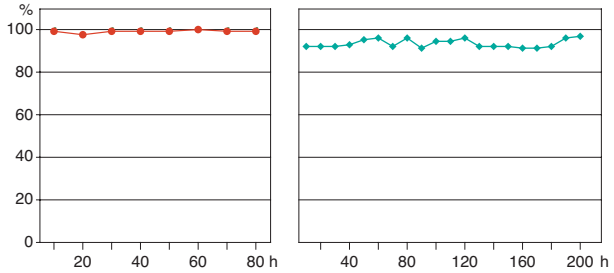
Based on fully synthetic and extremely robust totally spherical NUCLEODUR® silica, NUCLEODUR® C_{18} HTec offers outstanding mechanical rigidity and is thus the perfect choice also for self-packing of prep-columns. The special surface modification and endcapping procedure result in high chemical stability even at extreme chromatographic conditions like high flow rates, temperature or critical solvents (DMSO). Furthermore, NUCLEODUR® C_{18} HTec columns show a remarkably long lifetime in acidic (pH 1) as well as basic (pH 10) mobile phases.

pH stability test

Column:	150 x 4 mm NUCLEODUR® 100-5 C_{18} HTec
Flow rate:	1 ml/min
Detection:	UV, 254 nm
Injection:	5 µl

pH 1:
Eluent: acetonitrile – 1 % TFA in water (50:50, v/v); 80 °C
● % initial retention of ethylbenzene
693 injections

pH 10:
Eluent: methanol – 50 mM triethylamine (25:85, v/v); 50 °C
◆ % initial N of theophylline
1034 injections



Columns with NUCLEODUR® phases

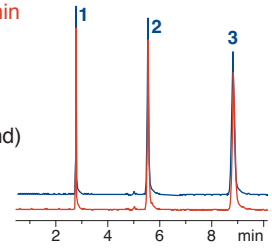
Up-scaling

Due to highest quality standards in our silica production and phase chemistry combined with optimised packing technology, NUCLEODUR® C_{18} HTec delivers exceptional transferability from analytical to preparative scale. This doesn't just apply to the use of different particle sizes (e.g. 5, 7 or 10 µm) but also for diverse column dimensions (e.g. ID 4.6 to 21 mm).

Up-scaling with NUCLEODUR® C_{18} HTec

Columns: **EC 250 x 4.6 mm NUCLEODUR® 100-5 C_{18} HTec**
VP 250 x 21 mm NUCLEODUR® 100-5 C_{18} HTec
Eluent: acetonitrile – water (80:20, v/v)
Flow rates: 1.3 ml/min / 27 ml/min
Temperature: 22 °C
Pressure: 84 bar / 109 bar
Detection: UV, 254 nm
Inj. volume: 3 µl / 60 µl
Peaks: (1 mg/ml of each compound)
1. Phenol
2. Naphthalene
3. Anthracene

MN Appl. No. 123780

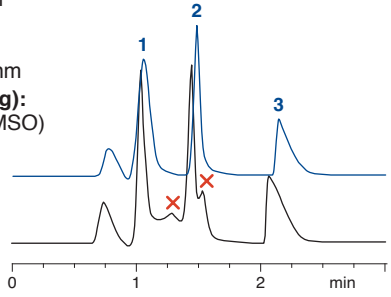


Capacity

A vital criterion for efficiency in preparative HPLC is the capacity of the separation medium. NUCLEODUR® C_{18} HTec is characterised by a notably high loadability under both basic and acidic conditions, while competitor columns show overload effects even at lower loads (x).

Loadability under acidic conditions

Columns: **VP 100 x 21 mm NUCLEODUR® 100-5 C_{18} HTec**
100 x 21.2 mm AXIA™ Gemini® 5 µm C18 110 Å
Eluent: acetonitrile – formic acid in H_2O pH 3.0 (30:70, v/v)
Flow rate: 28 ml/min
Temperature: 22 °C
Pressure: 124 bar
Detection: UV, 254 nm
Peaks (total load 40 mg):
(sample dissolved in DMSO)
1. 4-Acetamidophenol (5 mg)
2. 2-Acetamidophenol (10 mg)
3. Acetylsalicylic acid (25 mg)



Due to innovative surface coating procedures NUCLEODUR® C_{18} HTec offers excellent analytical separation properties and is the first choice for up-scaling to preparative column dimensions.

Ordering information

eluent in column acetonitrile / water

	Length →	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEODUR® 100-5 C_{18} HTec								particle size 5 µm
EC columns								
	2 mm ID	760311.20			760314.20		760316.20	761110.30
	3 mm ID	760311.30			760314.30		760316.30	761110.30
	4 mm ID	760311.40			760314.40		760316.40	761110.40
	4.6 mm ID	760311.46	760312.46	760313.46	760314.46	760315.46	760316.46	761110.40
VarioPrep columns								
	10 mm ID	762551.100			762554.100		762556.100	762591.80
	21 mm ID	762551.210			762554.210		762556.210	762593.160
	32 mm ID						762556.320	762592.320
	40 mm ID					762555.400	762556.400	762592.320
	50 mm ID						762556.500	762592.320
NUCLEODUR® 100-10 C_{18} HTec								particle size 10 µm
VarioPrep columns								
	10 mm ID	762571.100			762574.100		762576.100	762591.80
	21 mm ID	762571.210			762574.210		762576.210	762593.160
	32 mm ID						762576.320	762592.320
	40 mm ID					762575.400	762576.400	762592.320
	50 mm ID						762576.500	762592.320

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, analytical and preparative main columns in packs of 1.

NUCLEODUR® HTec bulk material in 5, 7 and 10 µm for self-packing of prep columns see page 172.

VP guard column cartridge	pack of	for VP column	required holder (see page 168)
VP 10/8, 10 x 8 mm ID	2	10 mm ID	8 mm (REF 718251)
VP 20/16, 20 x 16 mm ID	2	21 mm ID	16 mm (REF 718250)
VP 15/32, 15 x 32 mm ID	1	32 to 50 mm ID	32 mm (REF 718253)

NUCLEODUR® C_{18} ec · C_8 ec — nonpolar phases for routine analysis

key features:

- ideal and reliable standard RP phase for daily routine analysis and up-scaling for preparative HPLC
- medium density octadecyl (C_{18}) and octyl (C_8) modification with exhaustive endcapping
- wide range of application areas

technical characteristics:

pore size 110 Å; particle sizes 3 µm and 5 µm; 7 µm, 10 µm, 12 µm, 16 µm, 20 µm, 30 µm and 50 µm for preparative separations; carbon content 17.5 % for C18, 10.5 % for C8

pH stability 1 – 9, high reproducibility from lot to lot

recommended application:

basic, neutral or acidic drugs, derivatised amino acids, pesticides fat-soluble vitamins, aldehydes and ketones, phenolic compounds

USP L1 (C_{18}) / L7 (C_8)

NUCLEODUR® C_{18} ec for daily routine analysis and up-scaling for preparative HPLC

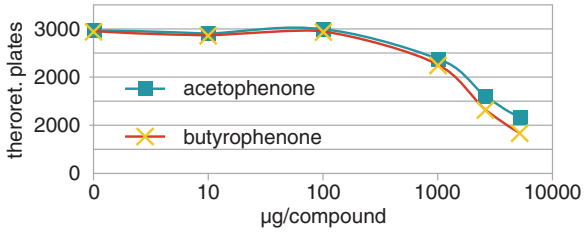
The efficiency of a separation is controlled by particle size and selectivity of the stationary phase. The exceptional surface coverage of monomeric bonded alkylsilanes, combined with an exhaustive endcapping, results in a surface with lowest silanol activity. This allows the tailing-free elution of polar compounds such as basic drugs. NUCLEODUR® C_{18} ec is available in 9 different particle sizes (3, 5, 7, 10, 12, 16, 20, 30 and 50 µm) which cover the whole range from high speed analytical HPLC up to medium and low pressure prep LC. NUCLEODUR® C_{18} ec is also an ideal tool for scale-up purposes.

Loadability

Loadability, probably the most important feature for preparative LC applications, is determined by pore size, pore volume and surface area of the packing. However, it can also be influenced by the molecular weight of the analytes. In the figure below the mass loading curve for acetophenone and butyrophenone on a NUCLEODUR® 100-20 C_{18} ec column describes the correlation between the increase of column loading and the decrease of separation efficiency.

Loading curve

Column: 250 x 4.6 mm NUCLEODUR® 100-20 C_{18} ec, mobile phase: acetonitrile – H_2O 80:20 (v/v), flow: 1.0 ml/min, temperature: 25 °C, detection: UV, 280 – 370 nm



Chemical stability

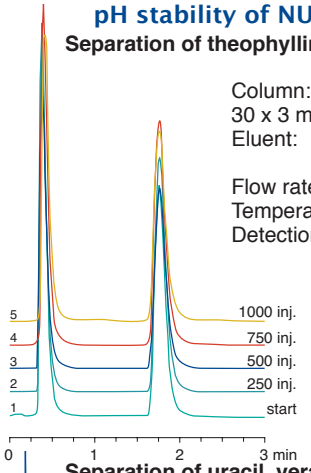
The utmost purity of the base silica and the exceptional silane bonding chemistry minimizes the risk of dissolution, or hydrolysis at pH extremes.

The chromatograms show the retention behavior at pH values of 1.5 and 10.0 for NUCLEODUR® 100-5 C_{18} ec.

pH stability of NUCLEODUR® C_{18} ec

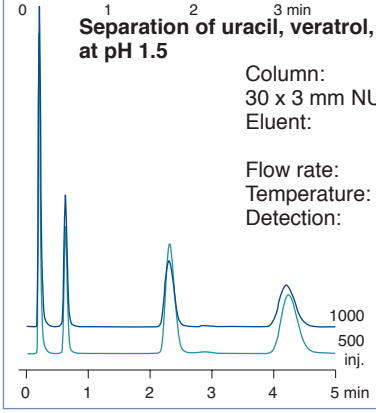
Separation of theophylline and caffeine at pH 10

Column:
30 x 3 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: methanol – aq. NH_3 (20:80, v/v), pH 10
Flow rate: 0.5 ml/min
Temperature: 25 °C
Detection: UV, 254 nm



Separation of uracil, veratrol, toluene and ethylbenzene at pH 1.5

Column:
30 x 3 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – H_2O (65:35, v/v), TFA, pH 1.5
Flow rate: 1.0 ml/min
Temperature: 25 °C
Detection: UV, 254 nm



NUCLEODUR® octyl phases

In addition to the program of NUCLEODUR® C_{18} phases MACHEREY-NAGEL offers the corresponding octyl modified NUCLEODUR® C_8 Gravity and NUCLEODUR® C_8 ec columns to expand the reversed phase tool box effectively. Based on the same totally spherical and highly pure silica the C_8 phases exhibit the same excellent chemical and mechanical stability features as the C_{18} counterparts. Indeed NUCLEODUR® C_8 Gravity can also be run at pH extremes (pH 1 – 11) by choosing appropriate elution parameters. Due to the shorter chain and less hydrophobic properties of the stationary phase the retention of non-polar compounds is decreased, and in consequence a reduction in time of analysis can be achieved. Moreover a stronger polar selectivity, particularly with the separation of ionizable analytes is frequently observed (as distinct from the C_{18} phases). NUCLEODUR® C_8 ec and NUCLEODUR® C_8 Gravity are most suitable for the development of new methods but also for robust routine analysis.

C_{18} or C_8 · the best of both worlds

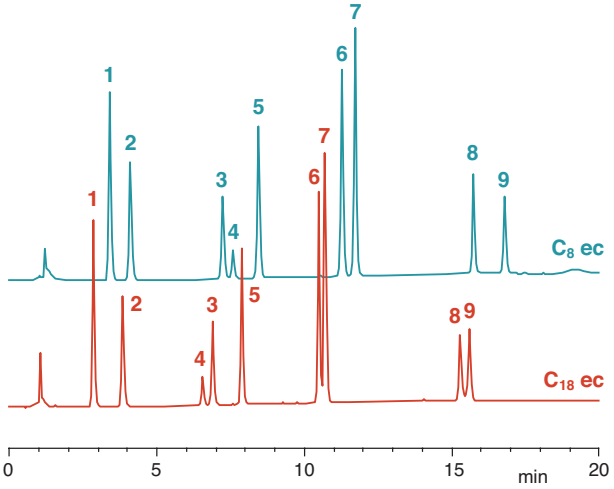
Chromatographers might wonder about the differences between C_8 and C_{18} phases and the preferred range of application. Indeed there are no general guidelines which could make the choice easier but it will always be beneficial to add both phases to the existing pool of reversed phase columns in the laboratory.

However, comparative studies reveal some different selectivity patterns of NUCLEODUR® C_8 ec and NUCLEODUR® C_{18} ec. The separation of phenols on the right shows baseline separation for 2-ethoxyphenol and dimethoxybenzene (veratrol) and in addition a reversal of the elution order of phenol and 4-methoxyphenol can be shown on the octyl phase.

Separation of phenols

Column: 250 x 4 mm NUCLEODUR® 100-5 C_8 ec / C_{18} ec
Eluent: A) water
B) methanol
Gradient for C_8: 2 min 20% B, then to 60% B in 12 min
Gradient for C_{18}: 2 min 25% B, then to 65% B in 12 min
Flow rate: 1.0 ml/min
Temperature: 25 °C
Detection: UV, 275 nm
Injection volume: 10 µl

Peaks:
1. Resorcinol
2. Pyrocatechol
3. 4-Methoxyphenol
4. Phenol
5. 2-Methoxyphenol
6. 2-Ethoxyphenol
7. Veratrol
8. Biphenyl-2-ol
9. Phenetole



MN Appl. No. 120890/120891

C_{18} or C_8 · some general principles

- High density C_8 and C_{18} phases allow tailing-free elution, also for very polar compounds.
- Octyl phases (C_8) show superior polar selectivity.
- Octadecyl phases (C_{18}) show superior hydrophobic selectivity.
- Hydrophobic compounds show shorter retention times on C_8 phases.

NUCLEODUR® C_{18} ec bulk material in 10, 12, 16, 20, 30 and 50 µm for self-packing of prep columns see page 172.

Ordering information

eluent in column acetonitrile / water

Length →	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEODUR® 100-3 C_{18} ec			octadecyl phase, particle size 3 µm, 17,5 % C				
Microbore columns							
 1 mm ID			717710.10	717711.10	717712.10	717713.10	

Columns with NUCLEODUR® phases

	Length →	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns
EC columns								
	2 mm ID	760050.20			760051.20		760052.20	761005.30
	3 mm ID	760050.30			760051.30		760052.30	761005.30
	4 mm ID	760050.40			760051.40		760052.40	761005.40
	4.6 mm ID	760050.46	760046.46	760054.46	760051.46	760053.46	760052.46	761005.40
NUCLEODUR® 100-5 C_{18} ec					octadecyl phase, particle size 5 µm, 17.5 % C			
Microbore columns								
	1 mm ID			717701.10	717700.10	717702.10	717703.10	
EC columns								
	2 mm ID	760004.20			760001.20		760002.20	761100.30
	3 mm ID	760004.30			760001.30		760002.30	761100.30
	4 mm ID	760004.40			760001.40		760002.40	761100.40
	4.6 mm ID	760004.46	760035.46	760013.46	760001.46	760008.46	760002.46	761100.40
VarioPrep columns								
	10 mm ID	762003.100			762029.100		762022.100	762090.80
	21 mm ID	762003.210			762029.210		762022.210	762091.160
	32 mm ID						762022.320	762311.320
	40 mm ID					762027.400	762022.400	762311.320
NUCLEODUR® 100-10 C_{18} ec					octadecyl phase, particle size 10 µm, 17.5 % C			
VarioPrep columns								
	10 mm ID	762011.100			762302.100		762010.100	762090.80
	21 mm ID	762011.210			762302.210		762010.210	762091.160
	32 mm ID						762010.320	762311.320
	40 mm ID					762303.400	762010.400	762311.320
	50 mm ID						762010.500	762311.320

NUCLEODUR® 100-3 C_8 ec					octyl phase, particle size 3 µm, 10.5 % C			
EC columns								
	2 mm ID	760063.20			760060.20		760062.20	761012.30
	3 mm ID	760063.30			760060.30		760062.30	761012.30
	4 mm ID	760063.40			760060.40		760062.40	761012.40
	4.6 mm ID	760063.46	760064.46	760059.46	760060.46	760061.46	760062.46	761012.40
NUCLEODUR® 100-5 C_8 ec					octyl phase, particle size 5 µm, 10.5 % C			
EC columns								
	2 mm ID	760700.20			760701.20		760703.20	761704.30
	3 mm ID	760700.30			760701.30		760703.30	761704.30
	4 mm ID	760700.40			760701.40		760703.40	761704.40
	4.6 mm ID	760700.46	760706.46	760704.46	760701.46	760702.46	760703.46	761704.40
VarioPrep columns								
	10 mm ID	762072.100			762061.100		762062.100	762092.80
	21 mm ID	762072.210			762061.210		762062.210	762093.160
	32 mm ID						762062.320	762321.320
	40 mm ID					762079.400	762062.400	762321.320

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, analytical and preparative main columns in packs of 1.
Other Microbore and VarioPrep columns on request; for available dimensions see page 168/169.

VP guard column cartridge	pack of	for VP column	required holder (see page 168)
VP 10/8, 10 x 8 mm ID	2	10 mm ID	8 mm (REF 718251)
VP 20/16, 20 x 16 mm ID	2	21 mm ID	16 mm (REF 718250)
VP 15/32, 15 x 32 mm ID	1	32 to 50 mm ID	32 mm (REF 718253)

SiOH — unmodified NUCLEODUR® silica for normal phase separations

- **key features:**
  - totally spherical high purity silica
  - pressure stable up to 800 bar
  - suitable for analytical and preparative separation of polar and midpolar compounds
- **technical characteristics:**
  unmodified high purity silica; pore size 110 Å; particle sizes 3 to 50 µm
  pore volume 0.9 ml/g, surface area (BET) 340 m^2/g; pH stability 2 – 8; metal content < 10 ppm (see page 100)
- **recommended application:**
  polar and midpolar compounds under normal phase conditions
  USP L3

Ordering information

eluent in column *n*-heptane

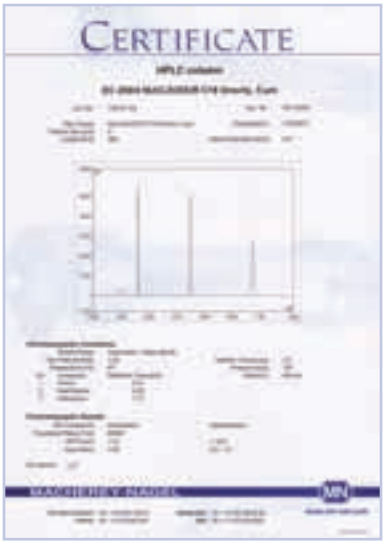
Length →	50 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEODUR® 100-3					particle size 3 µm
EC columns					
4.6 mm ID	**760170.46**		**760172.46**	**760173.46**	**761007.40**
NUCLEODUR® 100-5					particle size 5 µm
EC columns					
4 mm ID				**760007.40**	**761055.40**
4.6 mm ID	**760023.46**		**760012.46**	**760007.46**	**761055.40**
VarioPrep columns					
10 mm ID	**762077.100**	**762078.100**		**762007.100**	**762094.80**
21 mm ID	**762077.210**	**762078.210**		**762007.210**	**762095.160**
32 mm ID				**762007.320**	**762330.320**
40 mm ID			**762075.400**	**762007.400**	**762330.320**

Unmodified NUCLEODUR® bulk material in 10, 12, 16, 20, 30 and 50 µm for self-packing of prep columns see page 172.

Our HPLC QC policy

- **highest production standard**
  our facilities are EN ISO 9001:2008 certified
- **strict quality specifications** for outstanding reliability
- **perfect reproducibility** within each batch and from lot to lot

- Each column is individually tested and supplied with test chromatogram and test conditions

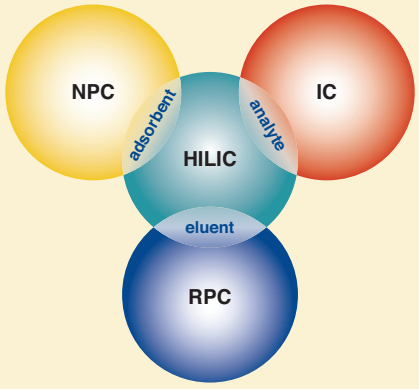


Test mixture for reversed phase columns

Designation	Pack of	REF
Test mixture for reversed phase columns in acetonitrile	1 ml	**722394**

NUCLEODUR® HILIC

zwitterionic phase



- **key features:**
  - ideal for reproducible and stable chromatography of highly polar analytes
  - suitable for analytical and preparative applications as well as **LC–MS**
  - very short column conditioning period
- **technical characteristics:**

  ammonium – sulfonic acid modified silica; pore size 110 Å; particle sizes 1,8, 3 and 5 µm; carbon content 7%; pH stability 2 – 8.5
- **recommended application:**

  hydrophilic compounds such as organic polar acids and bases, polar natural compounds, nucleosides, oligonucleotides, amino acids, peptides, water soluble vitamins

NUCLEODUR® HILIC

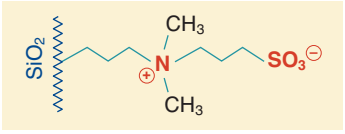
Separation science is always looking for new and effective strategies to accomplish the tasks of modern analytics. Especially for polar compounds reversed phase HPLC – the most common analytical method – is often limited. Here, hydrophilic stationary phases provide an additional tool for the separation of polar analytes in HPLC.

The expression HILIC (Hydrophilic Interaction LIquid Chromatography) was firstly published by Andrew Alpert in 1990 – since then it took quite some efforts to develop robust and reproducible hydrophilic HPLC phases for HILIC chromatography [A. Alpert, J. Chromatography 499 (1990), 177–196].

HILIC combines the characteristics of the 3 major methods in liquid chromatography – reversed phase (RPC), normal phase (NPC) and ion chromatography (IC):

- stationary phases (adsorbents) are mostly polar modifications of silica or polymers (SiOH, NH_2, Diol, (zwitter) ions, ...) – like in NPC
- mobile phases (eluents) are mixtures of aqueous buffer systems and organic modifier like acetonitrile or methanol – like in RPC
- fields of application include quite polar compounds as well as organic and inorganic ions – like in IC

"HILIC is NP chromatography of polar and ionic compounds under RP conditions."



NUCLEODUR® HILIC is a special zwitterionic modified stationary phase based on ultra spherical NUCLEODUR® particles. The betaine character of the ammonium-sulfonic acid ligands results in total charge equalisation and in an overall neutrally charged but highly polar surface.

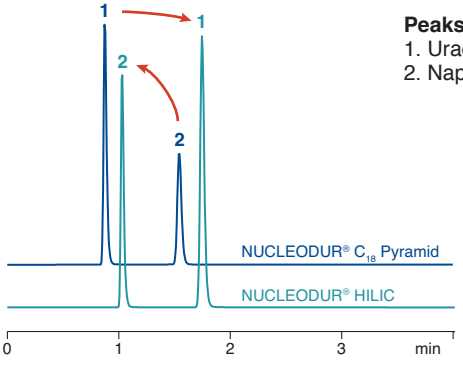
Retention characteristic

Commonly HILIC is described as partition chromatography or liquid/liquid extraction system between the mobile and stationary phase. Versus a water-poor mobile phase a water-rich layer on the surface of the polar stationary phase is formed. Thus, a distribution of the analytes between these two layers will occur.

Furthermore HILIC includes weak electrostatic mechanisms as well as hydrogen donor interactions between neutral polar molecules under high organic elution conditions. This distinguishes HILIC from ion exchange chromatography – main principle for HILIC separation is based on compound's polarity and degree of solvation. More polar compounds will have stronger interaction with the stationary aqueous layer than less polar compounds – resulting in a stronger retention.

Separation of uracil and naphthalene

Columns: 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 3 µm
125 x 4 mm NUCLEODUR® HILIC, 3 µm
Eluent: acetonitrile – water (90:10, v/v)
Flow rate: 1.0 ml/min, temperature 25 °C
Detection: UV, 254 nm



Peaks:
1. Uracil
2. Naphthalene

MN Appl. No. 122911/122912

Columns with NUCLEODUR® phases

Nonpolar compounds exhibit faster elution profiles due to minor hydrophobic interactions. Thus, as shown for the separation of uracil and naphthalene the elution order is quite often inverse on HILIC columns compared to RP columns.

In comparison with medium polar aminopropyl phases or modification with less balanced charge equalisation NUCLEODUR® HILIC shows a superb separation and peak shape for critical compounds like adenosine phosphates.

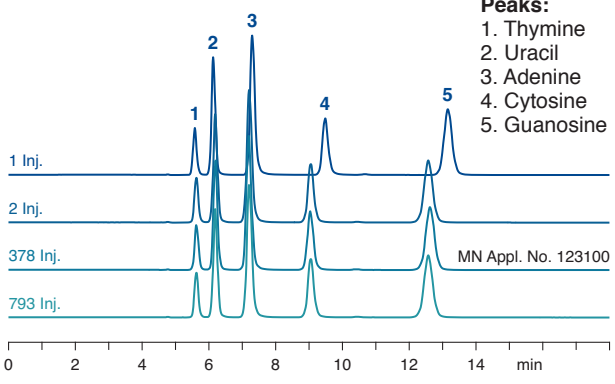
Stability features

Due to an advanced and unique surface modification procedure (pat. pend.) NUCLEODUR® HILIC columns provide short equilibration times – after just 20 min equilibration already the 2nd injection shows stable and reproducible results. Beyond this, NUCLEODUR® HILIC columns are characterized by an outstanding column life time – even after nearly 800 runs the columns show no loss of pristine performance – peak shape and retention are still immaculate.

Due to its high loadability NUCLEODUR® HILIC is absolutely suitable for preparative and semi-preparative applications.

Stability and equilibration

Column: 250 x 4 mm NUCLEODUR® HILIC, 5 µm
Eluent: acetonitrile – 5 mM ammonium acetate (80:20, v/v)
Flow rate: 0.6 ml/min
Temperature: 25 °C
Detection: UV, 254 nm



Overall NUCLEODUR® HILIC provides excellent chromatographic features and is hereby the perfect choice for separation of polar or charged compounds.

Ordering information

eluent in column acetonitrile – water 80:20, v/v

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEODUR® HILIC, 1.8 µm								particle size 1.8 µm
EC columns								
2 mm ID	**760521.20**	**760523.20**	**760525.20**	**760526.20**		**760528.20**		
3 mm ID	**760521.30**	**760523.30**						
4 mm ID	**760521.40**	**760523.40**						
4.6 mm ID	**760521.46**	**760523.46**						
NUCLEODUR® HILIC, 3 µm								particle size 3 µm
EC columns								
2 mm ID		**760532.20**			**760531.20**		**760530.20**	**761580.30**
3 mm ID		**760532.30**			**760531.30**		**760530.30**	**761580.30**
4 mm ID		**760532.40**			**760531.40**		**760530.40**	**761580.40**
4.6 mm ID		**760532.46**		**760534.46**	**760531.46**	**760533.46**	**760530.46**	**761580.40**
NUCLEODUR® HILIC, 5 µm								particle size 5 µm
EC columns								
2 mm ID		**760552.20**			**760551.20**		**760550.20**	**761590.30**
3 mm ID		**760552.30**			**760551.30**		**760550.30**	**761590.30**
4 mm ID		**760552.40**			**760551.40**		**760550.40**	**761590.40**
4.6 mm ID		**760552.46**		**760554.46**	**760551.46**	**760553.46**	**760550.46**	**761590.40**

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, all other columns in packs of 1.
Microbore and VarioPrep columns with NUCLEODUR® HILIC on request; for available dimensions see page 168/169.

Columns with NUCLEODUR® phases

NUCLEODUR® CN / CN-RP — cyano-modified high purity silica phase

- **key features:**
  - high retention capacity especially for very polar and unsaturated compounds
  - multi-mode column (RP and NP) widens scope of selectivity
  - stable against hydrolysis at low pH (working range pH 1 – 8)
- **technical characteristics:**
  cyanopropyl-modified high purity silica; pore size 110 Å; particle sizes 3 µm and 5 µm; 7% C; special endcapping
  high reproducibility from lot to lot;
  different retention characteristics in comparison to C_8 and C_{18}
- **recommended application:**
  tricyclic antidepressants
  steroids
  organic acids
  USP L10

Columns for HPLC

Alternative bonded-phase functionality

In reversed phase HPLC it is fairly common to start with C_{18} or C_8 columns, if new methods have to be developed. However, superior polarity and selectivity properties often required for more sophisticated separations, are not always sufficiently provided by classical RP phases, which are usually characterized by a hydrophobic layer of monomeric or polymeric bonded alkylsilanes.

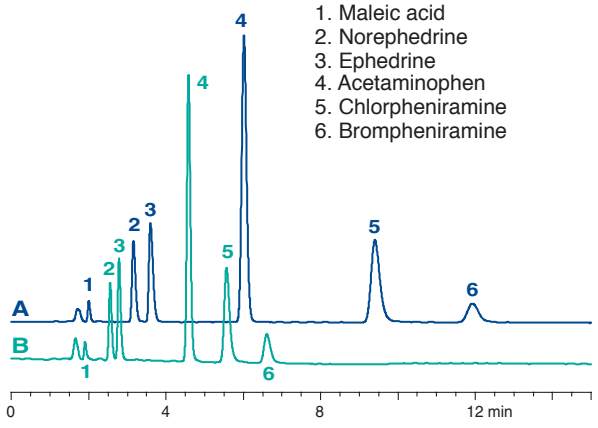
One approach to improve the resolution of compounds poorly separated on nonpolar stationary phases, is to change bonded-phase functionality. The fully end-capped and highly reproducible NUCLEODUR® 100-5 CN-RP phase has cyanopropyl groups on the surface able to generate a clearly recognizable different retention behaviour compared to purely alkyl-functionalized surface modifications (see figure below).

The polarity of the NUCLEODUR® 100-5 CN-RP phase can be classified as intermediate based on multiple retention mechanisms such as dipole-dipole, π-π, and also hydrophobic interactions [C. S. Young and R. J. Weigand, LCGC 20 (2002) 464 – 473]. Therefore, this phase shows a distinct selectivity for polar organic compounds as well as for molecules containing π electron systems (e.g. analytes with double bonds, tricyclic antidepressants) [V. R. Meyer, Practical High Performance Liquid Chromatography (John Wiley & Sons, New York, 3rd ed., 1999)]. Short-chain bonded phases are sometimes suspected of revealing shortcomings in stability towards hydrolysis at low pH [J. J. Kirkland, LCGC 14 (1996) 486 – 500]. The following chromatograms show that even after 100 sample injections and four weeks storage at pH 1 (curve 2), neither a considerable shift in retention, nor a visible change in peak symmetry could be noticed (curve 1 = new column).

Separation of cold medicine ingredients on two different NUCLEODUR® phases

Columns: **A) 250 x 4 mm NUCLEODUR® 100-5 C_{18} ec**
B) 250 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – 100 mM sodium citrate pH 2.5 (15:85, v/v)
Flow rate: 1.0 ml/min, temperature 25 °C
Detection: UV, 270 nm, injection volume: 10 µl

Peaks:
1. Maleic acid
2. Norephedrine
3. Ephedrine
4. Acetaminophen
5. Chlorpheniramine
6. Brompheniramine

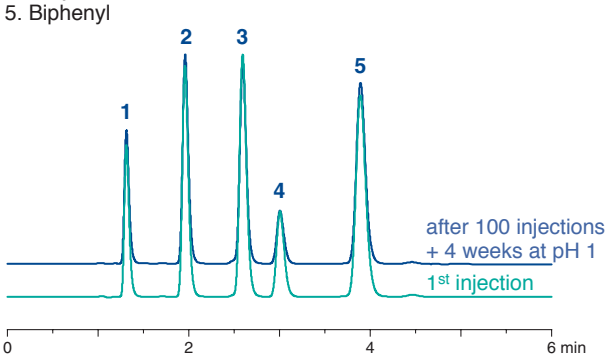


MN Appl. No. 119340

Stability of NUCLEODUR® CN-RP at pH 1

Column: 125 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – water, 2% TFA pH 1 (50:50, v/v)
Flow rate: 1.0 ml/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 5 µl

Peaks:
1. Benzamide
2. Dimethyl phthalate
3. Phenetole
4. *o*-Xylene
5. Biphenyl



MN Appl. No. 119350

Columns with NUCLEODUR® phases

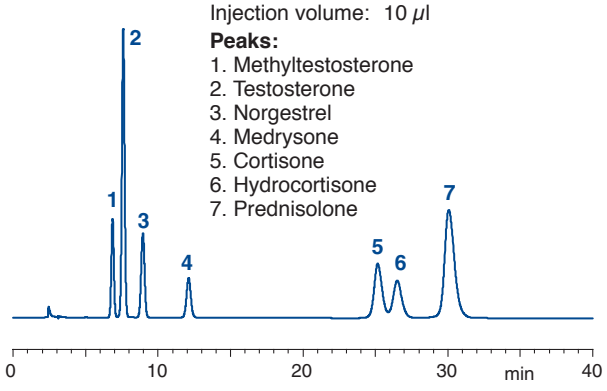
Due to the exceptional polarity features the cyano phase can also be run in the normal phase mode. NUCLEODUR® CN columns for normal phase applications are shipped in *n*-heptane. The drastic change in selectivity and order of elution for a mixture of various steroids in normal and reversed phase mode is displayed in following figure. Moreover the high coverage combined with a thorough endcapping makes NUCLEODUR® 100-5 CN-RP suitable for the separation of ionizable compounds such as basic drugs.

Separation of steroids in normal phase and reversed phase mode

Normal phase mode

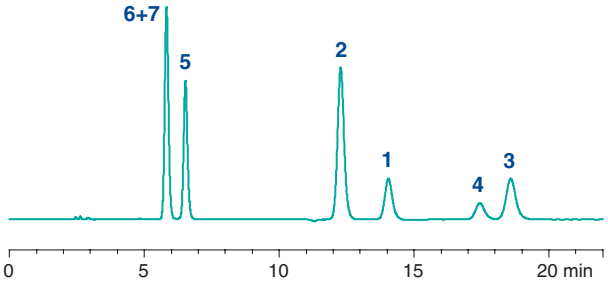
Column: 250 x 4 mm NUCLEODUR® 100-5 CN
Eluent: *n*-heptane – 2-propanol (90:10, v/v)
Flow rate: 1.0 ml/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 10 µl

Peaks:
1. Methyltestosterone
2. Testosterone
3. Norgestrel
4. Medrysone
5. Cortisone
6. Hydrocortisone
7. Prednisolone



Reversed phase mode

Column: 250 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – water (25:75, v/v)
other conditions as for normal phase mode



MN Appl. Nos. 119271/119272

Ordering information

Length →	50 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEODUR® 100-3 CN-RP	particle size 3 µm; eluent in column acetonitrile / water				
EC columns					
2 mm ID	**760159.20**	**760157.20**			**761430.30**
3 mm ID		**760157.30**			**761430.30**
4 mm ID			**760156.40**		**761430.40**
4.6 mm ID			**760156.46**		**761430.40**
NUCLEODUR® 100-5 CN-RP	particle size 5 µm; eluent in column acetonitrile / water				
EC columns					
4 mm ID		**760153.40**		**760152.40**	**761420.40**
4.6 mm ID		**760153.46**	**760154.46**	**760152.46**	**761420.40**
NUCLEODUR® 100-5 CN	particle size 5 µm; eluent in column *n*-heptane				
EC columns					
4 mm ID		**760151.40**		**760150.40**	**761419.40**
4.6 mm ID		**760151.46**	**760149.46**	**760150.46**	**761419.40**

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, all other columns in packs of 1.
Microbore and VarioPrep columns with NUCLEODUR® CN / CN-RP on request; for available dimensions see page 168/169.

Columns with NUCLEODUR® phases

NUCLEODUR® NH_2 / NH_2-RP — amino-modified high purity silica

- **key features:**
  - multi-mode columns (for RP, NP and IC)
  - stable against hydrolysis at low pH (working range pH 2 – 8), 100 % stable in water; suitable for **LC/MS**
  - widens scope of analytical HPLC into the polar range
- **technical characteristics:**

  aminopropyl-modified high purity silica; pore size 110 Å; particle sizes 3, 5 and 7 µm; 2.5 % C; not endcapped
- **recommended application:**

  polar compounds under RP conditions (sugars, DNA bases), hydrocarbons under NP conditions

  USP L8

- **normal phase chromatography (NP)** with hexane, dichloromethane or 2-propanol as mobile phase for polar compounds such as substituted anilines, esters, chlorinated pesticides
- **reversed phase chromatography (RP)** of polar compounds in aqueous-organic eluent systems
- **ion exchange chromatography** of anions and organic acids using conventional buffers and organic modifiers

Some compounds, especially polar substances, cannot be sufficiently resolved on C_{18} phases. Polar-modified silica phases offer alternative selectivities such expanding the spectrum of analytical HPLC into the polar range.

Multi-mode columns

Besides cyano modifications, amino modifications belong to the most frequently used polar silica phases – both feature the important advantage, that they can be run in the RP mode using aqueous-organic eluent mixtures as well as in the NP mode e.g. with hexane as mobile phase. NUCLEODUR® Amino, too, belongs to the so-called multi-mode columns.

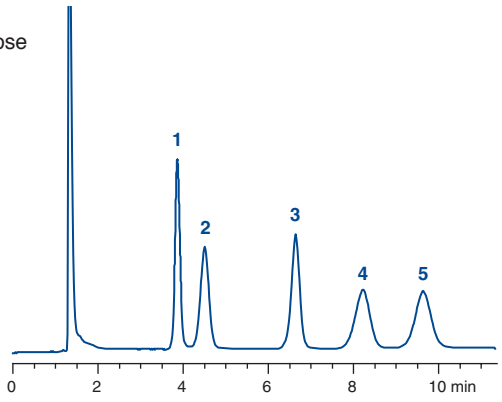
It can be used for reversed phase chromatography (RP) of polar compounds such as sugars in aqueous-organic eluent systems, for normal phase chromatography (NP) of substituted aromatics or chlorinated pesticides with organic mobile phases such as hexane, dichloromethane or 2-propanol, but also for ion exchange chromatography of anions and organic acids using conventional buffers and organic modifiers.

Main field of application of NUCLEODUR® Amino is the separation of simple and complex sugars, sugar alcohols and other hydroxy compounds under RP conditions as well as hydrocarbons under NP conditions.

Reversed phase separation of sugars

Column: 250 x 4 mm NUCLEODUR® 100-5 NH_2-RP
Eluent: acetonitrile – water (79:21, v/v)
Flow rate: 2 ml/min
Detection: RI

Peaks:
1. Fructose
2. Glucose
3. Saccharose
4. Maltose
5. Lactose

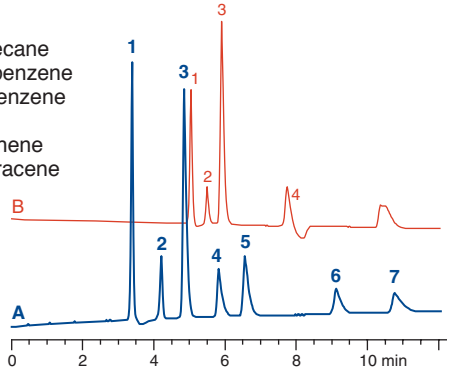


MN Appl. No. 122160

Normal phase separation of middle distillates in accordance with DIN EN 12916

Columns: **A) 250 x 4 mm NUCLEODUR® 100-5 NH_2**
B) conventional aminopropyl phase
Eluent: heptane
Flow rate: 1 ml/min
Detection: RI

Peaks:
1. Cyclohexane
2. 1-Phenyldodecane
3. 1,2-Dimethylbenzene
4. Hexamethylbenzene
5. Naphthalene
6. Dibenzothiophene
7. 9-Methylanthracene



MN Appl. No. 122180

Columns for HPLC

Columns with NUCLEODUR® phases

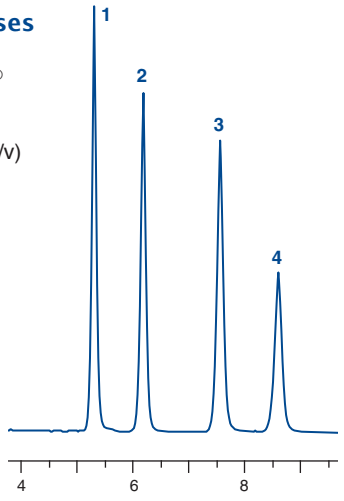
Even at lower flow rates than for C18 phases, NUCLEODUR® Amino achieves good separations of polar compounds such as DNA bases – this reduces the back pressure as well as the solvent consumption. Even very polar compounds like streptomycin are retained sufficiently for quantitative and qualitative analysis.

The example below proves the enhanced pH stability of the NUCLEODUR® amino phase and also the outstanding suitability of this column for the separation of total herbicides (AMPA, glyphosate, glufonisate, ...) – you may find the complete application in our online application data base at *www.mn-net.com*.

Separation of DNA bases

Column: 250 x 4 mm NUCLEODUR® 100-5 NH_2-RP
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 0.6 ml/min
Temperature: 35 °C
Pressure: 30 bar
Detection: UV, 254 nm

Peaks:
1. Thymine
2. Uracil
3. Cytosine
4. Adenine

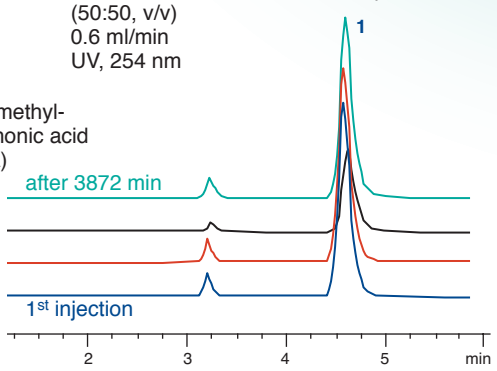


MN Appl. No. 122180

Hydrolytical resistance for NUCLEODUR® NH_2-RP

Column: 250 x 4 mm NUCLEODUR® 100-5 NH_2-RP
Eluent: acetonitrile – 50 mmol KH_2PO_4, pH 1.75 (50:50, v/v)
Flow rate: 0.6 ml/min
Detection: UV, 254 nm

Peaks:
1. Aminomethyl-phosphonic acid (AMPA)



MN Appl. No. 122190

One of the main problems with conventional amino phases is insufficient resistance towards hydrolysis. Due to a special method of surface modification NUCLEODUR® NH_2 features a pronounced stability at higher as well as at lower pH values. The figure at right shows, that even after several days of exposure of the column material at pH 1.75 good separation efficiency and peak symmetry are maintained. The resulting high column life allows cost reduction due to lower column consumption.

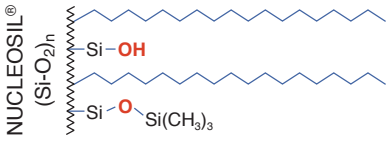
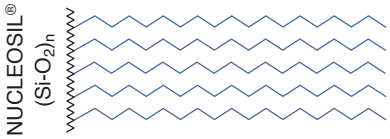
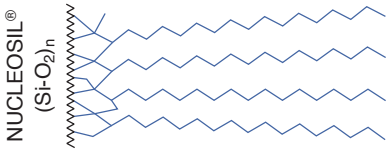
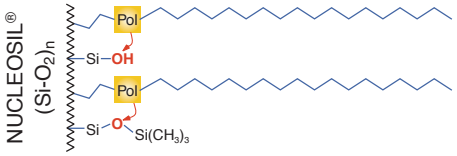
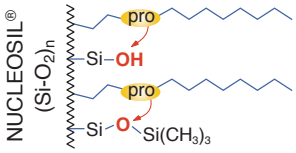
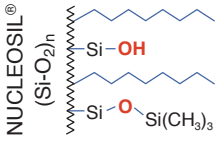
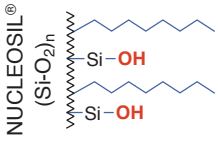
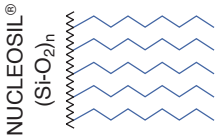
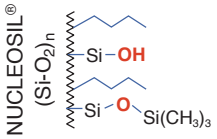
Based on the superspherical silica NUCLEODUR® this phase – like all other members of the NUCLEODUR® family – features a very good pressure stability, which makes it the perfect choice for preparative separations as well as for LC-MS applications. Additionally, the high batch-to-batch reproducibility of NUCLEODUR® NH_2 offers the advantage of reliable analyses especially for routine work.

Ordering information

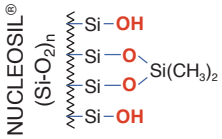
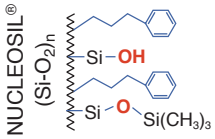
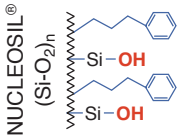
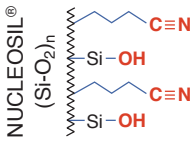
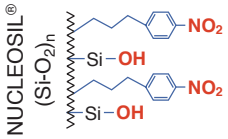
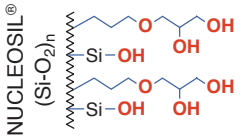
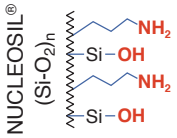
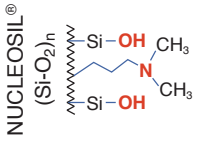
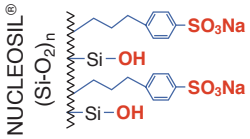
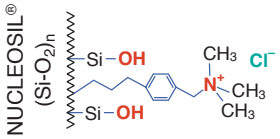
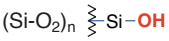
Length →	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEODUR® 100-3 NH_2-RP	particle size 3 µm; eluent in column acetonitrile / water				
EC columns					
2 mm ID	**760740.20**	**760741.20**			**761035.30**
4.6 mm ID			**760742.46**	**760739.46**	**761035.40**
NUCLEODUR® 100-5 NH_2-RP	particle size 5 µm; eluent in column acetonitrile / water				
EC columns					
2 mm ID		**760730.20**		**760732.20**	**761137.30**
3 mm ID		**760730.30**		**760732.30**	**761137.30**
4 mm ID		**760730.40**		**760732.40**	**761137.40**
4.6 mm ID		**760730.46**	**760731.46**	**760732.46**	**761137.40**
NUCLEODUR® 100-5 NH_2	particle size 5 µm; eluent in column *n*-heptane				
EC columns					
4 mm ID		**760720.40**		**760722.40**	**761130.40**
4.6 mm ID		**760720.46**	**760721.46**	**760722.46**	**761130.40**

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, all other columns in packs of 1.
Microbore and VarioPrep columns with NUCLEODUR® NH_2 / NH_2-RP on request; for available dimensions see page 168/169.

Overview of NUCLEOSIL® HPLC phases

Phase	Specification	Stability	Structure	Separation principle	Page
NUCLEOSIL® RP phases					
C_{18}	octadecyl phase, medium density modification, endcapping 15 % C · USP **L1**	pH 2 – 8		hydrophobic interactions (van der Waals interactions) slight residual silanol interactions	132 – 135
C_{18} HD	octadecyl phase, high density monomeric modification, endcapping 20 % C · USP **L1**	pH 2 – 9		hydrophobic interactions (van der Waals interactions)	134
C_{18} AB	octadecyl phase, special crosslinked modification, endcapping 25 % C · USP **L1**	pH 1 – 9		steric interactions and hydrophobic interactions	134
C_{18} Nautilus	octadecyl phase, embedded polar group, endcapping 16 % C · USP **L60**	pH 2 – 8 up to 100 % H_2O		hydrophobic interactions and polar interactions	134
PROTECT I	special RP phase, protective polar group, monomeric modification, endcapping 11 % C	pH 2 – 8		hydrophobic interactions and polar interactions	135
C_8 ec	octyl phase, medium density modification, endcapping 9 % C · USP **L7**	pH 2 – 8		hydrophobic interactions (van der Waals interactions) slight residual silanol interactions	136
C_8	octyl phase, no endcapping 8.5 % C · USP **L7**	pH 2 – 8		hydrophobic interactions (van der Waals interactions) noticeable silanol interactions	136 – 137
C_8 HD	octyl phase, high density monomeric modification, endcapping 13 % C · USP **L7**	pH 2 – 8		hydrophobic interactions (van der Waals interactions)	137
C_4	butyl phase, medium density modification, endcapping ~ 2 % C · USP **L26**	pH 2 – 8		hydrophobic interactions (van der Waals interactions) residual silanol interactions	137

Widest choice of modifications

Phase	Specification	Stability	Structure	Separation principle	Page
C_2	dimethyl phase 3.5 % C · USP **L16**	pH 2 – 8		hydrophobic interactions (van der Waals interactions) noticeable silanol interactions	138
C_6H_5 ec	phenyl phase, medium density modification, endcapping 8 % C · USP **L11**	pH 2 – 8		π–π interactions and hydrophobic interactions slight residual silanol interactions	174*
C_6H_5	phenyl phase, no endcapping 8 % C · USP **L11**	pH 2 – 8		π–π interactions and hydrophobic interactions noticeable silanol interactions	138
Polar NUCLEOSIL® phases and NUCLEOSIL® ion exchangers					
CN / CN–RP	cyano (nitrile) phase USP **L10**	pH 2 – 8		π–π interactions, polar interactions and hydrophobic interactions	139
NO_2	nitrophenyl	pH 2 – 8		π–π interactions, polar interactions and hydrophobic interactions	174*
OH	diol USP **L20**	pH 2 – 8		polar interactions (hydrogen bonds)	140
NH_2 / NH_2–RP	amino USP **L8**	pH 2 – 8		polar interactions, hydrophobic interactions, weak ion exchange interactions	141
$N(CH_3)_2$	dimethylamino	pH 2 – 8		polar interactions, hydrophobic interactions, weak ion exchange interactions	141
SA	sulphonic acid, strongly acidic cation exchanger (SCX) USP **L9**	pH 2 – 8		strong ion exchange interactions	142
SB	quaternary ammonium groups, strongly basic anion exchanger (SAX) USP **L14**	pH 2 – 8		strong ion exchange interactions	142
Unmodified NUCLEOSIL®	spherical silica · USP **L3**	pH 2 – 8		polar interactions	140

* available as bulk packing (custom-packed columns on request)

Columns with NUCLEOSIL® C_{18} phases

NUCLEOSIL® octadecyl phases (C_{18})

$-(CH_2)_{17} - CH_3$

- **NUCLEOSIL® standard octadecyl phases**
  nonpolar phases · USP **L1**
  pH stability at 20 °C: 2 – 8; carbon content depending on pore size (see ordering information)
- **NUCLEOSIL® C_{18} HD**
  nonpolar hydrophobic high density phases, monomeric modification · USP **L1**
  pH stability 2 – 9; carbon content 20%
  corresponding NUCLEODUR® phases see C_{18} Gravity page 108 – 111
- **NUCLEOSIL® C_{18} AB**
  crosslinked hydrophobic phase, polymeric modification, inert towards acidic and basic substances with high affinity for silica; pH stability 1 – 9; carbon content 25% · USP **L1**
  distinct steric selectivity
  corresponding NUCLEODUR® phases see C_{18} Isis page 112 – 113
- **NUCLEOSIL® C_{18} Nautilus**
  stable in 100% aqueous eluents; carbon content 16% · USP **L60**
  interesting polar selectivity features
  very good base deactivation
- **wide pore octadecyl phases**
- all octadecyl phases are endcapped

Custom-packed columns with different column dimensions are available on request.

Ordering information

eluent in column acetonitrile / water

Length →	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEOSIL® 50-5 C_{18} ec		particle size 5 µm, pore size 50 Å, 14.5% C			
EC columns					
4.6 mm ID				**720098.46**	**721829.40**
NUCLEOSIL® 100-3 C_{18}		particle size 3 µm, pore size 100 Å, 15% C			
EC columns					
4 mm ID		**720150.40**		**720133.40**	**721866.40**
4.6 mm ID	**720841.46**	**720150.46**	**720949.46**	**720133.46**	**721866.40**
ChromCart® cartridges					
4 mm ID		**721883.40**			**721866.40**
4.6 mm ID		**721883.46**	**721806.46**	**721865.46**	**721866.40**
NUCLEOSIL® 100-5 C_{18}		particle size 5 µm, pore size 100 Å, 15% C			
EC columns					
2 mm ID		**720002.20**		**720014.20**	**721602.30**
3 mm ID		**720002.30**		**720014.30**	**721602.30**
4 mm ID	**720141.40**	**720002.40**	**720120.40**	**720014.40**	**721602.40**
4.6 mm ID	**720141.46**	**720002.46**	**720120.46**	**720014.46**	**721602.40**
ChromCart® cartridges					
2 mm ID		**721622.20**			**721602.30**
3 mm ID		**721622.30**			**721602.30**
4 mm ID		**721622.40**		**721662.40**	**721602.40**
4.6 mm ID		**721622.46**	**721642.46**	**721662.46**	**721602.40**

Columns with NUCLEOSIL® C_{18} phases

Length →	100 mm	125 mm	150 mm	250 mm	Guard columns
VarioPrep columns					
10 mm ID				715340.100	715360.80
21 mm ID				715340.210	715361.160
NUCLEOSIL® 100-7 C_{18}				particle size 7 µm, pore size 100 Å, 15 % C	
EC columns					
4 mm ID				720018.40	
4.6 mm ID		720951.46	720110.46	720018.46	
VarioPrep columns					
8 mm ID				715332.80	715360.80
10 mm ID				715332.100	715360.80
16 mm ID				715332.160	715361.160
21 mm ID				715332.210	715361.160
NUCLEOSIL® 100-10 C_{18}				particle size 10 µm, pore size 100 Å, 15 % C	
EC columns					
4 mm ID				720023.40	
4.6 mm ID		720701.46	720140.46	720023.46	
ChromCart® cartridges					
4 mm ID				721689.40	
4.6 mm ID				721689.46	
NUCLEOSIL® 120-3 C_{18}				particle size 3 µm, pore size 120 Å, 11 % C	
EC columns					
4 mm ID	720149.40	720040.40		720055.40	721606.40
4.6 mm ID	720149.46	720040.46	720740.46	720055.46	721606.40
ChromCart® cartridges					
4 mm ID		721626.40		721666.40	721606.40
NUCLEOSIL® 120-5 C_{18}				particle size 5 µm, pore size 120 Å, 11 % C	
EC columns					
4 mm ID		720051.40		720041.40	721783.40
4.6 mm ID		720051.46	720730.46	720041.46	721783.40
ChromCart® cartridges					
4 mm ID		721629.40		721712.40	721783.40
NUCLEOSIL® 120-7 C_{18}				particle size 7 µm, pore size 120 Å, 11 % C	
EC columns					
4 mm ID				720042.40	

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, analytical and preparative main columns in packs of 1.
ChromCart® columns require the CC connecting kit (REF 721690).
Microbore columns and further VarioPrep columns with NUCLEOSIL® packings are available on request. For possible dimensions see page 168/169.

VP guard column cartridge	pack of	for VP column	required holder (see page 168)
VP 10/8, 10 x 8 mm ID	2	8 and 10 mm ID	8 mm (REF 718251)
VP 20/16, 20 x 16 mm ID	2	16 and 21 mm ID	16 mm (REF 718250)

Columns with NUCLEOSIL® C_{18} phases

Length →	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEOSIL® 120-10 C_{18}		particle size 10 µm, pore size 120 Å, 11 % C			
EC columns					
4 mm ID				720043.40	
4.6 mm ID				720043.46	
NUCLEOSIL® 100-3 C_{18} HD		particle size 3 µm, pore size 100 Å, 20 % C			
EC columns					
4 mm ID		720191.40			721494.40
4.6 mm ID		720191.46	720193.46		721494.40
NUCLEOSIL® 100-5 C_{18} HD		particle size 5 µm, pore size 100 Å, 20 % C			
EC columns					
4 mm ID		720296.40		720280.40	721853.40
4.6 mm ID		720296.46	720294.46	720280.46	721853.40
ChromCart® cartridges					
4 mm ID		721852.40		721850.40	721853.40
NUCLEOSIL® 100-5 C_{18} AB		particle size 5 µm, pore size 100 Å, 25 % C			
EC columns					
4 mm ID		720935.40		720936.40	721603.40
4.6 mm ID		720935.46	720305.46	720936.46	721603.40
ChromCart® cartridges					
4 mm ID		721623.40		721663.40	721603.40
NUCLEOSIL® 100-3 C_{18} Nautilus		particle size 3 µm, pore size 100 Å, 16 % C			
EC columns					
4 mm ID		720472.40			721611.40
4.6 mm ID		720472.46	720471.46		721611.40
NUCLEOSIL® 100-5 C_{18} Nautilus		particle size 5 µm, pore size 100 Å, 16 % C			
EC columns					
4 mm ID		720430.40		720431.40	721140.40
4.6 mm ID		720430.46	720432.46	720431.46	721140.40

Wide pore silica packings

Many biologically interesting molecules can not be separated using conventional narrow pore silicas with pore sizes of about 100 Å.

This is why MACHEREY-NAGEL offers a complete line of wide pore packings with pore sizes of 300, 500, 1000 and 4000 Å. These materials can also be used for size exclusion chromatography (SEC).

Length →	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEOSIL® 300-5 C_{18}		particle size 5 µm, pore size 300 Å, 6.5 % C			
EC columns					
4 mm ID				720065.40	721608.40
4.6 mm ID				720065.46	721608.40

Columns with NUCLEOSIL® C_{18} / Protect I

	Length →	100 mm	125 mm	150 mm	250 mm	Guard columns
NUCLEOSIL® 300-7 C_{18}				particle size 7 µm, pore size 300 Å, 6,5 % C		
VarioPrep columns						
	10 mm ID				715806.100	715360.80
	21 mm ID				715806.210	715361.160
NUCLEOSIL® 500-7 C_{18}				particle size 7 µm, pore size 500 Å, 2 % C		
EC columns						
	4.6 mm ID				720074.46	
NUCLEOSIL® 1000-7 C_{18}				particle size 7 µm, pore size 1000 Å, ~ 1 % C		
EC columns						
	4.6 mm ID				720077.46	
NUCLEOSIL® 4000-7 C_{18}				particle size 7 µm, pore size 4000 Å, < 1 % C		
EC columns						
	4.6 mm ID				720085.46	

8 mm ChromCart® guard column cartridges in packs of 3, analytical and preparative main columns in packs of 1.
As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
ChromCart® columns require the CC connecting kit (REF 721690).
Microbore columns and VarioPrep columns with NUCLEOSIL® packings are available on request. For possible dimensions see page 168/169.

VP guard column cartridge	pack of	for VP column	required holder (see page 168)
VP 10/8, 10 x 8 mm ID	2	10 mm ID	8 mm (REF 718251)
VP 20/16, 20 x 16 mm ID	2	21 mm ID	16 mm (REF 718250)

NUCLEOSIL® 100 Protect I — special RP phase with protective polar group

- RP phase with pronounced hydrophilic properties, monomeric coating, endcapped
  carbon content 11 % C

Ordering information

Eluent in column is acetonitrile / water

	Length →	125 mm	150 mm	250 mm	Guard columns
NUCLEOSIL® 100-5 Protect I			particle size 5 µm, pore size 100 Å		
EC columns					
	4 mm ID	720175.40		720170.40	721154.40
	4.6 mm ID	720175.46	720174.46	720170.46	721154.40

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, all other columns in packs of 1.

Analytical columns with NUCLEOSIL® C_8 phases

NUCLEOSIL® octyl phases (C_8)

$-(CH_2)_7-CH_3$

- **NUCLEOSIL® standard octyl phases**
  nonpolar phases for RP and ion-pairing chromatography
  endcapped and non-endcapped modifications available
  pH stability at 20 °C: 2 – 8
- **NUCLEOSIL® C_8 HD**
  nonpolar high density phases, monomeric modification, endcapped;
  corresponding NUCLEODUR® phases see C_8 Gravity page 108 – 111
- recommended for separation of moderately to highly polar (water-soluble) compounds
  applications: steroids, nucleosides, cyclodextrins, pharmacological plant constituents
- all phases: USP **L7**

Custom-packed columns with different column dimensions are available on request

Ordering information

eluent in column acetonitrile / water

	Length →	125 mm	150 mm	250 mm	Guard columns
NUCLEOSIL® 50-5 C_8 ec	particle size 5 µm, pore size 50 Å; endcapped, 9 % C				
EC columns					
	4.6 mm ID			**720092.46**	**721834.40**
NUCLEOSIL® 100-5 C_8 ec	particle size 5 µm, pore size 100 Å; endcapped, 9 % C				
EC columns					
	4 mm ID			**720165.40**	**721805.40**
	4,6 mm ID			**720165.46**	**721805.40**
NUCLEOSIL® 100-5 C_8	particle size 5 µm, pore size 100 Å; not endcapped, 8.5 % C				
EC columns					
	4 mm ID	**720001.40**		**720013.40**	**721601.40**
	4.6 mm ID	**720001.46**	**720990.46**	**720013.46**	**721601.40**
NUCLEOSIL® 100-7 C_8	particle size 7 µm, pore size 100 Å; not endcapped, 8.5 % C				
EC columns					
	4 mm ID			**720017.40**	
	4.6 mm ID			**720017.46**	
NUCLEOSIL® 100-10 C_8	particle size 10 µm, pore size 100 Å; not endcapped, 8.5 % C				
EC columns					
	4 mm ID			**720022.40**	
	4.6 mm ID			**720022.46**	
NUCLEOSIL® 120-3 C_8	particle size 3 µm, pore size 120 Å; not endcapped, 6.5 % C				
EC columns					
	4 mm ID	**720071.40**			**721785.40**
	4.6 mm ID	**720071.46**	**720214.46**		**721785.40**

Analytical columns with NUCLEOSIL® C_8 / C_4

	Length →	125 mm	150 mm	250 mm	Guard columns
NUCLEOSIL® 120-5 C_8	particle size 5 µm, pore size 120 Å; not endcapped, 6.5 % C				
EC columns					
	4 mm ID	**720050.40**		**720052.40**	**721787.40**
	4.6 mm ID	**720050.46**	**720735.46**	**720052.46**	**721787.40**
NUCLEOSIL® 300-5 C_8	particle size 5 µm, pore size 300 Å; not endcapped, ~ 3 % C				
EC columns					
	4.6 mm ID			**720062.46**	**721101.40**
NUCLEOSIL® 100-5 C_8 HD	particle size 5 µm, pore size 100 Å, 13 % C				
EC columns					
	4 mm ID	**720195.40**		**720196.40**	**721500.40**
	4.6 mm ID	**720195.46**	**720194.46**	**720196.46**	**721500.40**

NUCLEOSIL® butyl phases (C_4)

$-(CH_2)_3 - CH_3$

- endcapped phases for RP and ion-pairing chromatography · USP **L26**
- pH stability at 20 °C: 2 – 8; carbon content ~ 2 %
- recommended for separation of macromolecules and hydrophobic substances
- retention times are shorter than on C_8 and C_{18} phases

For butyl phases for biochemical separations please refer to page 159.

Ordering information

eluent in column acetonitrile / water

	Length →	125 mm	150 mm	250 mm	Guard columns
NUCLEOSIL® 120-5 C_4	particle size 5 µm, pore size 120 Å				
EC columns					
	4.6 mm ID			**720096.46**	**721889.40**
NUCLEOSIL® 300-5 C_4	particle size 5 µm, pore size 300 Å				
EC columns					
	4 mm ID	**720901.40**		**720059.40**	**721607.40**
	4.6 mm ID		**720220.46**	**720059.46**	**721607.40**

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, all other columns in packs of 1.
Microbore and VarioPrep columns with NUCLEOSIL® packings are available on request; for possible dimensions see page 168/169.

Analytical columns with NUCLEOSIL® RP phases

NUCLEOSIL® dimethyl phase (C_2)

$-(CH_3)_2$

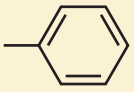
- non-endcapped phase for RP and ion-pairing chromatography · USP **L16**
- pH stability at 20 °C: 2 – 8; carbon content 3.5 %
- retention times are much shorter than for the other RP phases

Ordering information

eluent in column acetonitrile / water

	Length →	250 mm	Guard columns
NUCLEOSIL® 100-7 C_2	particle size 7 µm, pore size 100 Å		
EC columns			
4.6 mm ID		**720089.46**	**721069.40**

NUCLEOSIL® phenyl phases (C_6H_5)

$-(CH_2)_3$ 

- relatively nonpolar, non-endcapped phases for RP and ion pairing chromatography · USP **L11**
- pH stability at 20 °C: 2 – 8; carbon content 8 % C
- polarity similar to C_8, but with different selectivity for polycyclic aromatic hydrocarbons, polar aromatics, fatty acids etc.
- recommended for separation of moderately polar compounds

Ordering information

eluent in column acetonitrile / water

	Length →	250 mm	Guard columns
NUCLEOSIL® 100-5 C_6H_5	particle size 5 µm, pore size 100 Å, not endcapped		
EC columns			
4.6 mm ID		**720956.46**	**721862.40**
NUCLEOSIL® 100-7 C_6H_5	particle size 7 µm, pore size 100 Å, not endcapped		
EC columns			
4 mm ID		**720019.40**	
4.6 mm ID		**720019.46**	

NUCLEOSIL® cyano phases

$-(CH_2)_3-CN$

- polar to mid-polar cyano (nitrile) modified silica · USP **L10**
- for reversed phase and normal phase chromatography:
  normal phase: with low-polarity solvents for many compounds, which can also be separated on unmodified silica, however, due to the rapid equilibration much more suitable for gradient separations
  reversed phase: with different selectivity than C_{18}, C_8 or phenyl modified packings
- pH stability at 20 °C: 2 – 8; carbon content 5 % for 100 Å pores, ~ 3 % for 120 Å pores

Eluent in column is *n*-heptane (except for CN-RP: acetonitrile/water). When using an eluent which is not miscible with *n*-heptane (e.g. water), it is necessary to rinse the column with THF first.

Ordering information

	Length →	250 mm	Guard columns
NUCLEOSIL® 100-5 CN	particle size 5 µm, pore size 100 Å; eluent in column *n*-heptane		
EC columns			
4 mm ID		**720090.40**	**721604.40**
4.6 mm ID		**720090.46**	**721604.40**
NUCLEOSIL® 100-5 CN-RP	particle size 5 µm, pore size 100 Å; eluent in column CH_3CN / H_2O		
EC columns			
4 mm ID		**720205.40**	**721917.40**
4.6 mm ID		**720205.46**	**721917.40**
NUCLEOSIL® 100-10 CN	particle size 10 µm, pore size 100 Å; eluent in column *n*-heptane		
EC columns			
4 mm ID		**720024.40**	
4.6 mm ID		**720024.46**	
NUCLEOSIL® 120-7 CN	particle size 7 µm, pore size 120 Å; eluent in column *n*-heptane		
EC columns			
4 mm ID		**720057.40**	
4.6 mm ID		**720057.46**	

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, all other columns in packs of 1.

Analytical columns with NUCLEOSIL® OH phases

Unmodified NUCLEOSIL® silica

SiOH

- spherical silica, pH stability 2 – 8 · USP **L3**

Physical properties of unmodified NUCLEOSIL® materials

Phase	Pore size	Pore volume	Surface (BET)	Density	Pressure stability
NUCLEOSIL® 50	50 Å	0.8 ml/g	420 m^2/g	0.45 g/ml	600 bar
NUCLEOSIL® 100	100 Å	1.0 ml/g	350 m^2/g	0.36 g/ml	600 bar
NUCLEOSIL® 120	120 Å	0.65 ml/g	200 m^2/g	0.55 g/ml	800 bar
NUCLEOSIL® 300	300 Å	0.8 ml/g	100 m^2/g	0.45 g/ml	400 bar
NUCLEOSIL® 500	500 Å	0.8 ml/g	35 m^2/g	0.45 g/ml	400 bar
NUCLEOSIL® 1000	1000 Å	0.8 ml/g	25 m^2/g	0.45 g/ml	300 bar
NUCLEOSIL® 4000	4000 Å	0.7 ml/g	10 m^2/g	0.48 g/ml	300 bar

Ordering information

Eluent in column is *n*-heptane. When using an eluent which is not miscible with *n*-heptane (e.g. water), it is necessary to rinse the columns with THF first.

	Length →	250 mm	Guard columns
NUCLEOSIL® 50-5		particle size 5 µm, pore size 50 Å	
EC columns			
 4.6 mm ID		**720093.46**	**721600.40**
NUCLEOSIL® 100-5		particle size 5 µm, pore size 100 Å	
EC columns			
 4.6 mm ID		**720099.46**	**721872.40**

NUCLEOSIL® diol phases

$$-(CH_2)_3-O-CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-\underset{\displaystyle OH}{\underset{|}{CH_2}}$$

- dihydroxypropyl modified silica for RP and NP chromatography · USP **L20**
- less polar than unmodified silica, very easily wettable with water
- pH stability at 20 °C: 2 – 8; carbon content 5 %

Ordering information

Eluent in column is *n*-heptane. When using an eluent which is not miscible with *n*-heptane (e.g. water), it is necessary to rinse the columns with THF first.

	Length →	250 mm	Guard columns
NUCLEOSIL® 100-5 OH (Diol)		particle size 5 µm, pore size 100 Å	
EC columns			
 4.6 mm ID		**720143.46**	**721478.40**
NUCLEOSIL® 100-7 OH (Diol)		particle size 7 µm, pore size 100 Å	
EC columns			
 4.6 mm ID		**720070.46**	

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).

NUCLEOSIL® amino phases

$-(CH_2)_3 - NH_2$

- aminopropyl modified polar silica phase · USP **L8**
- for multi-mode chromatography:

  normal phase chromatography with hexane, dichloromethane or 2-propanol as mobile phase for polar compounds such as substituted anilines, esters, chlorinated pesticides
  reversed phase chromatography of polar compounds like carbohydrates in aqueous-organic eluent systems
  anion exchange chromatography of anions and organic acids using common buffers (e.g. acetate or phosphate) in conjunction with organic modifiers (e.g. acetonitrile)
- pH stability at 20 °C: 2 – 8; carbon content 3.5 %

Eluent in column is *n*-heptane (except for NH_2 RP: acetonitrile/water). When using an eluent which is not miscible with *n*-heptane (e.g. water), it is necessary to rinse the column with THF first.

Ordering information

	Length →	250 mm	Guard columns
NUCLEOSIL® 100-5 NH_2	particle size 5 µm, pore size 100 Å; eluent in column *n*-heptane		
EC columns			
 4.6 mm ID		**720095.46**	**721605.40**
NUCLEOSIL® 100-5 NH_2 RP	particle size 5 µm, pore size 100 Å; eluent in column acetonitrile / water (80:20)		
EC columns			
 4.6 mm ID		**720095.46RP**	**721605.40RP**
NUCLEOSIL® 100-10 NH_2	particle size 10 µm, pore size 100 Å; eluent in column *n*-heptane		
EC columns			
 4.6 mm ID		**720025.46**	

NUCLEOSIL® dimethylamino phase

$-(CH_2)_3 - N(CH_3)_2$

- weakly basic anion exchanger for the separation of many anions
- can also be used in a similar way as the NH_2 phase
- pH stability at 20 °C: 2 – 8; carbon content 4 %

Ordering information

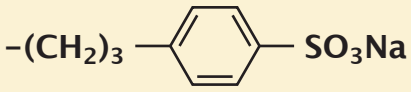
Eluent in column is *n*-heptane. When using an eluent which is not miscible with *n*-heptane (e.g. water), it is necessary to rinse the columns with THF first.

	Length →	250 mm	Guard columns
NUCLEOSIL® 100-5 $N(CH_3)_2$	particle size 5 µm, pore size 100 Å		
EC columns			
 4.6 mm ID		**720994.46**	**721610.40**

8 mm ChromCart® guard column cartridges in packs of 3, all other columns in packs of 1.

Analytical columns with NUCLEOSIL® SA / SB

NUCLEOSIL® SA phases



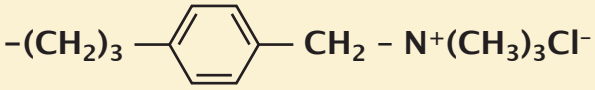
- strongly acidic cation exchangers (SCX) with benzenesulphonic acid modification · USP **L9**
- capacity ~ 1 meq/g
- pH stability at 20 °C: 2 – 8; carbon content 6.5 %

Ordering information

eluent in column 0.15 M $(NH_4)_2HPO_4$, pH 5

Length →	125 mm	150 mm	250 mm	Guard columns
NUCLEOSIL® 100-5 SA			particle size 5 µm, pore size 100 Å	
EC columns				
4 mm ID			**720097.40**	**721487.40**
4.6 mm ID	**720709.46**	**720182.46**	**720097.46**	**721487.40**
ChromCart® cartridges				
4.6 mm ID	**721486.46**		**721342.46**	**721487.40**
NUCLEOSIL® 100-10 SA			particle size 10 µm, pore size 100 Å	
EC columns				
4.6 mm ID			**720028.46**	**721706.40**

NUCLEOSIL® SB phases



- strongly basic anion exchangers (SAX) with quaternary ammonium modification · USP **L14**
- capacity ~ 1 meq/g
- pH stability at 20 °C: 2 – 8; carbon content 10 %

Ordering information

eluent in column 0.15 M $(NH_4)_2HPO_4$, pH 5

Length →	125 mm	150 mm	250 mm	Guard columns
NUCLEOSIL® 100-5 SB			particle size 5 µm, pore size 100 Å	
EC columns				
4 mm ID			**720996.40**	**721885.40**
4.6 mm ID	**720989.46**	**720183.46**	**720996.46**	**721885.40**
ChromCart® cartridges				
4.6 mm ID	**721688.46**		**721884.46**	**721885.40**
NUCLEOSIL® 100-10 SB			particle size 10 µm, pore size 100 Å	
EC columns				
4.6 mm ID			**720029.46**	**721886.40**

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
ChromCart® columns require the CC connecting kit (REF 721690).
8 mm ChromCart® guard column cartridges in packs of 3, all other columns in packs of 1.

Analytical columns with other RP phases

LiChrospher® · Superspher® packings manufactured by E. Merck (D)

Phase	USP	Particle size	Pore size	Modification	Endcapped	Carbon content
LiChrospher® 100 RP 8, 5 µm	L7	nom. 5 µm	100 Å	octyl	–	12.5%
LiChrospher® 100 RP 8 ec, 5 µm	L7	nom. 5 µm	100 Å	octyl	✔	12.5%
LiChrospher® 100 RP 18, 5 µm	L1	nom. 5 µm	100 Å	octadecyl	–	21%
LiChrospher® 100 RP 18 ec, 5 µm	L1	nom. 5 µm	100 Å	octadecyl	✔	21%
LiChrospher® 60 RP select B, 5 µm	L7	nom. 5 µm	60 Å	octyl	✔	12%
Superspher® 100 RP 18	L1	4 µm	100 Å	octadecyl	–	21%
Superspher® 100 RP 18 ec	L1	4 µm	100 Å	octadecyl	✔	21.6%

all phases as packed ChromCart® cartridges; **eluent in column acetonitrile / water**

Ordering information

Length →	125 mm	150 mm	250 mm	Guard columns
LiChrospher® 100 RP 8, 5 µm				
2 mm ID	728025.20		728026.20	728051.30
3 mm ID	728025.30		728026.30	728051.30
4 mm ID	728025.40		728026.40	728051.40
4.6 mm ID	728025.46	728027.46	728026.46	728051.40
LiChrospher® 100 RP 8 ec, 5 µm				
2 mm ID	728028.20		728029.20	728052.30
3 mm ID	728028.30		728029.30	728052.30
4 mm ID	728028.40		728029.40	728052.40
4.6 mm ID	728028.46	728030.46	728029.46	728052.40
LiChrospher® 100 RP 18, 5 µm				
2 mm ID	728031.20		728032.20	728053.30
3 mm ID	728031.30		728032.30	728053.30
4 mm ID	728031.40		728032.40	728053.40
4.6 mm ID	728031.46	728033.46	728032.46	728053.40
LiChrospher® 100 RP 18 ec, 5 µm				
2 mm ID	728034.20		728035.20	728054.30
3 mm ID	728034.30		728035.30	728054.30
4 mm ID	728034.40		728035.40	728054.40
4.6 mm ID	728034.46	728036.46	728035.46	728054.40
LiChrospher® 60 RP select B, 5 µm				
2 mm ID	728037.20		728038.20	728055.30
3 mm ID	728037.30		728038.30	728055.30
4 mm ID	728037.40		728038.40	728055.40
4.6 mm ID	728037.46	728039.46	728038.46	728055.40
Superspher® 100 RP 18				
2 mm ID	728543.20		728545.20	728546.30
3 mm ID	728543.30		728545.30	728546.30
4 mm ID	728543.40		728545.40	728546.40
4.6 mm ID	728543.46	728544.46	728545.46	728546.40
Superspher® 100 RP 18 ec				
2 mm ID	728540.20		728553.20	728550.30
3 mm ID	728540.30		728553.30	728550.30
4 mm ID	728540.40		728553.40	728550.40
4.6 mm ID	728540.46	728552.46	728553.46	728550.40

ChromCart® columns require the CC connecting kit (REF 721690).
8 mm ChromCart® guard column cartridges in packs of 3, all other columns in packs of 1.

Columns for special HPLC separations

Summary

Anion columns

for analysis of inorganic anions

NUCLEOGEL® Anion I

- strongly basic polymer-based anion exchanger, particle size 10 µm
  pH stability: 1 – 14
- eluent in column 4 mM salicylate buffer pH 7.8
- contrary to the silica-based phase also suited for fluoride analysis

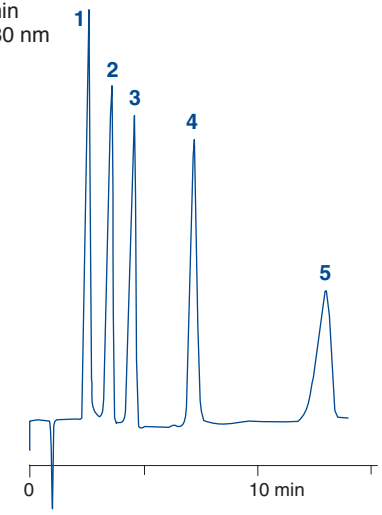
NUCLEOSIL® Anion II

- base material NUCLEOSIL® silica, particle size 10 µm, pore size 300 Å
  strongly basic anion exchanger, exchange capacity 50 µeq/g
  pH stability 2 – 7.5
- eluent in column 2 mM potassium hydrogen phthalate buffer pH 5.6
  recommended buffer concentration for separation of inorganic anions: 2 mmol/l phthalate
- preferred method of detection: conductivity or negative UV detection

Separation of an anion standard

Column: 250 x 4 mm NUCLEOSIL® Anion II
Eluent: 2 mM potassium hydrogen phthalate, pH 5.7
Flow rate: 2 ml/min
Detection: UV, 280 nm

Peaks:
1. $H_2PO_4^-$
2. Cl^-
3. NO_2^-
4. NO_3^-
5. SO_4^{2-}

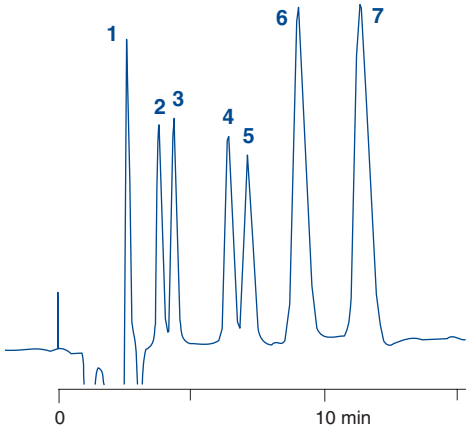


MN Appl. No. 106440

Separation of inorganic anions

Column: 120 x 4.6 mm NUCLEOGEL® Anion I
Eluent: 4 mM salicylic acid / Tris pH 7.8
Flow rate: 1 ml/min
Detection: UV, 254 nm

Peaks:
1. F^-
2. Cl^-
3. NO_2^-
4. Br^-
5. NO_3^-
6. PO_4^{3-}
7. SO_4^{2-}



MN Appl. No. 115050

Ordering information

	Length →	120 mm	250 mm	Guard columns
NUCLEOGEL® Anion I				
Valco type columns				
	4.6 mm ID	**719533**		**719543**
NUCLEOSIL® Anion II				
EC columns				
	4 mm ID		**720094.40**	**721452.40**

NUCLEOGEL® Anion I Valco type guard columns measure 21 x 4 mm and require the guard column holder C (REF 719539, see page 169). Valco type columns in packs of 1, guard columns in packs of 2.
As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). EC columns and guard column cartridges in packs of 1.

HPLC columns for environmental analyses

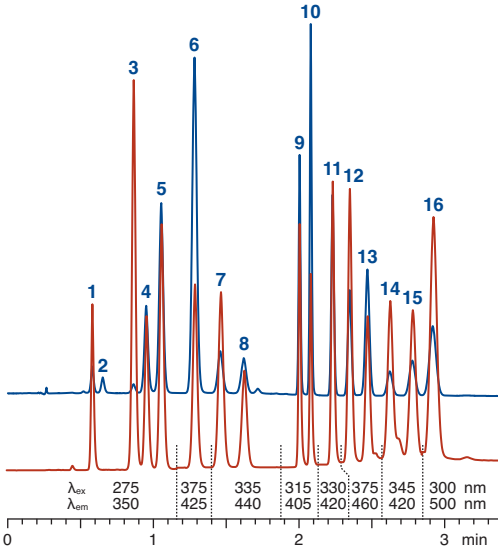
NUCLEODUR® C_{18} PAH — special octadecyl phase for PAH analyses

- base material NUCLEODUR® silica, particle size 3 µm, pore size 110 Å; polymeric coating · USP **L1**
- eluent in column acetonitrile / water 70:30
- allows efficient gradient separation of the 16 PAH according to EPA
- detection of the separated PAH by UV (250 to 280 nm), with diode array or with fluorescence detection at different wavelengths for excitation and emission (acenaphthylene cannot be analysed with fluorescence detection)

Analysis of 16 EPA PAHs with or without acetonitrile

Separation with acetonitrile

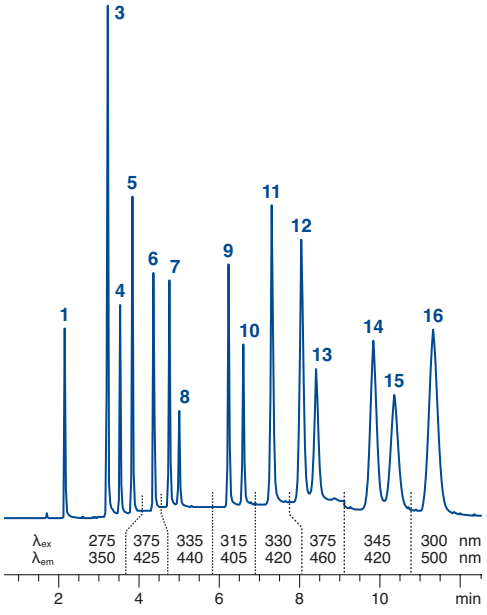
Colum:	100 x 4 mm NUCLEODUR® C_{18} PAH, 3 µm
Eluents:	A) methanol – water (80:20, v/v) B) acetonitrile
Gradient:	2 – 20 % B in 1.2 min, 20 – 100 % B in 0.5 min, 100 % B for 2.5 min, 100 – 2 % B in 0.4 min
Flow rate:	2.5 ml/min
Temperature:	35 °C
Detection:	UV, 254 nm fluorescence (see chromatogram)



MN Appl. No. 123820

Separation without acetonitrile

Colum:	125 x 4 mm NUCLEODUR® C_{18} PAH, 3 µm
Eluents:	A) water B) methanol
Gradient:	65 – 97 % B in 6 min, 97 % B for 5 min, 97 – 65 % B in 0.5 min
Flow rate:	2 ml/min
Temperature:	35 °C
Detection:	fluorescence (see chromatogram)



MN Appl. No. 123830

Peaks:

1. Naphthalene
2. Acenaphthylene (not detectable by fluorescence)
3. Acenaphthene
4. Fluorene
5. Phenantrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[a]anthracene
10. Chrysene
11. Benzo[b]fluoranthene
12. Benzo[k]fluoranthene
13. Benzo[a]pyrene
14. Dibenz[ah]anthracene
15. Benzo[ghi]perylene
16. Indeno[1,2,3-cd]pyrene

Ordering information

	Length →	100 mm	125 mm	Guard columns
NUCLEODUR® C_{18} PAH, 3 µm				
EC columns				
	3 mm ID	**760783.30**	**760784.30**	**761780.30**
	4 mm ID	**760783.40**	**760784.40**	**761780.40**
PAH standard according to EPA for HPLC				
PAH standard for HPLC	16 PAH according to EPA method 610 in acetonitrile (1 ml) for composition see chromatogram above			**722393**

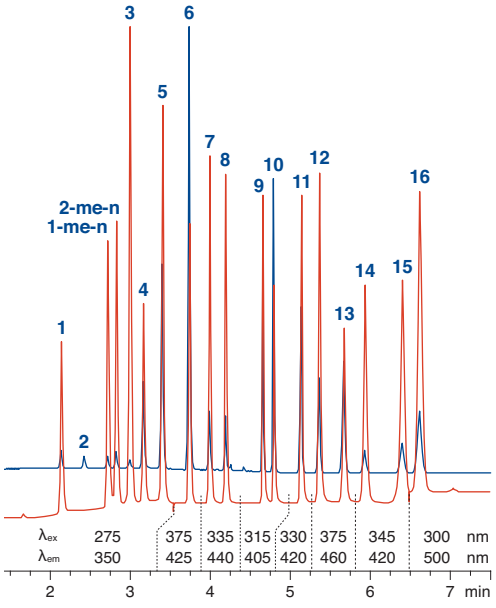
As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, EC columns in packs of 1.

Separation of 18 PAHs on NUCLEODUR® C_{18} PAH

Colum: 125 x 4 mm NUCLEODUR® C_{18} PAH, 3 µm
Eluents: A) methanol – water (70:30, v/v)
B) acetonitrile
Gradient: 0 – 20 % B in 1.5 min, 20 – 50 % B in 1.5 min, 50 – 100 % B in 1.0 min, 100 % B for 3 min, 100 – 0 % B in 0.5 min
Flow rate: 1.5 ml/min
Temperature: 35 °C
Inj. volumes: UV: 1 µl, fluorescence: 0.5 µl
Detection: UV, 254 nm
fluorescence
(see chromatogram)

Peaks:
(concentrations 10 ng/µl per compound)
1. – 16. see opposite page
1-me-n: 1-methylnaphthalene
2-me-n: 2-methylnaphthalene

MN Appl. No. 123840

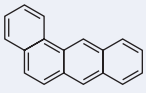


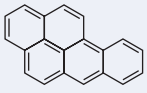
Analysis of polycyclic aromatic hydrocarbons (PAHs) by HPLC

Polycyclic aromatic hydrocarbons (PAHs) are chemical compounds that consist of fused aromatic rings and do not contain heteroatoms or carry substituents. As a pollutant, they are of concern because some compounds have been identified as carcinogenic, mutagenic, and teratogenic. PAHs are natural components of coal or gas. They are delivered to our environment by pyrolysis (incomplete burning) of organic materials like coal, oil, fuel, wood, tabaco, ... and hence can be found globally. Today most PAHs accrue from anthropogenic processes – but also natural origins (forest fire) are possible. Regarding to past pollutions an important impact had production of coke and gas from black coal. Waste products (e.g. tar) from coking or gas plants are often origin of serious ground water pollutions.

Since a number of PAHs (e. g. benzo[a]pyrene, 3-methylcholanthrene and benzanthracene) have been proven to be carcinogenic, control of the PAH content of food, water and soil is an important task for routine analysis. For choice and limiting values of the polycyclics we refer to the governmental regulations, which exist in many countries (e.g. EPA method 610 of the United States Environmental Protection Agency).

PAH can be determined by different chromatographic techniques (TLC, GC, HPLC). Thus the 6 PAHs according to German drinking water specification (TVO) can e.g. be analysed by TLC (see German Standard DIN 38 409), while a much larger number of polycyclic aromatics can be determined by GC or HPLC.


benz[a]anthracene


benzo[a]pyrene

HPLC columns for PAH analysis

For PAH analyses of PAHs we have developed specially modified C_{18} phases based on NUCLEODUR® and NUCLEOSIL® which allow efficient gradient separation of 16 PAHs according to EPA. Detection of the separated PAHs can be achieved by UV (250 – 280 nm), with diode array or with fluorescence detection at different wavelengths for excitation and emission. Acenaphthylene cannot be analysed with fluorescence detection. For cost-effective routine PAH analysis we recommend applications using methanol instead of acetonitrile as eluent. For rapid analysis NUCLEODUR® C_{18} PAH (3 µm) in short columns (100 or 50 mm) provides excellent results at high flow rates. Hereby separation of 16 PAHs according to EPA can be achieved in less than 3 min.

New regulations require determination of 2 additional PAHs (1- and 2-methylnaphthalene) – so we developed highly efficient methods for 18 PAHs on the new NUCLEODUR® C_{18} PAH.

References

Determination of PASH in Diesel fuel by HPLC and photodiode-array detection; J. Bunot, W. Herbel, H. Steinhart, J. High Res. Chrom. **15** (1992) 682 – 685
GIT Spezial Chromat. **2** (1992) 80 – 85

HPLC columns for environmental analyses

NUCLEOSIL® 100-5 C_{18} PAH — special octadecyl phase for PAH analyses

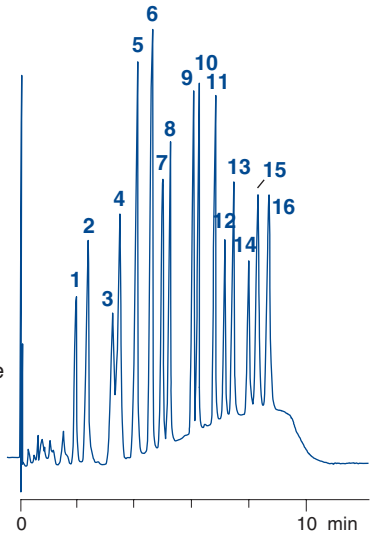
- base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å; polymeric coating · USP **L1**
- eluent in column acetonitrile / water 70:30
- allows efficient gradient separation of the 16 PAH according to EPA
- detection of the separated PAH by UV (250 to 280 nm), with diode array or with fluorescence detection at different wavelengths for excitation and emission (acenaphthylene cannot be analysed with fluorescence detection)

Rapid separation of 16 PAH according to EPA

Column:	50 x 4 mm NUCLEOSIL® 100-5 C_{18} PAH
Eluents:	A) water B) acetonitrile
Gradient:	from 55 to 100 % B in 2.5 min; then 3.5 min at 100 % B; finally in 0.1 min from 100 to 55 % B
Flow rate:	1 ml/min
Pressure:	25 – 30 bar
Temperature:	25 °C
Detection:	UV, 260 nm
Injection volume:	10 µl

Peaks:

1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Phenantrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[a]anthracene
10. Chrysene
11. Benzo[b]fluoranthene
12. Benzo[k]fluoranthene
13. Benzo[a]pyrene
14. Dibenz[ah]anthracene
15. Benzo[ghi]perylene
16. Indeno[1,2,3-cd]pyrene



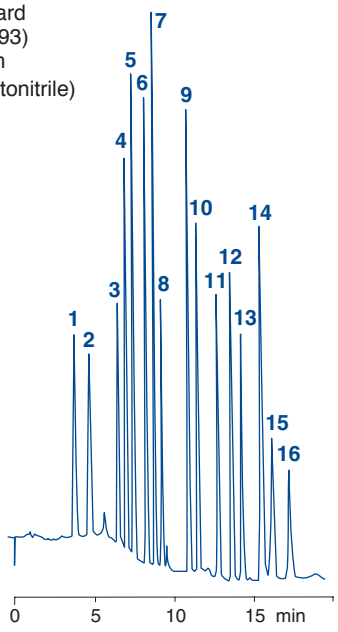
MN Appl. No. 115030

Separation of the PAH standard according to EPA

Column:	150 x 4 mm NUCLEOSIL® 100-5 C_{18} PAH
Eluents:	A) methanol – water (80:20) B) acetonitrile – tetrahydrofuran (93:7)
Gradient:	0 – 100 % B in 10 min, then 5 min at 100 % B
Flow rate:	1 ml/min
Pressure:	140 bar
Temperature:	20 °C
Sample:	PAH standard (REF 722393)
Detection:	UV, 260 nm

Peaks: (10 µg/ml each in acetonitrile)

1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Phenantrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[a]anthracene
10. Chrysene
11. Benzo[b]fluoranthene
12. Benzo[k]fluoranthene
13. Benzo[a]pyrene
14. Dibenz[ah]anthracene
15. Benzo[ghi]perylene
16. Indeno[1,2,3-cd]pyrene



MN Appl. No. 115040

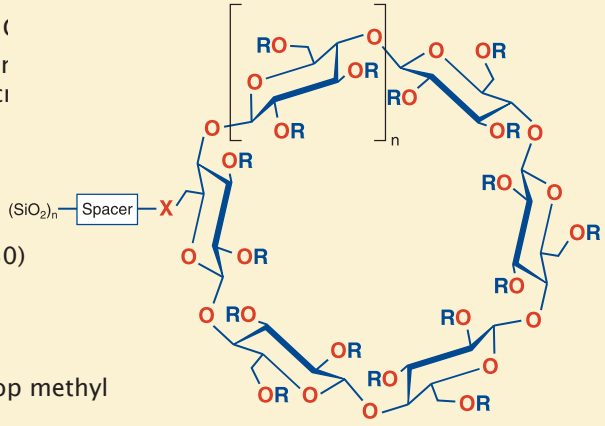
Ordering information

Length →	50 mm	100 mm	150 mm	250 mm	Guard columns
NUCLEOSIL® 100-5 C_{18} PAH					
EC columns					
2 mm ID				720117.20	721599.30
3 mm ID		720819.30	720923.30	720117.30	721599.30
4 mm ID	720756.40	720819.40	720923.40	720117.40	721599.40
4.6 mm ID				720117.46	721599.40
PAH standard according to EPA for HPLC					
PAH standard for HPLC	16 PAH according to EPA method 610 in acetonitrile (1 ml) for composition see chromatogram above				722393

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
8 mm ChromCart® guard column cartridges in packs of 3, EC columns in packs of 1.

NUCLEODEX columns — enantiomer separation based on cyclodextrins

- base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å
  modified cyclodextrins as chiral selectors
- **NUCLEODEX β-OH:** β-cyclodextrin (R = H; n = 2) · USP **L45**
  separation based on hydrogen bonds and dipole interactions between functional groups of the analyte and hydroxyl groups of the cyclodextrin
  examples for successful enantiomer separations: chlorthalidone and other compounds, which require free hydroxyl groups for enantioselective interactions
  eluent in column CH_3OH / 0.1% TEAA pH 4 (55:45)
- **NUCLEODEX α-PM:** permethylated α-cyclodextrin (R = (
  for all permethylated phases the ability to form hydroger bonds is reduced, the hydrophobicity of the phase is inci compared to β-OH, resulting in shorter retention times
  examples for successful enantiomer separations: mecoprop and dichlorprop as free carboxylic acids, *trans*-stilbene oxide, styrene oxide
  eluent in column CH_3OH / 50 mM phosphate pH 3 (70:30)
- **NUCLEODEX β-PM:** permethylated β-cyclodextrin (R = CH_3; n = 2) · USP **L45**
  examples for successful enantiomer separations: mephobarbital (prominal), pesticide derivatives mecoprop methyl and dichlorprop methyl
  eluent in column CH_3OH / 0.1% TEAA pH 4 (65:35)
- **NUCLEODEX γ-PM:** permethylated γ-cyclodextrin (R = CH_3; n = 3)
  examples for successful enantiomer separations: steroids or other larger molecules
  eluent in column CH_3OH / 0.1% TEAA pH 4 (55:45)



NUCLEODEX phases are especially suited for the control of optical purity, but also for semipreparative separations and for the analysis of positional and *cis-trans* isomers.
For numerous separations on NUCLEODEX phases please visit our website: *www.mn-net.com*.

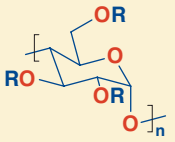
Ordering information

Length →	200 mm	Guard columns
EC columns 		
NUCLEODEX β-OH		
4 mm ID	720124.40	721460.40
NUCLEODEX α-PM		
4 mm ID	720127.40	721464.40
NUCLEODEX β-PM		
4 mm ID	720125.40	721462.40
NUCLEODEX γ-PM		
4 mm ID	720752.40	721466.40
NUCLEODEX screening kit	721920	
consists of one CC 30/4 each with NUCLEODEX β-OH, α-PM, β-PM and γ-PM and a CC column holder 30 mm		

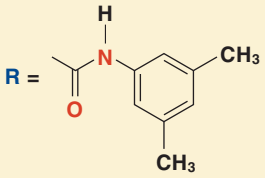
As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
All columns and guard column cartridges in packs of 1.

HPLC columns for enantiomer separation

NUCLEOCEL *ALPHA* enantiomer separation based on an amylose derivative



- base material silica,
  chiral selector amylose tris-(3,5-dimethylphenylcarbamate)
  USP **L51**
- similar phases: Chiralpak® AD, Kromasil® AmyCoat™, Europak 01
  high resolution type (S) with 5 µm particle size,
  allows use of shorter columns (150 mm) for faster separations
  pressure stability up to ~150 bar (2000 psi)



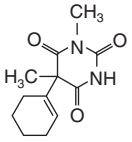
NUCLEOCEL *ALPHA* for normal phase applications:
eluent in column *n*-heptane – propanol-2 (90:10, v/v)
typical eluents are heptane – propanol mixtures

NUCLEOCEL *ALPHA-RP* for reversed phase applications:
eluent in column acetonitrile – water (50:50, v/v)
designed for use either in polar organic mode or with eluents containing high concentrations of chaotropic salts such as perchlorate

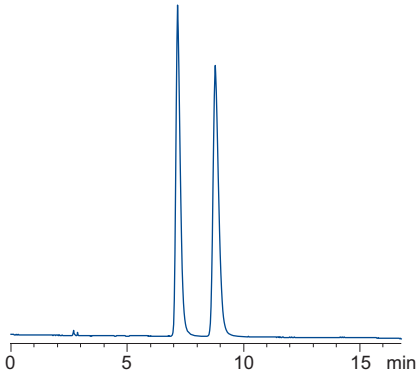
- recommended applications: pharmaceutically active compounds, chiral pollutants (e.g. herbicides, PCB), chiral compounds in food (dyes, preservatives), chiral catalysts and bioorganic compounds

Enantiomer separation of hexobarbital

Column:	250 x 4.6 mm NUCLEOCEL *ALPHA S*
Eluent:	*n*-heptane – 2-propanol (80:20, v/v)
Flow rate:	1 ml/min
Temperature:	22 °C
Detection:	UV, 210 nm
Injection volume:	5 µl
Concentration:	1 µg/µl



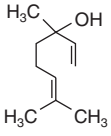
α = 1.39
R_s = 3.78



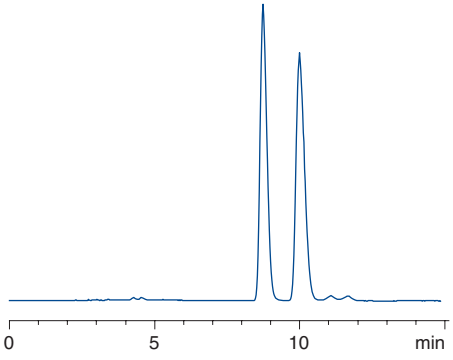
MN Appl. No. 121940

Enantiomer separation of linalool

Column:	250 x 4.6 mm NUCLEOCEL *ALPHA-RP S*
Eluent:	acetonitrile – water (50:50, v/v)
Flow rate:	1 ml/min
Temperature:	35 °C
Detection:	UV, 210 nm
Injection volume:	5 µl
Concentration:	1 µg/µl



α = 1.21
R_s = 2.44



MN Appl. No. 121920

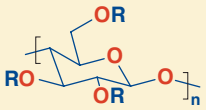
Ordering information

	Length →	150 mm	250 mm	Guard columns
EC columns 	**NUCLEOCEL *ALPHA S*, 5 µm**			
	4.6 mm ID	**720644.46**	**720645.46**	**721000.40**
	NUCLEOCEL *ALPHA-RP S*, 5 µm			
	4.6 mm ID	**720654.46**	**720655.46**	**721001.40**

As guard columns for 4.6 mm EC columns use 4 mm ID ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). All columns and guard columns in packs of 1.

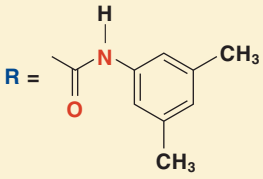
NUCLEOCEL *DELTA* enantiomer separation based on a cellulose derivative

- base material silica,
  chiral selector cellulose tris-(3,5-dimethylphenylcarbamate)
  USP **L40**
- similar phases: Chiralcel® OD, Kromasil® CelluCoat™, Eurocel® 01, Lux™ Cellulose-1



high resolution type (S) with 5 µm particle size,
allows use of shorter columns (150 mm) for faster separations
pressure stability up to ~150 bar (2000 psi)

NUCLEOCEL *DELTA* for normal phase applications:
eluent in column *n*-heptane – propanol-2 (90:10, v/v)
typical eluents are heptane – propanol mixtures

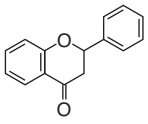


NUCLEOCEL *DELTA-RP* for reversed phase applications:
eluent in column acetonitrile – water (40:60, v/v)
designed for use either in polar organic mode or with eluents containing high concentrations of chaotropic salts such as perchlorate

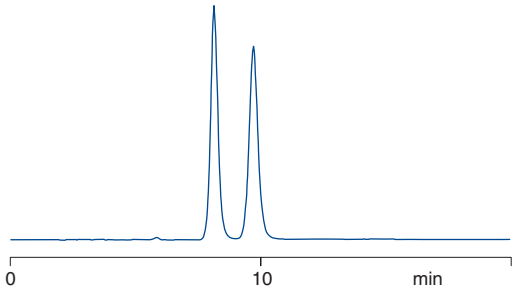
- recommended applications: pharmaceutically active compounds, chiral pollutants (e.g. herbicides, PCB), chiral compounds in food (dyes, preservatives), chiral catalysts and bioorganic compounds

Enantiomer separation of flavanone

Column:	250 x 4.6 mm NUCLEOCEL *DELTA S*
Eluent:	*n*-heptane – 2-propanol (90:10, v/v)
Flow rate:	1 ml/min
Temperature:	25 °C
Detection:	UV, 254 nm
Injection volume:	5 µl
Concentration:	1 µg/µl



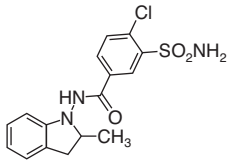
$\alpha = 1.29$
$R_s = 2.6$



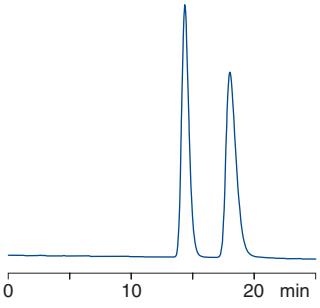
MN Appl. No. 121260

Enantiomer separation of indapamide

Column:	250 x 4.6 mm NUCLEOCEL *DELTA-RP S*
Eluent:	acetonitrile – water (40:60, v/v)
Flow rate:	0.5 ml/min
Temperature:	40 °C
Detection:	UV, 254 nm
Injection volume:	5 µl
Concentration:	1 µg/µl



$\alpha = 1.3$
$R_s = 2.6$



MN Appl. No. 121230

Ordering information

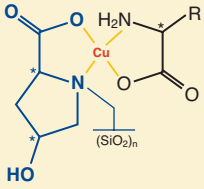
	Length →	150 mm	250 mm	Guard columns
EC columns 	**NUCLEOCEL *DELTA S*, 5 µm**			
	4.6 mm ID	**720446.46**	**720445.46**	**721002.40**
	NUCLEOCEL *DELTA-RP S*, 5 µm			
	4.6 mm ID	**720451.46**	**720450.46**	**721003.40**

As guard columns for 4.6 mm EC columns use 4 mm ID ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). All columns and guard columns in packs of 1.

VarioPrep columns with NUCLEOCEL *ALPHA* and NUCLEOCEL *DELTA* on request; for available dimensions see page 168

HPLC columns for enantiomer separation

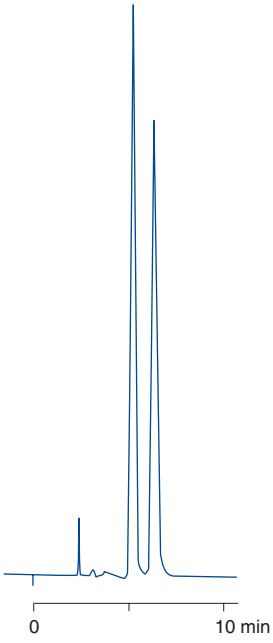
NUCLEOSIL® CHIRAL-1 enantiomer separation based on ligand exchange



- base material NUCLEOSIL® silica, particle size 5 µm, pore size 120 Å
- chiral selector L-hydroxyproline / Cu^{2+} complexes · USP **L32**
- principal interaction mode:
  formation of ternary mixed-ligand complexes with Cu(II) ions
  differences in the stability of the diastereomeric complexes cause chromatographic separation
- eluent in column 0.5 mM copper sulphate solution
- recommended application: enantiomers with two polar functional groups with the correct spacing such as α-amino acids, α-hydroxycarboxylic acids (e.g. lactic acid), *N*-alkyl-α-amino acids etc.

Separation of *D,L*-alanine enantiomers

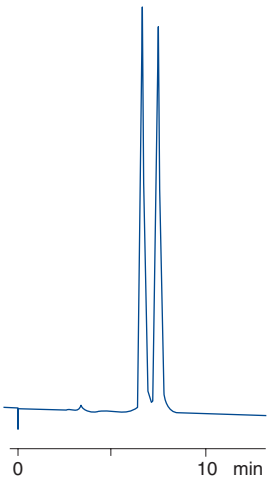
Column:	250 x 4 mm NUCLEOSIL® CHIRAL-1
Eluent:	0.5 mM $CuSO_4$
Flow rate:	1 ml/min
Pressure:	60 bar
Temperature:	60 °C
Detection:	UV, 250 nm



MN Appl. No. 105410

Separation of *D,L*-threonine enantiomers

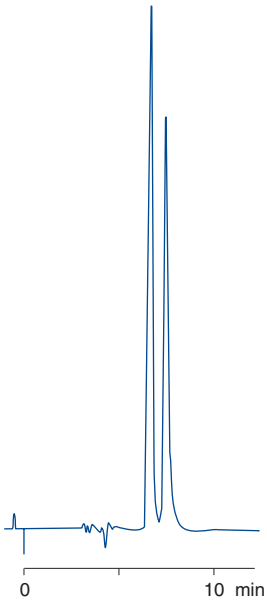
Column:	250 x 4 mm NUCLEOSIL® CHIRAL-1
Eluent:	0.25 mM $CuSO_4$
Flow rate:	0.8 ml/min
Pressure:	65 bar
Temperature:	60 °C
Detection:	UV, 240 nm



MN Appl. No. 105410

Enantiomer separation of lactic acid

Column:	250 x 4 mm NUCLEOSIL® CHIRAL-1
Eluent:	0.5 mM $CuSO_4$
Flow rate:	0.8 ml/min
Temperature:	80 °C
Detection:	UV, 240 nm
Injection volume:	1 µl



MN Appl. No. 105560

Ordering information

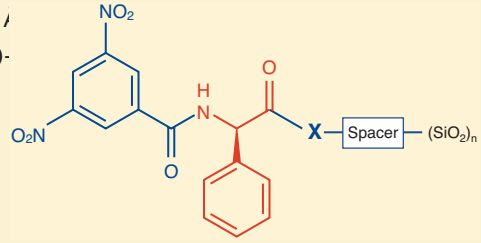
		Length →	250 mm	Guard columns
NUCLEOSIL® CHIRAL-1				
EC columns				
	4 mm ID		**720081.40**	**721455.40**

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
All columns and guard columns in packs of 1.

NUCLEOSIL® CHIRAL-2 / NUCLEOSIL® CHIRAL-3

enantiomer separation in organic eluent systems

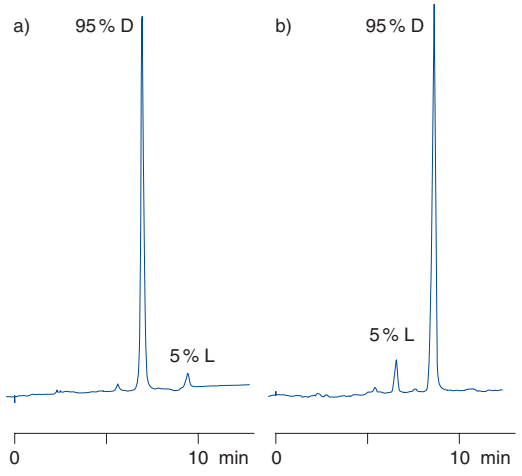
- base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å
- chiral selector for NUCLEOSIL® CHIRAL-2 is *N*-(3,5-dinitrobenzoyl)-*D*-phenylglycine, for CHIRAL-3 the optical antipode is used, "brush type" phases · CHIRAL-3 = USP **L36**



- principle interaction modes: charge-transfer interactions, hydrogen bonds, dipole-dipole interactions and steric effects
- eluent in column *n*-heptane / 2-propanol / TFAA 100:0.5:0.5
- recommended application: analysis of stereoisomers such as separation of enantiomers and diastereomers, control of optical purity of plant protectives (pesticides, e.g. propionic acid derived herbicides) pharmaceuticals etc. and for product control in chiral organic syntheses
- For control of the optical purity of a substance, the two columns NUCLEOSIL® CHIRAL-2 and NUCLEOSIL® CHIRAL-3 allow to select conditions such that the minor enantiomer, which is present as an impurity, is eluted before the main peak. Thus, overlapping peaks are avoided. This makes an exact quantification of the impurity much easier.

Control of optical purity of mecoprop methyl

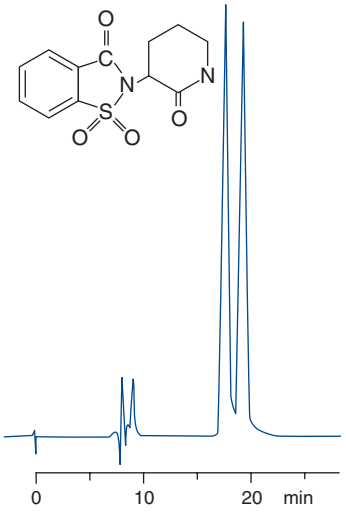
Columns:	250 x 4 mm a) NUCLEOSIL® CHIRAL-2 b) NUCLEOSIL® CHIRAL-3
Eluent:	*n*-heptane – 2-propanol – TFA (100:0.05:0.05, v/v/v)
Flow rate:	1 ml/min
Temperature:	ambient
Detection:	UV, 230 nm
Injection volume:	1 µl (sample with 90 % ee)



MN Appl. No. 111360

Enantiomer separation of *D,L*-supidimide

Column:	250 x 4 mm NUCLEOSIL® CHIRAL-2
Eluent:	tetrahydrofuran – *n*-heptane (10:3, v/v)
Flow rate:	1.0 ml/min
Detection:	UV, 220 nm



MN Appl. No. 105690

Ordering information

		Length →	250 mm	Guard columns
EC columns	**NUCLEOSIL® CHIRAL-2**			
	4 mm ID		**720088.40**	**721458.40**
	NUCLEOSIL® CHIRAL-3			
	4 mm ID		**720350.40**	**721458.40**

8 x 4 mm ID ChromCart® guard column cartridges for NUCLEOSIL® CHIRAL-2 and CHIRAL-3 are identical and used with guard column adaptor EC (REF 721359). They are supplied in packs of 3, the EC columns in packs of 1.

HPLC columns for enantiomer separation

RESOLVOSIL BSA-7 — protein phase for enantiomer separation

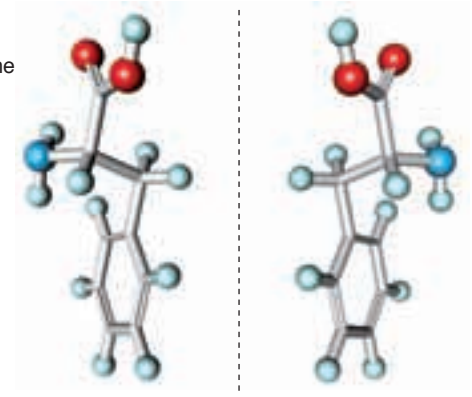
- base material NUCLEOSIL® silica, particle size 7 µm, pore size 300 Å
- chiral selector bovine serum albumin (BSA)
- separation based on selective interaction of proteins with low molecular compounds, i.e. principles of bioaffinity, including hydrophobic interactions (similar to a true reversed phase), interactions of polar groups and steric effects
- eluent in column 0.1 M phosphate buffer pH 7.5, 2% 1-propanol
- recommended applications: amino acid derivatives, aromatic amino acids, aromatic sulphoxides, barbiturates, benzodiazepinones, benzoin and benzoin derivatives, β-blockers, coumarin derivatives, and for monitoring stereoselective microbial and enzymatic conversions

Enantiomer separation of *N*-benzoyl-*D,L*-amino acids

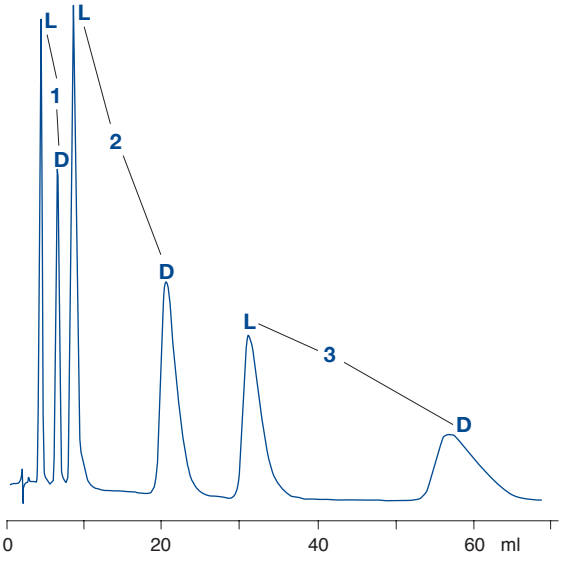
S. Allenmark et al. in "Affinity chromatography and biological recognition" (I. Chaiken, M. Wilchek, and I. Parikh. Eds.), Academic Press, New York, 1983, p. 259 – 260

Column: 150 x 4 mm RESOLVOSIL BSA-7
Eluent: 50 mM phosphate buffer pH 6.5 + 1 % 1-propanol
Flow rate: 0.70 ml/min
Detection: UV, 225 nm

Peaks:
1. Serine
2. Alanine
3. Phenylalanine



MN Appl. No. 105450



Ordering information

	Length →	150 mm	Guard column
RESOLVOSIL BSA-7			
EC columns			
	4 mm ID	**720046.40**	**721702.40**

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
EC columns and guard columns in packs of 1.

NUCLEOSIL® 4000-7 PEI — anion exchange of proteins and peptides

- base material NUCLEOSIL® silica, particle size 7 µm, pore size 4000 Å
  polymeric, covalently bonded polyethyleneimine network, weakly basic anion exchanger
  ion exchange capacity 0.15 mmol/g; protein binding capacity 61 mg BSA/g
- pH stability 2 – 8.5; max. working pressure 250 bar
- separation principle: reversible adsorption of negatively charged substances to positively charged groups on the exchanger material and their subsequent displacement by either increasing ionic strength or pH changes in the mobile phase
- high selectivity for numerous proteins; e.g β-lactoglobulins A and B, two proteins differing in just two amino acids, can be separated in only 10 minutes; biological activity of purified proteins is preserved
- good binding and desorption kinetics for nucleotides as well
- eluent in column methanol
- more examples for the purification of different peptides and proteins can be found in our application database at *www.mn-net.com*

Recovery of proteins

Column: 50 x 4 mm NUCLEOSIL® 4000-7 PEI
Eluent: 10 mM NaH_2PO_4, 1.5 M NaCl, pH 7.0
Flow rate: 1 ml/min
Sample: 50 µg of each protein

Protein	Recovery [%]
Myoglobin	100
Transferrin	95
Ovalbumin	98
Bovine serum albumin	100
Glucose oxidase	100
α-Amylase	100
Soybean trypsin inhibitor	100
β-Lactoglobulin	97
Ferritin	85

Recovery of specific enzyme activity after HPLC

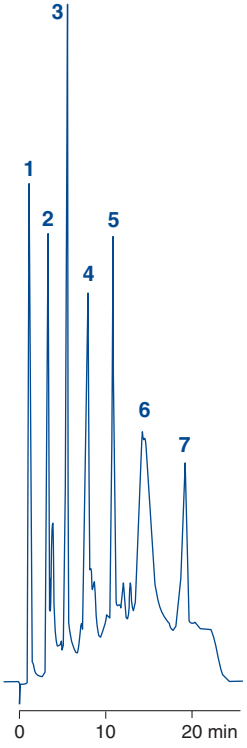
Columns: 50 x 4 mm NUCLEOSIL® 4000-7 PEI
Eluents: A) 20 mM Tris-HCl pH 8.5; B) A + 1.5 M NaCl
Gradient: 0 – 100 % B in 5 min, 1 ml/min, 30 bar
Detection: UV, 280 nm

Enzyme	Recovery [%]
Catalase (bovine liver)	93
L-Lactic dehydrogenase LDH-1 isoenzyme (porcine heart)	102
Callicrein (porcine pancreas)	98
Glucose oxidase (Aspergillus niger)	104
Peroxidase (horseradish)	100

Separation of protein standards

Column: 125 x 4 mm NUCLEOSIL® 4000-7 PEI
Eluents: A) 2 mM Tris / acetate pH 8.0
B) 20 mM Tris / acetate pH 8.0 + 1.5 M KCl
Gradient: linear 0 – 40 % B in 20 min
Flow rate: 1 ml/min
Pressure: 76 bar
Detection: UV, 280 nm
Inj. volume: 20 µl

Peaks:
1. Catalase
2. Myoglobin
3. α-Amylase
4. Transferrin
5. α-Lactalbumin
6. Glucose oxidase
7. Soybean trypsin inhibitor



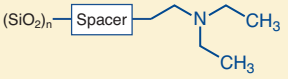
MN Appl. No. 108310

Ordering information

	Length →	125 mm	250 mm	Guard columns
NUCLEOSIL® 4000-7 PEI				
EC analytical columns	4 mm ID	**720402.40**		**721091.40**
VarioPrep prep. columns	10 mm ID	**715230.100**	**715231.100**	

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
Guard columns in packs of 3, other columns in packs of 1.

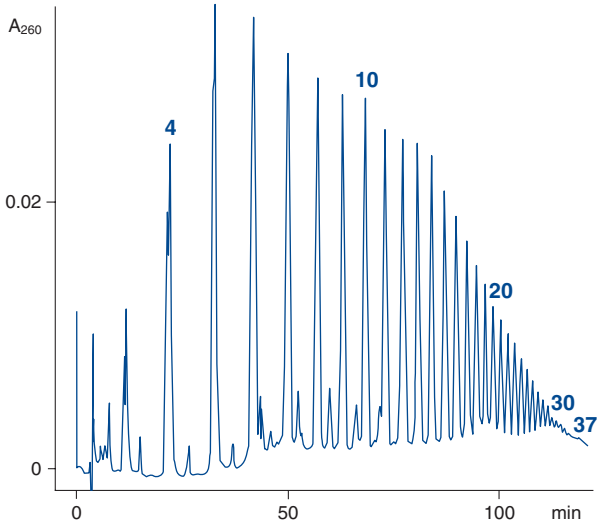
NUCLEOGEN® columns anion exchange chromatography of nucleic acids



- base material silica, particle size 7 µm
  DEAE anion exchanger
- **NUCLEOGEN® 60-7 DEAE:** pore size 60 Å
  for separation of oligonucleotides up to chain lengths of 40 bases with recoveries > 95 %
  capacity 200 A_{260}/ml (~ 300 A_{260} for a 125 x 4 mm ID column, 1875 A_{260} for a 125 x 10 mm ID column); preparative separations possible when using higher flow rates and longer gradient times
- **NUCLEOGEN® 500-7 DEAE:** pore size 500 Å
  for separation of tRNA, 5S RNA, viroids and messenger RNA in the intermediate molecular weight range (25,000 – 1,000,000 daltons) with recoveries > 95 %
  capacity 730 A_{260} for a 125 x 6 mm ID column, 1940 A_{260} for a 125 x 10 mm ID column
- **NUCLEOGEN® 4000-7 DEAE:** pore size 4000 Å
  for separation of plasmids, DNA restriction fragments, ribosomal RNA, messenger RNA and viral RNA, i.e. very high molecular weight nucleic acids (e.g. 1 – 50 megadaltons)
  capacity 120 A_{260} for a 125 x 6 mm ID column, 350 A_{260} for a 125 x 10 mm ID column
- eluent in column methanol
- for more separations of deoxyoligonucleotides, plasmids and DNA restriction fragments visit our website *www.mn-net.com*

Separation of oligo(rA)$_n$

Column:	125 x 4 mm NUCLEOGEN® 60-7 DEAE
Buffers:	A) 20 mM phosphate, pH 5.5, 5 M urea B) buffer A + 1 M KCl
Gradient:	0 – 100 % B in 200 min
Flow rate:	2 ml/min, 110 bar
Temperature:	ambient
Detection:	UV, 260 nm

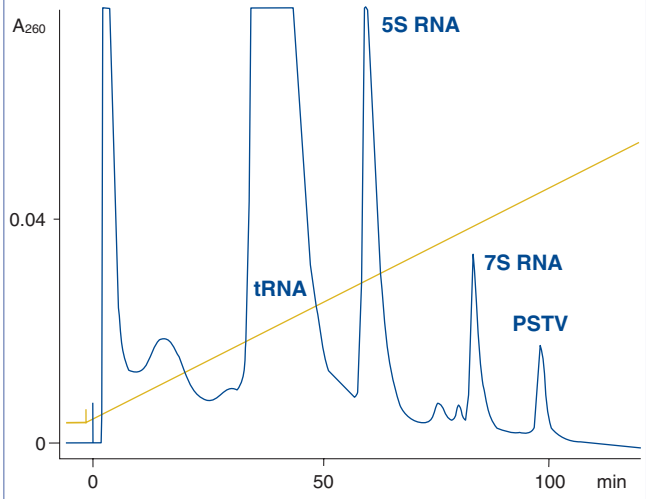


MN Appl. No. 115180

Preparative separation of a crude RNA extract of viroid (PSTV) infected tomato plants

D. Riesner, BioEngineering **1** (1988) 42 – 48

Column:	125 x 6 mm NUCLEOGEN® 500-7 DEAE
Buffers:	A) 250 mM KCl, 20 mM phosphate buffer pH 6.6, 5 M urea B) 1 M KCl, 20 mM phosphate buffer pH 6.6, 5 M urea
Gradient:	0 – 50 % B in 120 min, 50 – 100 % B in 250 min
Flow rate:	3 ml/min, 40 bar
Temperature:	ambient
Detection:	260 nm



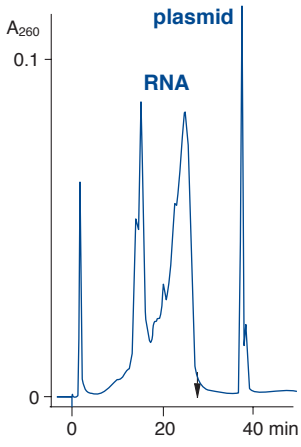
MN Appl. No. 107490

Separation of plasmid pBR 322

M. Colpan, D. Riesner, private communication

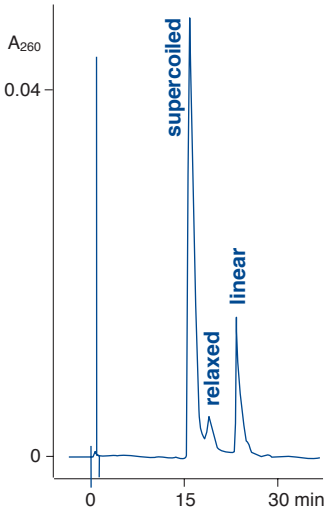
A) isolation of plasmid DNA from a crude cell lysate

Sample:	5 µg plasmid pBR 322 containing cleared lysate from *E. coli*
Column:	125 x 6 mm NUCLEOGEN® 4000-7 DEAE
Eluents:	A) 20 mM K phosphate buffer pH 6.9; 5 M urea B) eluent A + 1.5 M KCl
Gradient:	20 % – 100 % B in 50 min; arrow = ionic strength of 850 mM
Flow rate:	1.0 ml/min, 70 bar, ambient temperature
Detection:	UV, 260 nm



B) separation of supercoiled plasmid from relaxed and linear forms

Sample:	plasmid pBR 322, supercoiled, relaxed and linear
Column:	125 x 6 mm NUCLEOGEN® 4000-7 DEAE
Eluents:	A) 20 mM phosphate buffer pH 6.8; 6 M urea B) eluent A + 2 M KCl
Gradient:	42 % – 100 % B in 230 min
Flow rate:	1.5 ml/min, 45 bar, ambient temperature



MN Appl. No. 107480

Ordering information

Length →	125 mm	Guard columns
NUCLEOGEN® 60-7 DEAE		
EC analytical columns		
4 mm ID	736596.40	736400.40
VarioPrep preparative columns		
10 mm ID	736597.100	736400.40
NUCLEOGEN® 500-7 DEAE		
Valco type analytical columns		
6 mm ID	736598	736400.40
VarioPrep preparative columns		
10 mm ID	736599.100	736400.40
NUCLEOGEN® 4000-7 DEAE		
Valco type analytical columns		
6 mm ID	736601	736400.40
VarioPrep preparative columns		
10 mm ID	736602.100	736400.40

NUCLEOGEN® ChromCart® guard column cartridges are 30 mm long, require the CC column holder 30 mm (REF 721823, see page 167) and are supplied in packs of 2. All other columns in packs of 1.

For information on DNA/RNA purification kits please ask for our catalogue "Bioanalysis"

HPLC columns for biochemical separations

NUCLEOGEL® SAX — anion exchange of biological macromolecules

- polymer-based strongly basic anion exchanger $-N^+(CH_3)_3$, gel matrix quaternised PEI; particle size 8 µm, pore size 1000 Å · USP **L23**
- pH working range 1 – 13, max. working pressure 200 bar
- eluent in column 0.1 M Na_2SO_4 + 0.2 % NaN_3
- recommended application:
  purification of peptides, large proteins and oligonucleotides, high capacity for proteins even at pH 10

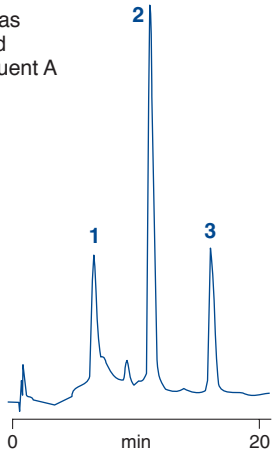
Ordering information

Pore size		Length →	50 mm	Guard columns
NUCLEOGEL® SAX				
Valco type analytical columns				
	1000 Å	4.6 mm ID	**719469**	**719600**
		7.7 mm ID	**719471**	**719600**

Separation of hen's egg white

Sample: frozen egg white was thawed, filtered and diluted 1 : 8 with eluent A
Column: 50 x 4.6 mm NUCLEOGEL® SAX 1000-8
Eluents: A) 0.01 M Tris-HCl, pH 7.5
B) A + 0.5 M NaAc, pH 7.5
Gradient: linear, 0 – 100 % B in 20 min
Flow rate: 1 ml/min
Inj. volume: 50 µl
Detection: UV, 280 nm

Peaks:
1. Conalbumin
2. Ovalbumin
3. not identified

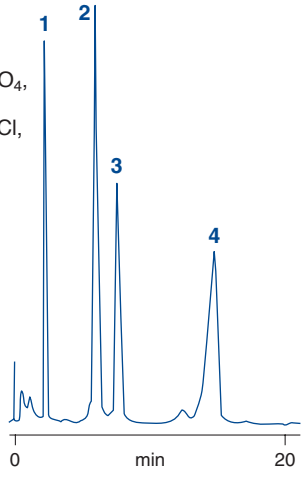


MN Appl. No. 115200

Separation of protein standards

Column: 50 x 4.6 mm NUCLEOGEL® SCX 1000-8
Eluents: A) 0.02 M KH_2PO_4, pH 6.0
B) A + 0.5 M NaCl, pH 6.0
Gradient: linear, 0 – 100 % B in 20 min
Flow rate: 1 ml/min
Detection: UV, 280 nm

Peaks:
1. Myoglobin
2. α-Chymotrypsinogen A
3. Cytochrome C
4. Lysozyme



MN Appl. No. 108260

NUCLEOGEL® SCX — cation exchange of biological macromolecules

- polymer-based strongly acidic cation exchanger $-SO_3^-$, hydrophilic gel matrix; particle size 8 µm, pore size 1000 Å · USP **L22**
- pH working range 1 – 13, max. working pressure 200 bar
- eluent in column 0.1 M Na_2SO_4 + 0.2 % NaN_3
- recommended application: proteins, peptides and carbohydrates with high isoelectric point

Ordering information

Pore size		Length →	50 mm	Guard columns
NUCLEOGEL® SCX				
Valco type analytical columns				
	1000 Å	4.6 mm ID	**719475**	**719540**
		7.7 mm ID	**719477**	**719540**

NUCLEOGEL® SAX and SCX Valco type guard columns measure 5 x 3 mm and require the guard column holder B, REF 719539, see page 169 (guard columns in packs of 2, columns in packs of 1).

NUCLEOSIL® MPN — RP chromatography of biological macromolecules

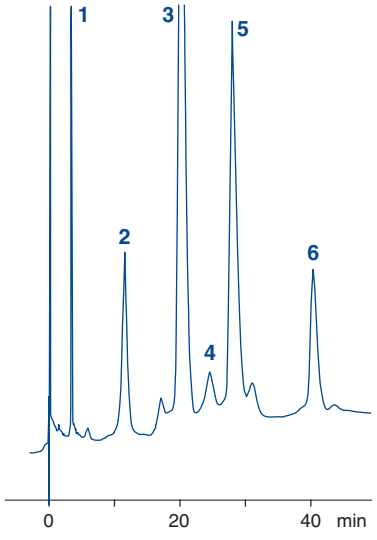
- silica-based reversed phase materials with monomerically bonded alkyl chains, brush type structure predominantly hydrophobic forces with a small portion of hydrophilic interactions
- **NUCLEOSIL® 100-5 C_{18} MPN:** octadecyl phase, particle size 5 µm, pore size 100 Å · USP **L1**
  dynamic protein binding capacity per g packing: 6 mg BSA, 110 mg cytochrome C
- **NUCLEOSIL® 120-3 C_{18} MPN:** octadecyl phase, particle size 3 µm, pore size 120 Å · USP **L1**
  dynamic protein binding capacity per g packing: 16 mg BSA, 55 mg cytochrome C
  outstanding selectivity for peptides
- **NUCLEOSIL® 300-5 C_4 MPN:** butyl phase, particle size 5 µm, pore size 300 Å · USP **L26**
  dynamic protein binding capacity per g packing: 14 mg BSA, 27 mg cytochrome C
  especially suited for the purification of larger, hydrophobic peptides and very different proteins
- pH working range 2 – 8, max. working pressure 250 bar
- maximum separation efficiency can be achieved when the injected protein mass does not exceed 1 – 2 % of the maximum protein loading capacity
- eluent in column methanol

Separation of haemoglobin chains

Column:	250 x 4 mm NUCLEOSIL® 300-5 C_4 MPN
Eluents:	A) 20 % acetonitrile, 80 % water, 0.1 % TFA
	B) 60 % acetonitrile, 40 % water, 0.1 % TFA
Gradient:	40 – 60 % B in 60 min
Flow rate:	1 ml/min
Detection:	UV, 220 nm

Peaks:
1. Hem
2. β-globin
3. α-globin
4. $^{A}\gamma^{T}$-globin
5. $^{G}\gamma$-globin
6. $^{A}\gamma^{I}$-globin

MN Appl. No. 108240



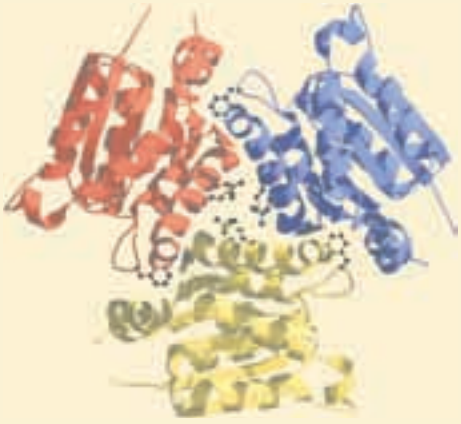
Ordering information

Length →	50 mm	125 mm	250 mm	Guard columns
EC analytical columns				
NUCLEOSIL® 100-5 C_{18} MPN				
4 mm ID		720230.40	720231.40	
NUCLEOSIL® 120-3 C_{18} MPN				
4 mm ID		720232.40		
NUCLEOSIL® 300-5 C_4 MPN				
4 mm ID	720244.40	720045.40	720245.40	721113.40

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
Guard columns in packs of 2, EC columns in packs of 1.

HPLC columns for biochemical separations

NUCLEOSIL® PPN



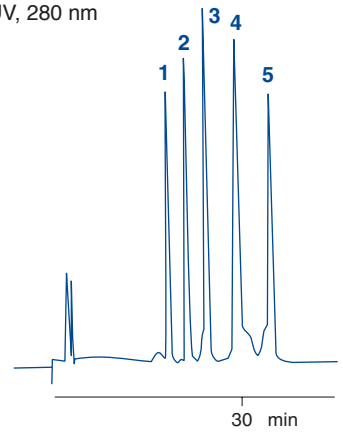
RP chromatography of biological macromolecules

- silica-based reversed phase materials with polymerically bonded alkyl chains; exclusively hydrophobic interactions
- **NUCLEOSIL® 100-5 C_{18} PPN:** octadecyl phase, particle size 5 µm, pore size 100 Å · USP **L1**
  dynamic protein binding capacity per g packing: 8 mg BSA, 64 mg cytochrome C; suited for the separation of peptides and proteins up to about 40 kD, also suited for basic peptides
- **NUCLEOSIL® 500-5 C_{18} PPN:** octadecyl phase, particle size 5 µm, pore size 500 Å · USP **L1**
  dynamic protein binding capacity per g packing: 22 mg BSA, 40 mg cytochrome C; especially suited for large peptides and medium-size hydrophilic proteins
- pH working range 1 – 9, max. working pressure 250 bar
- eluent in column methanol

Separation of a protein standard

Column: 125 x 4 mm NUCLEOSIL® 100-5 C_{18} PPN
Eluents: A) 0.1 % TFA in H_2O
B) 0.08 % TFA in CH_3CN
Gradient: 20 – 60 % B in 10 min
Flow rate: 1.0 ml/min
Detection: UV, 280 nm

Peaks:
1. Ribonuclease
2. Cytochrome C
3. Lysozyme

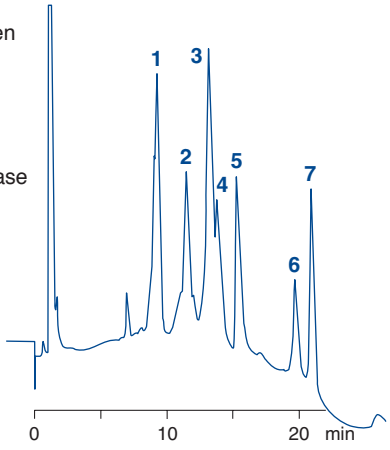


MN Appl. No. 108220

Separation of pancreatic secretion of piglets

Column: 125 x 4 mm NUCLEOSIL® 500-5 C_{18} PPN
Eluents: A) 0.1 % TFA in H_2O
B) 0.08 % TFA in CH_3CN
Gradient: linear 30 – 50 % B in 14 min, then 50 – 65 % B in 6 min
Flow rate: 1 ml/min
Detection: UV, 215 nm

Peaks:
1. Trypsin + trypsinogen
2. Proelastase
3. Lipase
   + α-chymotrypsin
4. Chymotrypsinogen
5. α-Amylase
6., 7. Procarboxypeptidase



MN Appl. No. 108280

Ordering information

Length →	50 mm	125 mm	250 mm	Guard columns
EC analytical columns				
NUCLEOSIL® 100-5 C_{18} PPN				
4 mm ID	**720250.40**	**720251.40**	**720252.40**	**721594.40**
NUCLEOSIL® 500-5 C_{18} PPN				
4 mm ID	**720256.40**	**720257.40**	**720258.40**	**721687.40**

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359).
Guard columns in packs of 2, EC columns in packs of 1.

NUCLEOGEL® RP columns

RP columns for biochemical applications

- polystyrene resin cross-linked with divinylbenzene, available particle sizes 5 µm and 8 µm, available pore sizes 100 Å, 300 Å, 1000 Å and 4000 Å · USP L21
  pH working range 1 – 13, max. working pressure 180 bar
- small pore columns for reversed phase separation of small molecules such as pharmaceuticals with basic properties, e.g. organic heterocycles
  also suited for separation of nucleosides and nucleotides up to 5000 daltons
  allow gradient as well as isocratic elution
- wide pore columns are especially recommended for large biomolecules
  higher background hydrophobicity compared to silica phases
- eluent in column acetonitrile / water

Ordering information

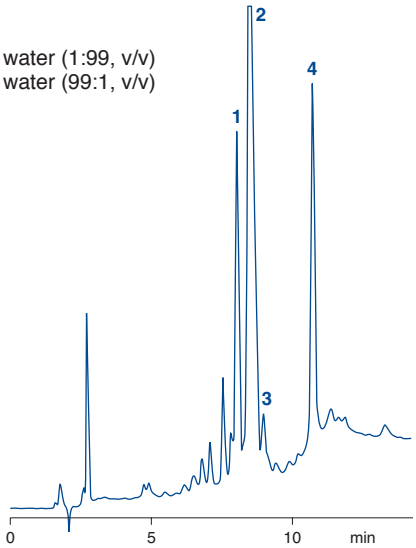
Length →	50 mm	150 mm	250 mm	300 mm	Guard columns
Valco type analytical columns 					
NUCLEOGEL® RP 100-5				pore size 100 Å, particle size 5 µm	
4.6 mm ID		**719454**	**719455**		**719542**
NUCLEOGEL® RP 100-8				pore size 100 Å, particle size 8 µm	
4.6 mm ID		**719456**	**719520**		**719542**
7.7 mm ID				**719457**	**719542**
NUCLEOGEL® RP 300-5				pore size 300 Å, particle size 5 µm	
4.6 mm ID	**719459**				**719542**
NUCLEOGEL® RP 300-8				pore size 300 Å, particle size 8 µm	
4.6 mm ID	**719460**				**719542**
7.7 mm ID	**719463**				**719542**

NUCLEOGEL® RP Valco type guard columns measure 5 x 3 mm and require the guard column holder B, REF 719539, see page 169. Guard columns in packs of 2, Valco type columns in packs of 1.

Analysis of the synthetic acyl carrier protein ACP(65-74)

Column: 150 x 4.6 mm
NUCLEOGEL® RP 100-8
Eluents: A) 0.1 % TFA in acetonitrile – water (1:99, v/v)
B) 0.1 % TFA in acetonitrile – water (99:1, v/v)
Gradient: 10 – 60 % B in 20 min
Flow rate: 1 ml/min
Detection: UV, 220 nm

Peaks:
1. ACP(66-74)(H-Gln)
2. ACP(65-74)
3. ACP(66-74)(Glp)
4. Thioanisole



MN Appl. No. 108500

HPLC columns for sugar analysis

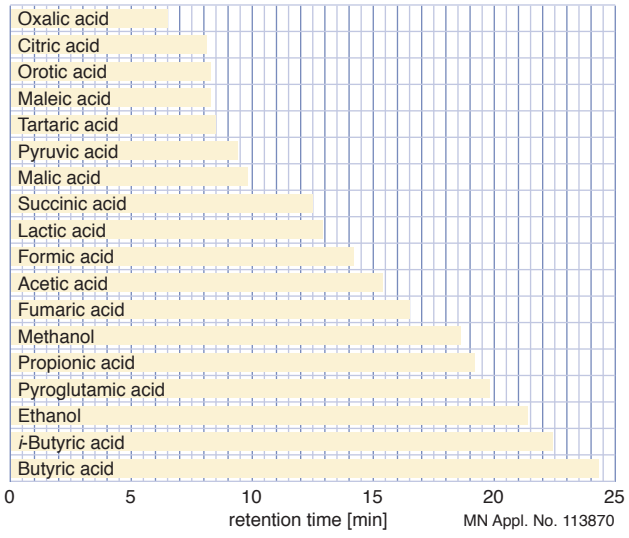
NUCLEOGEL® SUGAR 810 columns

separation of sugars

- sulphonated polystyrene / divinylbenzene resins in different ionic forms
  due to a different selectivity pattern compared to NUCLEOGEL® SUGAR columns, the range of application is considerably enlarged
- separation mechanism includes ion exclusion, ion exchange, size exclusion, ligand exchange as well as NP and RP chromatography
- H^+ form: separation of sugars, sugar alcohols and organic acids · USP **L17**
  eluent in column 0.01 N H_2SO_4
- Ca^{2+} form: separation of mono-, di- and oligosaccharides · USP **L19** · eluent in column water

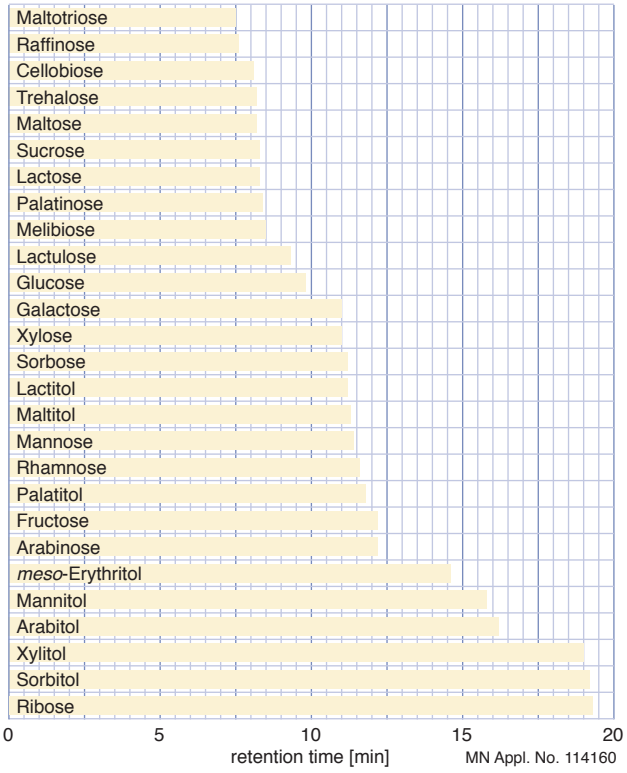
Organic acids and alcohols

Column: 300 x 7.8 mm NUCLEOGEL® SUGAR 810 H
Injection volume: 5 µl
Eluent: 5 mmol H_2SO_4
Flow rate: 0.6 ml/min
Temperature: 35 °C
Detection: RI



Sugars and sugar alcohols

Column: 300 x 7.8 mm NUCLEOGEL® SUGAR 810 Ca
Eluent: water , flow rate 0.6 ml/min
Detection: RI



Ordering information

	Length →	300 mm	Guard columns
Valco type columns			
NUCLEOGEL® SUGAR 810 H			
7.8 mm ID		**719574**	**719575**
NUCLEOGEL® SUGAR 810 Ca			
7.8 mm ID		**719570**	**719571**

NUCLEOGEL® SUGAR 810 ChromCart® guard columns measure 30 x 4 mm and require the ChromCart® column holder 30 mm, REF 721823, see page 167. They are supplied in packs of 2, all Valco type columns in packs of 1.

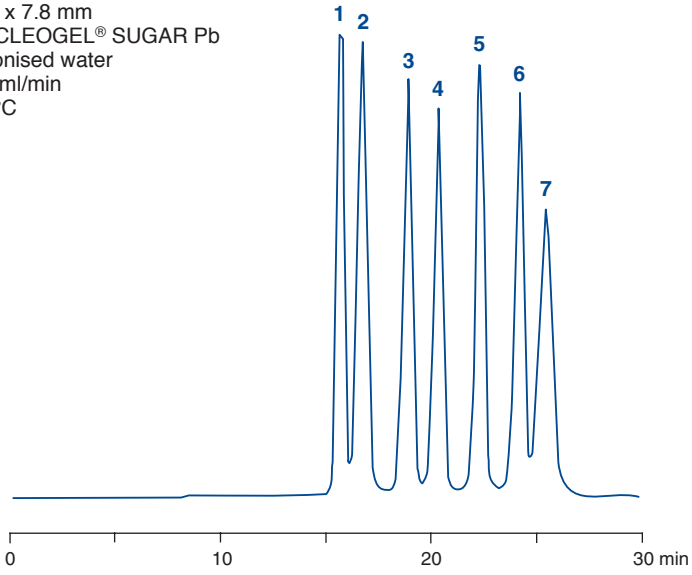
NUCLEOGEL® ION 300 OA / SUGAR columns — separation of sugars

- sulphonated spherical PS/DVB resins in different ionic forms; mean particle size 10 µm, pore size 100 Å
- separation mechanism includes steric exclusion, ligand exchange and partition effects, ligand exchange being the predominant force, since the hydrated metal ions form strong interactions with the hydroxyl groups of the sample molecules. The intensity of these interactions decreases in the sequence Pb, Ca, Na
- NUCLEOGEL® ION 300 OA: H^+ form for separation of sugars, alcohols and organic acids · USP **L17** eluent in column 0.01 N H_2SO_4
  - · Ca^{2+} form: separation of mono- and oligosaccharides, sugar alcohols · USP **L19**
  - · Na^+ form: separation of oligosaccharides from starch hydrolysates and food · USP **L58**
  - · Pb^{2+} form: separation of mono- and disaccharides from food and biological samples · USP **L34**
- eluent in column for Ca, Na and Pb phases: water + 0.02 % azide
- recommended operating temperatures: 60 – 95 °C; maximum pressure 100 bar

Separation of carbohydrates

Column: 300 x 7.8 mm NUCLEOGEL® SUGAR Pb
Eluent: deionised water
Flow rate: 0.4 ml/min
Temperature: 80 °C
Detection: RI

Peaks:
1. Sucrose
2. Maltose
3. Glucose
4. Xylose
5. Galactose
6. Arabinose
7. Mannose



MN Appl. No. 102430

Ordering information

Length →	300 mm	Guard columns
Valco type columns 		
NUCLEOGEL® ION 300 OA		
7.8 mm ID	719501	719537
NUCLEOGEL® SUGAR Ca		
6.5 mm ID	719531	719535
NUCLEOGEL® SUGAR Pb		
7.8 mm ID	719530	719534
NUCLEOGEL® SUGAR Na		
7.8 mm ID	719532	719536

NUCLEOGEL® ION and SUGAR Valco type guard columns measure 21 x 4 mm and require the guard column holder C (REF 719538, see page 169). Guard columns in packs of 2, Valco type columns in packs of 1.

HPLC columns for sugar analysis

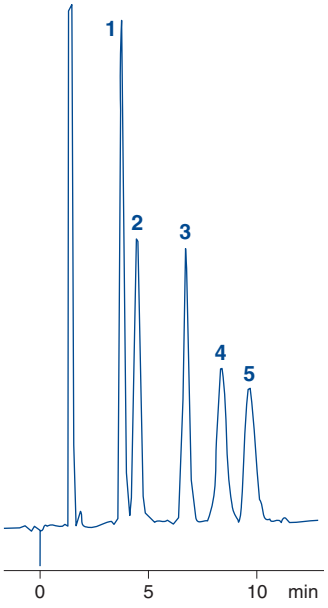
NUCLEOSIL® Carbohydrate — separation of mono- and disaccharides

- matrix: NUCLEOSIL® silica with amino modification, particle size 10 µm · USP **L8**
- recommended application: RP separation of mono- and disaccharides
- eluent in column acetonitrile / water (79:21, v/v)

Separation of sugars

Column:	250 x 4 mm NUCLEOSIL® Carbohydrate
Eluent:	acetonitrile – water (79:21, v/v)
Flow rate:	2 ml/min
Temperature:	25 °C
Detection:	RI
Injection volume:	10 µl

Peaks:
1. Fructose
2. Glucose
3. Saccharose
4. Maltose
5. Lactose



MN Appl. No. 102480

For the separation of oligosaccharides with longer chains ($10 < n < 40$) our phase NUCLEOSIL® 300-5 C_{18} can be successfully applied (see Application No. 102730 at *www.mn-net.com*). In this case a very flat gradient allows good resolution of the carbohydrates. For ordering information of this phase please see page 134.

Ordering information

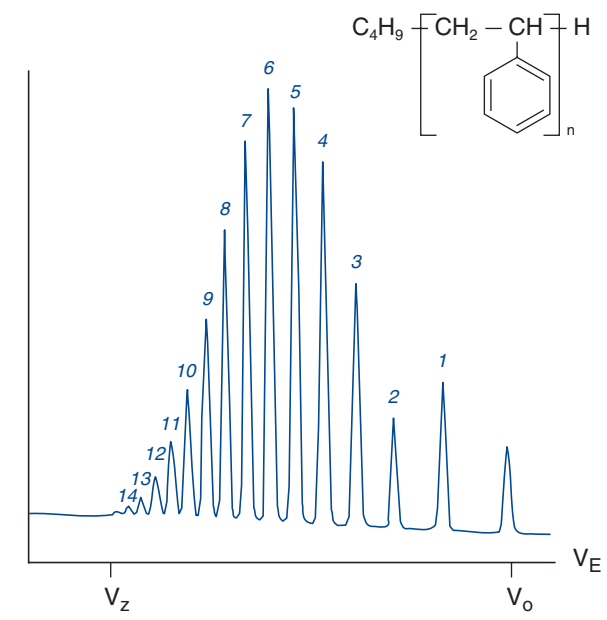
Length →	250 mm	Guard columns
NUCLEOSIL® Carbohydrate		
EC columns		
4 mm ID	**720905.40**	**721595.40**

As guard columns for EC columns use ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). Columns and guard columns in packs of 1.

NUCLEOGEL® GPC — for GPC of water-insoluble substances

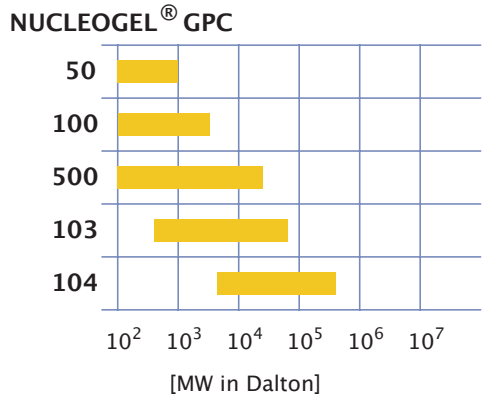
- highly crosslinked macroporous, spherical polystyrene – divinylbenzene polymer matrix with good mechanical stability
- eluent in column toluene

Chromatogram of styrene oligomers



exclusion volume — dead time

Working ranges for polystyrene



Ordering information

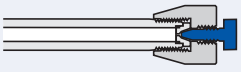
Phase	Exclusion limit [kDaltons]	Application	Column 300 x 7.7 mm
Valco type analytical columns			
5 µm particles			
NUCLEOGEL GPC 50-5	2	low molecular weight organics	**719402**
NUCLEOGEL GPC 100-5	4	oligomers, oils	**719403**
NUCLEOGEL GPC 500-5	25	low molecular weight polymers	**719404**
NUCLEOGEL GPC 103-5	60	low molecular weight polymers	**719405**
NUCLEOGEL GPC 104-5	500	polymers up to 500 kDaltons	**719406**
		guard column 50 x 7.7 mm	**719409**
10 µm particles			
NUCLEOGEL GPC 50-10	2	low molecular weight organics	**719410**
NUCLEOGEL GPC 100-10	4	oligomers, oils	**719411**
NUCLEOGEL GPC 500-10	25	low molecular weight polymers	**719412**
NUCLEOGEL GPC 103-10	60	low molecular weight polymers	**719413**
NUCLEOGEL GPC 104-10	500	polymers up to 500 kDaltons	**719414**
		guard column 50 x 7.7 mm	**719418**

Columns and guard columns in packs of 1.

EC standard columns for analytical HPLC

- analytical column system manufactured from stainless steel
  M 8 outer threads on both ends
  combination of sealing element and very fine-meshed stainless steel screen, PTFE ring and fitting adaptor
  column heads SW 12, with inner threads M 8 and UNF 10-32
- as built-in guard columns ChromCart® guard column cartridges with 8 mm length are used with the guard column adaptor EC (see below)
- supplied with NUCLEODUR® and NUCLEOSIL® spherical silicas

Available standard dimensions of EC columns · please ask for availability of certain phases

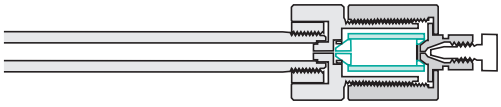
ID [mm]	Length [mm] 8*	20	30	50	75	100	125	150	200	250	300	End fitting design
2	-	x	x	x	x	x	x	x	x	x	x	
3	x	x	x	x	x	x	x	x	x	x	x	
4	x	x	x	x	x	x	x	x	x	x	x	
4.6	-	x	x	x	x	x	x	x	x	x	x	

* Please note that 3 mm ID ChromCart® guard column cartridges are applicable for 2 mm and 3 mm ID EC columns, and 4 mm ID guard column cartridges are used for 4 mm and 4.6 mm ID EC columns.

Installation of the EC guard column adaptor




EC column with CC guard column



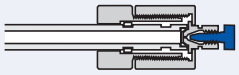
Accessories and replacement parts for EC columns · Ordering information

Description	Pack of	REF
Guard column adaptor EC	1	**721359**
1/16“ nut for connecting 1/16“ capillaries	5	**718583**
1/16“ ferrule	5	**718584**
1/16“ end cap, plastic	4	**718582**
EC fitting adaptor	1	**718987**
EC column head (nut)	1	**718988**
EC PTFE sealing ring	4	**718992**
3-part sealing combination for EC columns	5 kits	**718998**

ChromCart® cartridge system

- analytical column system manufactured from stainless steel (US patent 5,342,515)
- rapid and convenient installation
  columns are changed without removal of capillary connections
  all unions are screwed by hand
  easy installation of guard cartridges without special adaptor
  connection of columns of different lengths and inner diameters with one type of connecting kit (see below)
- supplied with NUCLEOSIL® spherical silicas as well as with well-known packings from other manufacturers

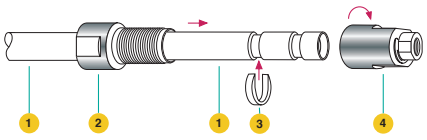
Available standard dimensions of ChromCart® cartridges · please ask for availability of certain phases

ID [mm]	Length [mm]				End fitting design
	8*	125	150	250	
2	–	x	x	x	
3	x	x	x	x	
4	x	x	x	x	
4.6	–	x	x	x	

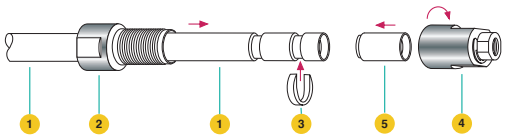
* Please note that 3 mm ID guard column cartridges are also applicable for 2 mm ID CC columns, and 4 mm ID guard column cartridges are also used for 4.6 mm ID CC columns.

Connection of ChromCart® cartridges and guard column cartridges

Use of 1 analytical column



Use of column and guard column



Legend

1. analytical column
2. sleeve
3. guide ring
4. nut
5. guard column
6. PEEK sealing cone
7. longer nut

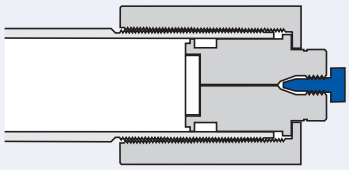
Accessories for the ChromCart® cartridge system · Ordering information

Description	Pack of	REF
CC connecting kit (consists of 2 nuts with end fittings, two sleeves and two guide rings)	1 kit	**721690**
CC nut with end fitting	1 set	**721691**
CC sleeve with outer threads	1	**721692**
CC guide ring	1	**721693**
CC coupling kit (consists of longer nut, PEEK seal, sleeve with outer threads and 2 guide rings for coupling two CC columns)	1 kit	**721694**
PEEK seal	2	**721695**
CC guard column holder 8 mm for stand-alone operation of 8 mm CC cartridges	1	**721820**
CC column holder 30 mm for stand-alone operation of 30 mm CC cartridges	1	**721823**

VarioPrep columns (VP)

- column system for preparative HPLC manufactured from stainless steel with adjustable end fittings (suitable for frequent use of back-flushing techniques)
- allows compensation of a dead volume, which could result at the column inlet after some time of operation, without need for opening the column
- supplied with NUCLEODUR® and NUCLEOSIL® spherical silicas
- up-scaling from analytical to preparative columns see page 172

Available standard dimensions of VarioPrep columns with axially adjustable end fitting

ID [mm]	Length [mm]									End fitting design
	10*	15*	20*	50	100	125	150	250	500	
8	x			x	x	x	x	x		
10				x	x	x	x	x		
16			x	x	x	x	x	x		
21				x	x	x	x	x		
32		x			x		x	x		
40				x	x	x	x	x	x	
50					x		x	x		
80								x	x	

10 x 8 mm guard columns for 8 and 10 mm ID VP columns, 20 x 16 mm guard columns for 16 and 21 mm ID VP columns, 15 x 32 mm guard columns for 32 to 50 mm ID VP columns. VP guard columns require the holders listed below.

VarioPrep guard column holders and replacement parts · ordering information

Description	Pack of	REF
VP guard column holder 8 mm for VarioPrep columns with 8 and 10 mm ID	1	**718251**
O-ring for VP guard column holder 8 mm	2	**718975**
VP guard column holder 16 mm for VarioPrep columns with 16 and 21 mm ID	1	**718250**
O-ring for VP guard column holder 16 mm	2	**718976**
VP guard column holder 32 mm for VarioPrep columns with 32 to 50 mm ID	1	**718253**
O-ring for VP guard column holder 32 mm	2	**718977**

Replacement parts for VarioPrep columns · Ordering information

Description	Pack of	REF
for VarioPrep columns with 10 mm ID		
VP plunger fitting 10 mm	1	**718837**
VP nut 10 mm	1	**718842**
VP sealing element set 10 mm	1 set	**718931**
VP sealing ring set 10 mm	1 set	**718852**
VP MN Inert sealing combination 10 mm	1 set	**718848**
for VarioPrep columns with 21 mm ID		
VP plunger fitting 21 mm	1	**718861**
VP nut 21 mm	1	**718862**
VP sealing element set 21 mm	1 set	**718853**
VP sealing ring set 21 mm	1 set	**718854**
VP MN Inert sealing combination 21 mm	1 set	**718870**

Microbore columns

- analytical column system for rapid HPLC and LC/MS analyses with high resolution
- available lengths: 40, 60, 100, 125, 150, 200, 250 and 300 mm, available IDs: 0.05, 0.075, 0.1, 0.15, 0.3, 0.4, 0.5, 0.75, 1, 1.5 mm
- Microbore columns up to 0.3 mm ID are fused silica capillaries, while microbore columns with 0.3 – 1.5 mm ID are stainless steel columns.
- supplied with NUCLEODUR® RP phases (NUCLEOSIL® on request)
- guard columns for microbore columns are available on request.

Advantages of microbore columns

- only small sample volumes required
- highest detection sensitivity
- low flow rate = reduced eluent consumption
- **time saving + reduced eluent consumption = reduced cost**

Change of flow rate and solvent saving as a function of the column inner diameter

ID [mm]	Flow rate [ml/min]	Solvent saving	Increase in sensitivity
4.6	1.3	–	–
4.0	1.0	~ 25 %	~ 1.3
3.0	0.56	~ 57 %	~ 2.4
2.0	0.25	~ 81 %	~ 5.3
1.0	0.06	~ 95 %	~ 21.7

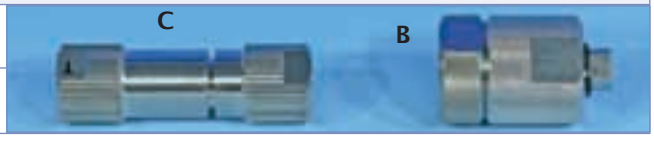
for a constant length relative to a column with 4.6 mm ID and a flow rate of 1.3 ml/min for isocratic application

Valco type columns

- analytical column system manufactured from stainless steel
  available inner diameters: 4.6 mm ID (1/4" OD) and 7.7 mm (3/8" OD)
- mainly used for some phases for special separations

Accessories for Valco type columns · Ordering information

Description	Pack of	REF
Guard column holder B for VA guard columns 5 x 3 mm	1	**719539**
Guard column holder C for VA guard columns 21 x 4 mm	1	**719538**



Frits 2 µm for 4.6 mm ID columns	5	**719485**
Frits 2 µm for 7.7 mm ID columns	5	**719486**
Column connecting nuts for 1/16" capillaries	5	**719487**
Ferrules for 1/16" capillaries	5	**719488**
Union for columns	1	**719489**
Column end plugs	5	**719490**

HPLC fittings and capillary tubing

Accessories for stainless steel HPLC columns

- Stainless steel columns are most frequently used in HPLC. The material is corrosion resistant, pressure stable and easy to work mechanically.

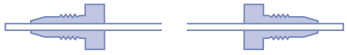
Ordering information

Stainless steel capillary tubing

Length		OD		ID	Pack of	REF
Capillary tubing in coils						
3 m	x	1/16"	x	0.25 mm	1 coil	**718737**
3 m	x	1/16"	x	0.5 mm	1 coil	**718738**
1 m	x	1/16"	x	0.12 mm	1 coil	**718790**
1 m	x	1/16"	x	0.25 mm	1 coil	**718735**
1 m	x	1/16"	x	0.5 mm	1 coil	**718736**

Capillary tubing, cut pieces, ready-to-use						
50 mm	x	1/16"	x	0.12 mm	2 tubes	**718731**
100 mm	x	1/16"	x	0.12 mm	2 tubes	**718732**
200 mm	x	1/16"	x	0.12 mm	2 tubes	**718733**
300 mm	x	1/16"	x	0.12 mm	2 tubes	**718734**
100 mm	x	1/16"	x	0.25 mm	5 tubes	**718588**
200 mm	x	1/16"	x	0.25 mm	5 tubes	**718635**
300 mm	x	1/16"	x	0.25 mm	5 tubes	**718589**
100 mm	x	1/16"	x	0.5 mm	5 tubes	**718516**
300 mm	x	1/16"	x	0.5 mm	5 tubes	**718517**
50 mm	x	1/32"	x	0.12 mm	2 tubes	**718670**
100 mm	x	1/32"	x	0.12 mm	2 tubes	**718671**
200 mm	x	1/32"	x	0.12 mm	2 tubes	**718672**
50 mm	x	1/32"	x	0.25 mm	2 tubes	**718673**
100 mm	x	1/32"	x	0.25 mm	2 tubes	**718674**
50 mm	x	1/32"	x	0.5 mm	2 tubes	**718676**
100 mm	x	1/32"	x	0.5 mm	2 tubes	**718677**
200 mm	x	1/32"	x	0.5 mm	2 tubes	**718678**

Stainless steel accessories

Description	Pack of	REF
Capillary accessories		
Knife file	1	**706121**
Cutter for 1/16" capillaries	1	**706290**
Capillary union 100 mm x 1/16" x 0.25 mm 	1	**718637**

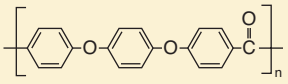
Eluent filters, stainless steel			
for 1/16" tubing	2 µm frit	1	**718750**
for 1/16" tubing	10 µm frit	1	**718752**
for 1/8" tubing	2 µm frit	1	**718751**
for 1/8" tubing	10 µm frit	1	**718753**

For accessories and replacement parts for EC columns see page 166, for accessories and replacement parts for ChromCart® cartridges see page 167, replacement parts for VarioPrep columns are listed on page 168.

PEEK accessories

- PEEK (= polyether ether ketone) is a high performance polymer belonging to the group of polyarylether ketones (PAEK), which meets all requirements of HPLC columns with respect to chemical resistance and mechanical stability. In some fields of application in HPLC, like e.g. in ion chromatography and chromatography of biopolymers, PEEK fulfils the requirements for a nonmetallic material.

PEEK



- All fittings can be tightened by hand. The following table summarizes the available PEEK products.

Ordering information

Description	Pack of	REF	
PEEK fittings			
1/16" PEEK fingertight fitting, 1-part combination nut + ferrule	1	**718770**	
1/16" PEEK fingertight nut	1	**718771**	
1/16" PEEK ferrule for REF 718771	1	**718772**	
1/16" PEEK double ferrule	1	**718775**	
1/16" PEEK union, both sides inner threads, equipped with 2 fingertight nuts and double ferrules	1	**718766**	
1/16" PEEK union, both sides inner threads, however without nuts and without ferrules	1	**718767**	
1/16" PEEK union, both sides outer threads	1	**718768**	

PEEK standard capillaries

OD	ID [mm]	Length		
1/16"	0.13	1 m	1	**718765**
1/16"	0.17	1 m	1	**718760**
1/16"	0.25	1 m	1	**718761**
1/16"	0.5	1 m	1	**718762**
1/16"	0.75	1 m	1	**718763**

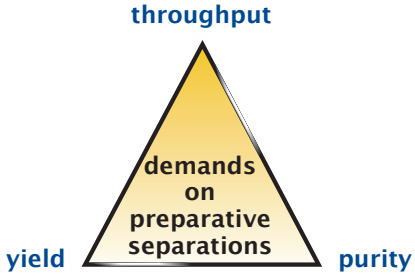
Tools for PEEK capillaries

Guillotine cutter for PEEK and PTFE capillaries	1	**718769**
Clean-Cut cutter for different capillary outer diameters	1	**718755**

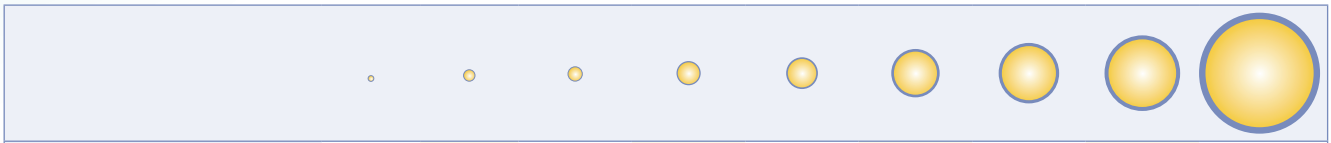
NUCLEODUR® high purity silica for HPLC

Basic rules of preparative HPLC

Basically, preparative HPLC follows the same rules as analytical scale chromatography. However, there are important differences in the aims of the two techniques. In analytical HPLC chromatographers focus on peak shape, and resolution of all eluted analytes, whereas in preparative chromatography yield and purity of the final product, as well as cost-effectiveness of the method, are emphasised.



Scale up factors and parameters for typical MN column dimensions



ID x length [mm]	4 x 250	8 x 250	10 x 250	16 x 250	21 x 250	32 x 250	40 x 250	50 x 250	80 x 250
Linear scale-up factor	1	4	6.25	16	27.6	64	100	161.3	400
Typical sample mass* [mg]	0.02 – 2	0.08 – 8	0.13 – 13	0.3 – 35	0.6 – 60	1.3 – 130	2 – 210	3 – 350	10 – 850
Typical flow rate [ml/min]	0.5 – 1.5	2 – 6	3 – 9	8 – 24	14 – 40	32 – 96	50 – 150	80 – 250	200 – 600

* For RP material; the maximum amounts given here always depend on the separation problem and on the sample composition. In some cases half of the amount given can cause drastic overload, in other cases the maximum amounts can be even higher still giving acceptable separations.

NUCLEODUR® bulk packings

- totally spherical high purity silica
- pore size 110 Å, pore volume 0.9 ml/g, surface (BET) 340 m^2/g, density 0.47 g/ml, pressure stability 800 bar
- larger particles for preparative applications

Ordering information

Phase	Endcapped	Carbon content	Particle size	Pack of 100 g	Pack of 1000 g
NUCLEODUR® C_{18} HTec premium octadecyl phases (see p. 118)					
NUCLEODUR® 100-5 C_{18} HTec	yes	18 % C	5 µm	**713830.0100**	**713830.1**
NUCLEODUR® 100-7 C_{18} HTec	yes	18 % C	7 µm	**713831.0100**	**713831.1**
NUCLEODUR® 100-10 C_{18} HTec	yes	18 % C	10 µm	**713832.0100**	**713832.1**
NUCLEODUR® C_{18} ec standard octadecyl phases (see p. 120)					
NUCLEODUR® 100-10 C_{18} ec	yes	17.5 % C	10 µm	**713611.0100**	**713611.1**
NUCLEODUR® 100-12 C_{18} ec	yes	17.5 % C	12 µm	**713618.0100**	**713618.1**
NUCLEODUR® 100-16 C_{18} ec	yes	17.5 % C	16 µm	**713621.0100**	**713621.1**
NUCLEODUR® 100-20 C_{18} ec	yes	17.5 % C	20 µm	**713601.0100**	**713601.1**
NUCLEODUR® 100-30 C_{18} ec	yes	17.5 % C	30 µm	**713631.0100**	**713631.1**
NUCLEODUR® 100-50 C_{18} ec	yes	17.5 % C	50 µm	**713550.0100**	**713550.1**
Unmodified NUCLEODUR® silica (see p. 123)					
NUCLEODUR® 100-10			10 µm	**713610.0100**	**713610.1**
NUCLEODUR® 100-12			12 µm	**713615.0100**	**713615.1**
NUCLEODUR® 100-16			16 µm	**713620.0100**	**713620.1**
NUCLEODUR® 100-20			20 µm	**713600.0100**	**713600.1**
NUCLEODUR® 100-30			30 µm	**713630.0100**	**713630.1**
NUCLEODUR® 100-50			50 µm	**713551.0100**	**713551.1**

NUCLEOSIL® bulk packings

- spherical silica
- pH stability 2 – 8 (for NUCLEOSIL® 100-5 C_{18} AB 1 – 9)
- for a characterisation of our NUCLEOSIL® silica see page 101

Physical properties of unmodified NUCLEOSIL® materials

Phase	Pore size	Pore volume	Surface (BET)	Density	Pressure stability
NUCLEOSIL® 50	50 Å	0.8 ml/g	420 m^2/g	0.45 g/ml	600 bar
NUCLEOSIL® 100	100 Å	1 ml/g	350 m^2/g	0.36 g/ml	600 bar
NUCLEOSIL® 120	120 Å	0.65 ml/g	200 m^2/g	0.55 g/ml	800 bar
NUCLEOSIL® 300	300 Å	0.8 ml/g	100 m^2/g	0.45 g/ml	400 bar
NUCLEOSIL® 500	500 Å	0.8 ml/g	35 m^2/g	0.45 g/ml	400 bar
NUCLEOSIL® 1000	1000 Å	0.8 ml/g	25 m^2/g	0.45 g/ml	300 bar
NUCLEOSIL® 4000	4000 Å	0.7 ml/g	10 m^2/g	0.48 g/ml	300 bar

For description of individual modifications see chapter “Columns with NUCLEOSIL®” from page 130.

Ordering information

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 10 g	Pack of 100 g
Octadecyl phases						$-(CH_2)_{17}-CH_3$
NUCLEOSIL® 50-5 C_{18} ec	yes	14.5 % C	50 Å	5 µm	712031.10	712031.100
NUCLEOSIL® 100-5 C_{18} AB	yes	24 % C	100 Å	5 µm	712952.10	712952.100
NUCLEOSIL® 100-3 C_{18}	yes	15 % C	100 Å	3 µm	712370.10	712370.100
NUCLEOSIL® 100-5 C_{18}	yes	15 % C	100 Å	5 µm	712130.10	712130.100
NUCLEOSIL® 100-7 C_{18}	yes	15 % C	100 Å	7 µm	712140.10	712140.100
NUCLEOSIL® 100-10 C_{18}	yes	15 % C	100 Å	10 µm	712150.10	712150.100
NUCLEOSIL® 120-3 C_{18}	yes	11 % C	120 Å	3 µm	712460.10	712460.100
NUCLEOSIL® 120-5 C_{18}	yes	11 % C	120 Å	5 µm	712470.10	712470.100
NUCLEOSIL® 120-7 C_{18}	yes	11 % C	120 Å	7 µm	712480.10	712480.100
NUCLEOSIL® 120-10 C_{18}	yes	11 % C	120 Å	10 µm	712490.10	712490.100
NUCLEOSIL® 300-5 C_{18}	yes	6.5 % C	300 Å	5 µm	712520.10	712520.100
NUCLEOSIL® 300-7 C_{18}	yes	6.5 % C	300 Å	7 µm	712530.10	712530.100
NUCLEOSIL® 300-10 C_{18}	yes	6.5 % C	300 Å	10 µm	712540.10	712540.100
NUCLEOSIL® 500-7 C_{18}	yes	2 % C	500 Å	7 µm	712760.10	712760.100
NUCLEOSIL® 1000-7 C_{18}	yes	~ 1 % C	1000 Å	7 µm	712790.10	712790.100
NUCLEOSIL® 4000-7 C_{18}	yes	<1 % C	4000 Å	7 µm	712926.10	712926.100
Octyl phases						$-(CH_2)_7-CH_3$
NUCLEOSIL® 50-5 C_8 ec	yes	9 % C	50 Å	5 µm	712032.10	712032.100
NUCLEOSIL® 100-5 C_8 ec	yes	9 % C	100 Å	5 µm	712101.10	712101.100
NUCLEOSIL® 100-5 C_8	no	8.5 % C	100 Å	5 µm	712100.10	712100.100
NUCLEOSIL® 100-7 C_8	no	8.5 % C	100 Å	7 µm	712110.10	712110.100
NUCLEOSIL® 100-10 C_8	no	8.5 % C	100 Å	10 µm	712120.10	712120.100
NUCLEOSIL® 120-3 C_8	no	6.5 % C	120 Å	3 µm	712570.10	712570.100
NUCLEOSIL® 120-5 C_8	no	6.5 % C	120 Å	5 µm	712580.10	712580.100
NUCLEOSIL® 120-7 C_8	no	6.5 % C	120 Å	7 µm	712500.10	712500.100
NUCLEOSIL® 120-10 C_8	no	6.5 % C	120 Å	10 µm	712590.10	712590.100
NUCLEOSIL® 300-5 C_8	no	~ 3 % C	300 Å	5 µm	712650.10	712650.100
NUCLEOSIL® 300-7 C_8	no	~ 3 % C	300 Å	7 µm	712550.10	712550.100
NUCLEOSIL® 300-10 C_8	no	~ 3 % C	300 Å	10 µm	712660.10	712660.100
NUCLEOSIL® 500-7 C_8	no	<1 % C	500 Å	7 µm	712830.10	712830.100

NUCLEOSIL® standard silica for HPLC

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 10 g	Pack of 100 g
Phenyl phases						$-(CH_2)_3-C_6H_5$
NUCLEOSIL® 100-5 C_6H_5 ec	yes	8% C	100 Å	5 µm	712311.10	712311.100
NUCLEOSIL® 100-5 C_6H_5	no	8% C	100 Å	5 µm	712310.10	712310.100
NUCLEOSIL® 100-7 C_6H_5	no	8% C	100 Å	7 µm	712340.10	712340.100
NUCLEOSIL® 120-7 C_6H_5	no	6.5% C	120 Å	7 µm	712510.10	712510.100
NUCLEOSIL® 300-7 C_6H_5	no	~ 3% C	300 Å	7 µm	712670.10	712670.100
NUCLEOSIL® 500-7 C_6H_5	no	~ 2% C	500 Å	7 µm	712923.10	712923.100
NUCLEOSIL® 1000-7 C_6H_5	no	~ 1% C	1000 Å	7 µm	712924.10	712924.100
Butyl phases						$-(CH_2)_3-CH_3$
NUCLEOSIL® 120-5 C_4	yes	~ 4% C	120 Å	5 µm	712290.10	712290.100
NUCLEOSIL® 300-5 C_4	yes	~ 2% C	300 Å	5 µm	712620.10	712620.100
NUCLEOSIL® 300-7 C_4	yes	~ 2% C	300 Å	7 µm	712630.10	712630.100
NUCLEOSIL® 300-10 C_4	yes	~ 2% C	300 Å	10 µm	712640.10	712640.100
NUCLEOSIL® 500-7 C_4	yes	<1% C	500 Å	7 µm	712750.10	712750.100
NUCLEOSIL® 1000-7 C_4	yes	<1% C	1000 Å	7 µm	712780.10	712780.100
NUCLEOSIL® 4000-7 C_4	yes	<1% C	4000 Å	7 µm	712925.10	712925.100
Dimethyl phases						$-(CH_3)_2$
NUCLEOSIL® 100-7 C_2	no	3.5% C	100 Å	7 µm	712080.10	712080.100
Cyano phases (nitrile)						$-(CH_2)_3-CN$
NUCLEOSIL® 100-5 CN		5% C	100 Å	5 µm	712160.10	712160.100
NUCLEOSIL® 100-10 CN		5% C	100 Å	10 µm	712170.10	712170.100
NUCLEOSIL® 120-7 CN		~ 3% C	120 Å	7 µm	712600.10	712600.100
NUCLEOSIL® 300-7 CN		~ 2.5% C	300 Å	7 µm	712820.10	712820.100
NUCLEOSIL® 500-7 CN		~ 2% C	500 Å	7 µm	712840.10	712840.100
Nitro phases						$-(CH_2)_3-C_6H_4\,NO_2$
NUCLEOSIL® 100-5 NO_2		~ 4.5% C	100 Å	5 µm	712180.10	712180.100
NUCLEOSIL® 100-10 NO_2		~ 4.5% C	100 Å	10 µm	712190.10	712190.100
Diol phases						$-(CH_2)_3-O-CH_2-CH(OH)-CH_2OH$
NUCLEOSIL® 100-7 OH (Diol)		5% C	100 Å	7 µm	712350.10	712350.100
NUCLEOSIL® 300-7 OH (Diol)		~ 1.5% C	300 Å	7 µm	712560.10	712560.100
NUCLEOSIL® 500-7 OH (Diol)		~ 1.5% C	500 Å	7 µm	712740.10	712740.100
NUCLEOSIL® 1000-7 OH (Diol)		~ 1% C	1000 Å	7 µm	712770.10	712770.100
NUCLEOSIL® 4000-7 OH (Diol)		~ 1% C	4000 Å	7 µm	712927.10	712927.100
Amino phases						$-(CH_2)_3-NH_2$
NUCLEOSIL® 100-5 NH_2		3.5% C	100 Å	5 µm	712200.10	712200.100
NUCLEOSIL® 100-10 NH_2		3.5% C	100 Å	10 µm	712210.10	712210.100
NUCLEOSIL® 120-7 NH_2		~ 2% C	120 Å	7 µm	712610.10	712610.100
NUCLEOSIL® 300-7 NH_2		~ 2% C	300 Å	7 µm	712919.10	712919.100
Dimethylamino phases						$-(CH_2)_3-N(CH_3)_2$
NUCLEOSIL® 100-5 $N(CH_3)_2$		4% C	100 Å	5 µm	712220.10	712220.100
NUCLEOSIL® 100-10 $N(CH_3)_2$		4% C	100 Å	10 µm	712230.10	712230.100
Cation exchanger, strongly acidic (SCX)						$-(CH_2)_3-C_6H_4-SO_3\,Na$
NUCLEOSIL® 100-5 SA		6.5% C	100 Å	5 µm	712240.10	712240.100
NUCLEOSIL® 100-10 SA		6.5% C	100 Å	10 µm	712250.10	712250.100

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 10 g	Pack of 100 g
Anion exchanger, strongly basic (SAX)					$-(CH_2)_3-C_6H_4-CH_2-N^+(CH_3)_3Cl^-$	
NUCLEOSIL® 100-5 SB		10 % C	100 Å	5 µm	712260.10	712260.100
NUCLEOSIL® 100-10 SB		10 % C	100 Å	10 µm	712270.10	712270.100
Unmodified silica						SiOH
NUCLEOSIL® 50-3			50 Å	3 µm	712000.10	712000.100
NUCLEOSIL® 50-5			50 Å	5 µm	712010.10	712010.100
NUCLEOSIL® 50-7			50 Å	7 µm	712020.10	712020.100
NUCLEOSIL® 50-10			50 Å	10 µm	712030.10	712030.100
NUCLEOSIL® 100-3			100 Å	3 µm	712360.10	712360.100
NUCLEOSIL® 100-5			100 Å	5 µm	712040.10	712040.100
NUCLEOSIL® 100-7			100 Å	7 µm	712050.10	712050.100
NUCLEOSIL® 100-10			100 Å	10 µm	712060.10	712060.100
NUCLEOSIL® 120-3			120 Å	3 µm	712390.10	712390.100
NUCLEOSIL® 120-5			120 Å	5 µm	712400.10	712400.100
NUCLEOSIL® 120-7			120 Å	7 µm	712410.10	712410.100
NUCLEOSIL® 120-10			120 Å	10 µm	712420.10	712420.100
NUCLEOSIL® 300-5			300 Å	5 µm	712430.10	712430.100
NUCLEOSIL® 300-7			300 Å	7 µm	712440.10	712440.100
NUCLEOSIL® 300-10			300 Å	10 µm	712450.10	712450.100
NUCLEOSIL® 500-5			500 Å	5 µm	712680.10	712680.100
NUCLEOSIL® 500-7			500 Å	7 µm	712690.10	712690.100
NUCLEOSIL® 500-10			500 Å	10 µm	712700.10	712700.100
NUCLEOSIL® 1000-5			1000 Å	5 µm	712710.10	712710.100
NUCLEOSIL® 1000-7			1000 Å	7 µm	712720.10	712720.100
NUCLEOSIL® 1000-10			1000 Å	10 µm	712730.10	712730.100
NUCLEOSIL® 4000-5			4000 Å	5 µm	712850.10	712850.100
NUCLEOSIL® 4000-7			4000 Å	7 µm	712860.10	712860.100
NUCLEOSIL® 4000-10			4000 Å	10 µm	712870.10	712870.100

POLYGOSIL® bulk packings

- irregular silica for analytical applications
- pH stability 2 – 8

Physical properties of unmodified POLYGOSIL® materials

Phase	Pore size	Pore volume	Surface (BET)	Density	Pressure stability
POLYGOSIL® 60	60 Å	0.75 ml/g	350 m^2/g	0.45 g/ml	600 bar
POLYGOSIL® 100	100 Å	1 ml/g	280 m^2/g	0.35 g/ml	400 bar
POLYGOSIL® 300	300 Å	0.8 ml/g	100 m^2/g	0.45 g/ml	400 bar
POLYGOSIL® 1000	1000 Å	0.8 ml/g	25 m^2/g	0.45 g/ml	300 bar

Modification of POLYGOSIL® follows the same processes as for NUCLEOSIL® silica.

POLYGOSIL® irregular silica for HPLC

Ordering information

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 10 g	Pack of 100 g
Octadecyl phases						**$-(CH_2)_{17}-CH_3$**
POLYGOSIL® 60-5 C_{18}	yes	12% C	60 Å	5 µm	711330.10	711330.100
POLYGOSIL® 60-7 C_{18}	yes	12% C	60 Å	7 µm	711340.10	711340.100
POLYGOSIL® 60-10 C_{18}	yes	12% C	60 Å	10 µm	711350.10	711350.100
POLYGOSIL® 100-5 C_{18}	yes	14% C	100 Å	5 µm	711560.10	711560.100
POLYGOSIL® 100-7 C_{18}	yes	14% C	100 Å	7 µm	711570.10	711570.100
POLYGOSIL® 100-10 C_{18}	yes	14% C	100 Å	10 µm	711580.10	711580.100
POLYGOSIL® 300-7 C_{18}	yes	4% C	300 Å	7 µm	711710.10	711710.100
POLYGOSIL® 1000-7 C_{18}	yes	~ 1% C	1000 Å	7 µm	711992.10	711992.100
Octyl phases						**$-(CH_2)_7-CH_3$**
POLYGOSIL® 60-5 C_8	no	7% C	60 Å	5 µm	711300.10	711300.100
POLYGOSIL® 60-7 C_8	no	7% C	60 Å	7 µm	711310.10	711310.100
POLYGOSIL® 60-10 C_8	no	7% C	60 Å	10 µm	711320.10	711320.100
Butyl phases						**$-(CH_2)_3-CH_3$**
POLYGOSIL® 300-7 C_4	yes	~ 1% C	300 Å	7 µm	711680.10	711680.100
POLYGOSIL® 1000-7 C_4	yes	< 1 % C	1000 Å	7 µm	711991.10	711991.100
Cyano phases (nitrile)						**$-(CH_2)_3-CN$**
POLYGOSIL® 60-5 CN		~ 5% C	60 Å	5 µm	711380.10	711380.100
POLYGOSIL® 60-10 CN		~ 5% C	60 Å	10 µm	711390.10	711390.100
Nitro phases						**$-(CH_2)_3-C_6H_4-NO_2$**
POLYGOSIL® 60-5 NO_2		~ 4.5% C	60 Å	5 µm	711400.10	711400.100
POLYGOSIL® 60-10 NO_2		~ 4.5% C	60 Å	10 µm	711410.10	711410.100
Unmodified silica						**SiOH**
POLYGOSIL® 60-5			60 Å	5 µm	711010.10	711010.100
POLYGOSIL® 60-7			60 Å	7 µm	711280.10	711280.100
POLYGOSIL® 60-10			60 Å	10 µm	711020.10	711020.100
POLYGOSIL® 100-5			100 Å	5 µm	711510.10	711510.100
POLYGOSIL® 100-7			100 Å	7 µm	711520.10	711520.100
POLYGOSIL® 100-10			100 Å	10 µm	711530.10	711530.100
POLYGOSIL® 300-7			300 Å	7 µm	711600.10	711600.100
POLYGOSIL® 1000-7			1000 Å	7 µm	711890.10	711890.100
Amino phases						**$-(CH_2)_3-NH_2$**
POLYGOSIL® 60-5 NH_2		~ 3% C	60 Å	5 µm	711360.10	711360.100
POLYGOSIL® 60-10 NH_2		~ 3% C	60 Å	10 µm	711370.10	711370.100
Dimethylamino phases						**$-(CH_2)_3-N(CH_3)_2$**
POLYGOSIL® 60-5 $N(CH_3)_2$		~ 3.5% C	60 Å	5 µm	711420.10	711420.100
POLYGOSIL® 60-10 $N(CH_3)_2$		~ 3.5% C	60 Å	10 µm	711430.10	711430.100

POLYGOPREP bulk packings

- irregular silica for preparative applications
- pH stability 2 – 8

Physical properties of unmodified POLYGOPREP materials

Phase	Pore size	Pore volume	Surface (BET)	Density	Pressure stability
POLYGOPREP 60	60 Å	0.75 ml/g	350 m^2/g	0.45 g/ml	600 bar
POLYGOPREP 100	100 Å	1 ml/g	280 m^2/g	0.35 g/ml	400 bar
POLYGOPREP 300	300 Å	0.8 ml/g	100 m^2/g	0.45 g/ml	400 bar
POLYGOPREP 1000	1000 Å	0.8 ml/g	35 m^2/g	0.45 g/ml	300 bar

Modification of POLYGOPREP follows the same processes as for NUCLEOSIL® silica.

Ordering information

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 100 g	Pack of 1 kg
Octadecyl phases						$-(CH_2)_{17}-CH_3$
POLYGOPREP 60-12 C_{18}	no*	12% C	60 Å	10 – 15 µm	**711009.100**	**711009.1000**
POLYGOPREP 60-20 C_{18}	no*	12% C	60 Å	15 – 25 µm	**711031.100**	**711031.1000**
POLYGOPREP 60-30 C_{18}	no*	12% C	60 Å	25 – 40 µm	**711480.100**	**711480.1000**
POLYGOPREP 60-50 C_{18}	no*	12% C	60 Å	40 – 63 µm	**711500.100**	**711500.1000**
POLYGOPREP 60-80 C_{18}	no*	12% C	60 Å	63 – 100 µm	**711011.100**	**711011.1000**
POLYGOPREP 60-130 C_{18}	no*	12% C	60 Å	63 – 200 µm	**711590.100**	**711590.1000**
POLYGOPREP 100-12 C_{18}	no*	14% C	100 Å	10 – 15 µm	**711018.100**	**711018.1000**
POLYGOPREP 100-20 C_{18}	no*	14% C	100 Å	15 – 25 µm	**711019.100**	**711019.1000**
POLYGOPREP 100-30 C_{18}	no*	14% C	100 Å	25 – 40 µm	**711032.100**	**711032.1000**
POLYGOPREP 100-50 C_{18}	no*	14% C	100 Å	40 – 63 µm	**711021.100**	**711021.1000**
POLYGOPREP 300-12 C_{18}	yes	4% C	300 Å	10 – 15 µm	**711024.100**	**711024.1000**
POLYGOPREP 300-20 C_{18}	yes	4% C	300 Å	15 – 25 µm	**711025.100**	**711025.1000**
POLYGOPREP 300-30 C_{18}	yes	4% C	300 Å	25 – 40 µm	**711720.100**	**711720.1000**
POLYGOPREP 300-50 C_{18}	yes	4% C	300 Å	40 – 63 µm	**711730.100**	**711730.1000**
POLYGOPREP 1000-30 C_{18}	yes	~ 1% C	1000 Å	25 – 40 µm	**711028.100**	**711028.1000**
POLYGOPREP 1000-50 C_{18}	yes	~ 1% C	1000 Å	40 – 63 µm	**711029.100**	**711029.1000**
Octyl phases						$-(CH_2)_7-CH_3$
POLYGOPREP 60-12 C_8	no*	7% C	60 Å	10 – 15 µm	**711007.100**	**711007.1000**
POLYGOPREP 60-20 C_8	no*	7% C	60 Å	15 – 25 µm	**711008.100**	**711008.1000**
POLYGOPREP 60-30 C_8	no*	7% C	60 Å	25 – 40 µm	**711470.100**	**711470.1000**
POLYGOPREP 60-50 C_8	no*	7% C	60 Å	40 – 63 µm	**711490.100**	**711490.1000**
Butyl phases						$-(CH_2)_3-CH_3$
POLYGOPREP 300-12 C_4	yes	~ 1% C	300 Å	10 – 15 µm	**711022.100**	**711022.1000**
POLYGOPREP 300-20 C_4	yes	~ 1% C	300 Å	15 – 25 µm	**711023.100**	**711023.1000**
POLYGOPREP 300-30 C_4	yes	~ 1% C	300 Å	25 – 40 µm	**711690.100**	**711690.1000**
POLYGOPREP 300-50 C_4	yes	~ 1% C	300 Å	40 – 63 µm	**711700.100**	**711700.1000**
POLYGOPREP 1000-30 C_4	yes	< 1% C	1000 Å	25 – 40 µm	**711026.100**	**711026.1000**
POLYGOPREP 1000-50 C_4	yes	< 1% C	1000 Å	40 – 63 µm	**711027.100**	**711027.1000**

* On request, these POLYGOPREP RP phases can be endcapped at surcharge.

POLYGOPREP irregular silica for HPLC

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 100 g	Pack of 1 kg
Cyano phases (nitrile)						**$-(CH_2)_3-CN$**
POLYGOPREP 60-12 CN		~ 4.5 % C	60 Å	10 – 15 µm	**711015.100**	**711015.1000**
POLYGOPREP 60-20 CN		~ 4.5 % C	60 Å	15 – 25 µm	**711016.100**	**711016.1000**
POLYGOPREP 60-30 CN		~ 4.5 % C	60 Å	25 – 40 µm	**711017.100**	**711017.1000**
Amino phases						**$-(CH_2)_3-NH_2$**
POLYGOPREP 60-12 NH_2		~ 3 % C	60 Å	10 – 15 µm	**711012.100**	**711012.1000**
POLYGOPREP 60-20 NH_2		~ 3 % C	60 Å	15 – 25 µm	**711013.100**	**711013.1000**
POLYGOPREP 60-30 NH_2		~ 3 % C	60 Å	25 – 40 µm	**711014.100**	**711014.1000**

Phase	Pore size	Particle size	Pack of 100 g	Pack of 1 kg	Pack of 5 kg
Unmodified POLYGOPREP silica					**SiOH**
POLYGOPREP 60-12	60 Å	10 – 15 µm		**711001.1000**	**711001.5000**
POLYGOPREP 60-20	60 Å	15 – 25 µm		**711240.1000**	**711240.5000**
POLYGOPREP 60-30	60 Å	25 – 40 µm		**711250.1000**	**711250.5000**
POLYGOPREP 60-50	60 Å	40 – 63 µm		**711260.1000**	**711260.5000**
POLYGOPREP 60-80	60 Å	63 – 100 µm		**711270.1000**	**711270.5000**
POLYGOPREP 60-130	60 Å	63 – 200 µm		**711037.1000**	**711037.5000**
POLYGOPREP 100-12	100 Å	10 – 15 µm		**711002.1000**	**711002.5000**
POLYGOPREP 100-20	100 Å	15 – 25 µm		**711003.1000**	**711003.5000**
POLYGOPREP 100-30	100 Å	25 – 40 µm		**711540.1000**	**711540.5000**
POLYGOPREP 100-50	100 Å	40 – 63 µm		**711550.1000**	**711550.5000**
POLYGOPREP 100-80	100 Å	63 – 100 µm		**711033.1000**	**711033.5000**
POLYGOPREP 100-130	100 Å	63 – 200 µm		**711034.1000**	**711034.5000**
POLYGOPREP 300-12	300 Å	10 – 15 µm	**711004.100**	**711004.1000**	
POLYGOPREP 300-20	300 Å	15 – 25 µm	**711610.100**	**711610.1000**	
POLYGOPREP 300-30	300 Å	25 – 40 µm	**711620.100**	**711620.1000**	
POLYGOPREP 300-50	300 Å	40 – 63 µm	**711630.100**	**711630.1000**	
POLYGOPREP 1000-12	1000 Å	10 – 15 µm	**711035.100**	**711035.1000**	
POLYGOPREP 1000-20	1000 Å	15 – 25 µm	**711036.100**	**711036.1000**	
POLYGOPREP 1000-30	1000 Å	25 – 40 µm	**711005.100**	**711005.1000**	
POLYGOPREP 1000-50	1000 Å	40 – 63 µm	**711006.100**	**711006.1000**	

Silica adsorbents for low pressure column chromatography

- silica 60, pore size ~ 60 Å; pore volume ~ 0.75 ml/g; spec. surface BET ~ 500 m^2/g
  highly porous, amorphous silicic acid in the form of hard, opalescent particles, prepared by precipitation of water glass with sulphuric acid
- For higher demands on the performance of column packings we recommend our high-purity irregular POLYGOPREP silicas (see previous page).
- silica FIA for the fluorescence indicator adsorption procedure for the determination of hydrocarbon groups in the testing of liquid fuels in accordance with DIN 51791 and ASTM D 1319-58T
- The FIA method determines saturated hydrocarbons, olefins and aromatic hydrocarbons of a sample chromatographically by adsorption and desorption in a column filled with FIA silica, in the presence of a fluorescent dye mixture.

Ordering information

Designation	Particle size	1 kg	5 kg	25 kg
Silica 60, 0.015 – 0.04 mm	–	**815650.1**	**815650.5**	**815650.25**
Silica 60, 0.025 – 0.04 mm	–	**815300.1**	**815300.5**	**815300.25**
Silica 60, 0.04 – 0.063 mm	230 – 400 mesh	**815380.1**	**815380.5**	**815380.25**
Silica 60 M, 0.04 – 0.063 mm	230 – 400 mesh	**815381.1**	**815381.5**	**815381.25**
Silica 60, 0.05 – 0.1 mm	130 – 270 mesh	**815390.1**	**815390.5**	**815390.25**
Silica 60, 0.05 – 0.2 mm	70 – 270 mesh	**815320.1**	**815320.5**	**815320.25**
Silica 60, 0.063 – 0.2 mm	70 – 230 mesh	**815330.1**	**815330.5**	**815330.25**
Silica 60, < 0.063 mm	+230 mesh	**815400.1**	**815400.5**	**815400.25**
Silica 60, < 0.08 mm	+190 mesh	**815310.1**	**815310.5**	**815310.25**
Silica 60, 0.1 – 0.2 mm	70 – 130 mesh	**815340.1**	**815340.5**	
Silica 60, 0.2 – 0.5 mm	35 – 70 mesh	**815350.1**	**815350.5**	**815350.25**
Silica 60, 0.5 – 1.0 mm	18 – 35 mesh	**815360.1**	**815360.5**	**815360.25**
Silica FIA fine	0.071 – 0.16 mm	**815410.1**		
Silica FIA coarse	0.071 – 0.63 mm	**815430.1**		

Aluminium oxide

- aluminium oxides produced by dehydration of different aluminium hydroxides, e.g. hydrargillite between 400 and 500 °C
- activity grade I, particle size 50 – 200 µm, specific surface (BET) ~ 130 m^2/g

Ordering information

Type	pH	1 kg	5 kg	25 kg
Aluminium oxide 90 basic	pH 9.5 ± 0.3	**815010.1**	**815010.5**	**815010.25**
Aluminium oxide 90 neutral	pH 7 ± 0.5	**815020.1**	**815020.5**	**815020.25**
Aluminium oxide 90 acidic	pH 4 ± 0.3	**815030.1**	**815030.5**	**815030.25**

Kieselguhr

- naturally occurring amorphous silicic acids of fossil origin, also known as diatomaceous earth or diatomite purified for chromatographic applications
- compared to silica, kieselguhr has a small surface of low activity → application in partition chromatography; impregnated with various substances (paraffin, silicone oil, undecane) it can be used for reversed phase chromatography
- The following grades of kieselguhr are manufactured by Johns-Manville. They are narrowly classified with homogeneous particle size distributions and high purity.

For columns packed with kieselguhr please see CHROMABOND® XTR for liquid-liquid extraction, page 54.

Ordering information

Designation	rel. purification factor	rel. flow rate	1 kg	5 kg
Filter-Cel	100	100	**815510.1**	**815510.5**
Standard Super-Cel	85	213	**815520.1**	**815520.5**
Hyflo Super-Cel	58	534	**815530.1**	**815530.5**
Celite 503	42	910	**815540.1**	**815540.5**
Celite 535	35	1269	**815550.1**	**815550.5**
Celite 545	32	1830	**815560.1**	**815560.5**

Adsorbents for column chromatography

Florisil®

- hard granular magnesia silica gel: MgO 15.5 ± 0.5 % · SiO_2 84.0 ± 0.5 % · Na_2SO_4 ≤ 1.0 %; 60/100 mesh
  typical applications: sample preparation (see chapter "Solid phase extraction", page 32); clean-up of pesticide residues, separation of chlorinated pesticides, extraction of steroids, sex hormones, antibiotics, lipids etc.

Ordering information

Designation	Particle size	1 kg	5 kg
Florisil standard 60/100 mesh	0.15/0.25 mm	**815710.1**	**815710.5**

Polyamide

- polyamide 6 = ε-aminopolycaprolactam
  separation mechanism mainly based on hydrogen bonds
  recommended application: separation of phenolic compounds (e.g. isolation of natural products), carboxylic acids, aromatic nitro compounds

For SPE columns packed with polyamide see CHROMABOND® PA page 32.

Ordering information

Designation	Particle size	1 kg	5 kg
Polyamide CC 6, < 0.07 mm	< 0.07 mm	**815610.1**	
Polyamide CC 6, 0.05 – 0.16 mm	0.05 – 0.16 mm	**815620.1**	**815620.5**
Polyamide CC 6, 0.10 – 0.30 mm	0.10 – 0.30 mm	**815600.1**	**815600.5**

Unmodified cellulose

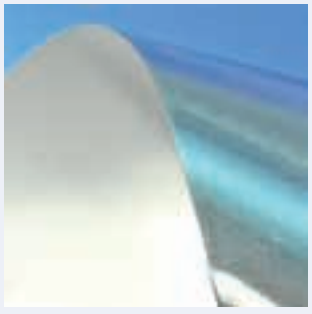
- **cellulose MN 100:** native fibrous cellulose, standard grade
  average degree of polymerisation 620 – 680, fibre length (85 %) 20 – 100 µm,
  specific surface acc. to Blaine ~ 6500 cm^2/g
  residue on ignition at 850 °C < 10000 ppm, < 20 ppm Fe, < 5 ppm Cu, < 7 ppm P, CH_2Cl_2 extract < 0.20 %
- **cellulose MN 2100:** native fibrous cellulose, purified grade (washed with different eluents)
  average degree of polymerisation 620 – 680, fibre length (85 %) 20 – 75 µm,
  specific surface acc. to Blaine ~ 5500 cm^2/g
  residue on ignition at 850 °C < 1000 ppm, < 2 ppm Fe, < 1 ppm Cu, < 2 ppm P, CH_2Cl_2 extract < 0.15 %
  grade MN 2100ff is a defatted cellulose MN 2100 with a CH_2Cl_2 extract < 0.02 %

Ordering information

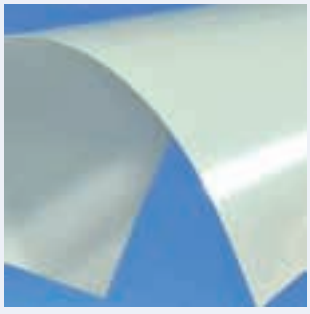
Designation	1 kg	5 kg	25 kg
Cellulose MN 100	**815050.1**	**815050.5**	**815050.25**
Cellulose MN 2100	**815060.1**	**815060.5**	**815060.25**
Cellulose MN 2100ff (cellulose MN 2100 defatted)	**815070.1**		

TLC · Contents

glass plates



ALUGRAM® aluminium sheets



POLYGRAM® polyester sheets

Basic principles of TLC

Thin layer chromatography (TLC) and high performance thin layer chromatography (HPTLC), also called planar chromatography, are, like all chromatographic techniques, based on a multistage distribution process involving

- a suitable adsorbent (the stationary phase) coated as a thin layer onto a suitable support (e.g. glass plate, polyester or aluminium sheet)
- solvents or solvent mixtures (the mobile phase or eluent)
- the sample molecules

The principle of TLC is known for more than 100 years [M. W. Beyerinck, Z. Phys. Chem. **3** (1889) 110]. The real break-through as an analytical method, however, came about 50 years ago as a consequence of the pioneering work of Egon Stahl [Thin layer chromatography, 2nd edition, Springer-Verlag Berlin, Reprint 1988].

Today TLC has gained increasing importance as an analytical separation technique, which is probably due to effects of instrumentalisation and automatisation [H. Jork, Laborpraxis 2 (1992) 110]. At the same time the applicability of thin layer chromatography was enhanced by the development of new adsorbents and supports.

Today MACHEREY-NAGEL offers a versatile range of ready-to-use layers, which are the result of 45 years of continuous research and development.

Features of modern TLC/HPTLC

The success of thin layer chromatography as a highly efficient microanalytical separation method is based on a large number of advantageous properties:

- high sample throughput in a short time
- suitable for screening tests
- pilot procedure for HPLC and flash chromatography
- after separation the analytical information can be stored for a longer period of time (the TLC ready-to-use layer acts as storage medium for data)
- separated substances can be subjected to subsequent analytical procedures (e.g. IR, MS) at a later date
- rapid and cost-efficient optimisation of the separation due to easy change of mobile and stationary phase

For a better understanding of a thin layer chromatographic separation we describe here the basic steps:

- sample preparation
- sample application
- development of a chromatogram, separation techniques
- evaluation in TLC – visualisation of separated substances, qualitative and quantitative determinations

Principle steps of a thin layer chromatographic separation

Sample preparation

For separation the sample must meet several requirements to obtain good results. Since the TLC plate is a disposable product, sample preparation in general is not as demanding as for the other chromatographic methods. However, eventually several steps for sample pretreatment may be necessary. These include sampling, mechanical crushing of a sample, extraction steps, filtration and sometimes enrichment of interesting components or clean-up, i.e. removal of undesired impurities.

Our TLC micro-sets introduce some simple methods of sample pretreatment. The dyes or dye mixtures of the beginner's set do not require complicated procedures. The advanced sets require the user to carry out some additional steps for preparing a sample, thus introducing the user to techniques often performed in industrial laboratories.

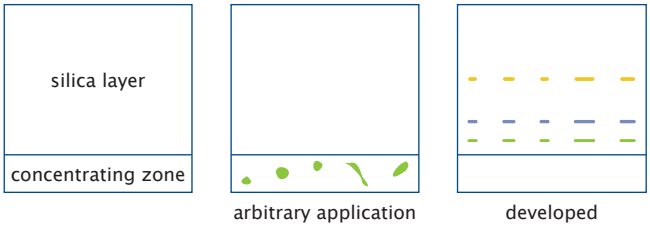
Thorough preparation of samples is an important prerequisite for the success of a TLC separation. For our range of products for more demanding sample pretreatment please see the chapter "SPE" from page 2.

Sample application

The aim of a chromatographic separation determines how the sample should be applied to the TLC plate or sheet. The most frequent technique is application with a glass capillary as spot or short streak.

Application as streak will yield better results especially for instrumental quantification. For both types of application some manual skill is required to obtain reproducible results. Substance zones which are too large from the beginning will cause poor separation since during chromatography they will become even larger and more diffuse.

A valuable aid for manual application especially of large volumes of very dilute samples is the concentrating zone (e.g. SILGUR-25 UV_{254}), which consists of a chromatographically inactive adsorbent (kieselguhr). The substances to be separated are concentrated to a small band in the concentrating zone and the separation starts at the beginning of the chromatographically active adsorbent silica.



Another method for sample concentration is a short pre-elution (few mm) with a solvent, in which all substances have a high R_f value.

If a quantitative evaluation with a TLC scanner is to follow the separation we recommend to use commercially available sample applicators for spotting. These range from simple spotting guides via nanoapplicators to completely automated spotting devices. Application as streak can be performed automatically by spraying of the sample without touching the layer of the TLC plate. Application as band over the whole width of the TLC plate is especially important for preparative TLC.

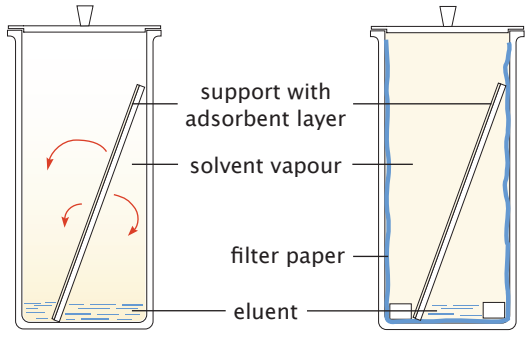
After application allow the solvent of the samples to evaporate completely (about 10 minutes) or blow with cold or hot air. Development of a chromatogram should never start before the solvent of the applied samples is evaporated completely.

Developing a chromatogram – separation techniques

The most frequently used separation technique is ascending TLC in a trough chamber (standard method, linear development). Usually it is applied as single development. However, multiple development, with or without change of eluent (step technique) can improve separation results. For 2-dimensional development only 1 spot of the sample is applied in one edge of a plate. After chromatography in the first direction the plate is dried, turned by 90° and developed in the 2nd dimension with another eluent. Thus complicated mixtures give 2-dimensional chromatograms taking advantage of the different separating properties of two eluents.

For selection and optimisation of the eluent numerous publications are available. A generally applicable standardised optimisation method is described by H. Keuker et al. [in "Proceedings of the International Symposium on Instrumental TLC", Brighton, Sussex, UK 1989, 105 – 114]

It is important to pay attention to the atmosphere in the developing chamber. If reproducible migration distances are required, saturation of the chamber atmosphere with eluent vapour is necessary. For this purpose the developing chamber is lined with well absorbing chromatography paper (e.g. MN 260) and charged with a correspondingly larger volume of eluent.



A) normal saturation, arrows show evaporation of eluent from the layer

B) chamber lined with filter paper, saturated with eluent vapour

Another interesting technique is the PMD technique (Programmed Multiple Development) [K. Burger, Fresenius Z. Anal. Chem. **318** (1984) 228 – 233], which is a true gradient development on silica for TLC. Contrary to the common multiple development every single run is slightly longer than the previous one. Thus broadening of substance zones during chromatography is easily compensated for. Usually, about 10 to 25 development cycles are run, generally with a universal gradient. Since this technique can be automated, you can also find the name AMD (Automated Multiple Development) [K. Burger, Pflanzenschutz-Nachrichten Bayer 41,2 (1988) 173] (also see our nano plates with extremely thin silica layer, page 192).

It should be noted, that the considerable increase in performance with these techniques also requires a considerable increase in instrumental expense.

Evaluation of a thin layer chromatogram

Evaluation depends on the purpose of the chromatographic analysis. For qualitative determination often localisation of substances is sufficient. This can be easily achieved by parallel runs with reference substances.

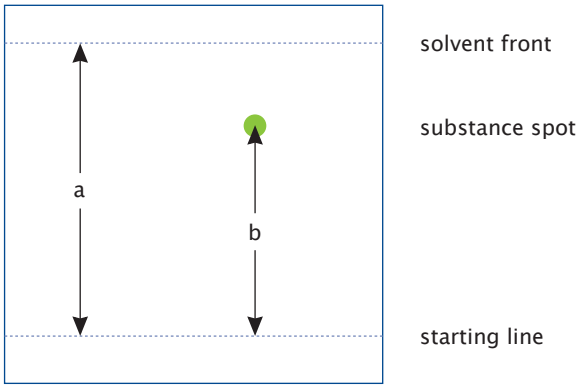
A parameter often used for qualitative evaluation is the R_f value (retention factor) or the 100fold value hR_f. The R_f value is defined as follows:

$$R_f = \frac{\text{distance starting line – middle of spot}}{\text{distance starting line – solvent front}} = \frac{b}{a}$$

i.e. the R_f values are between 0 and 1, best between 0.1 and 0.8 (i.e. 10 – 80 for hR_f). If reproducible R_f values are to be obtained, it is essential that several parameters such as chamber saturation, composition of solvent mixtures, temperature etc. are strictly controlled.

Quantitative evaluation is possible by suitable calibration measurements. For this purpose either the area of a substance spot is measured or a photometric evaluation is performed directly on the layer. The latter procedure, however, requires a higher instrumental expense.

The following paragraphs describe the most frequently used methods for evaluation in TLC.



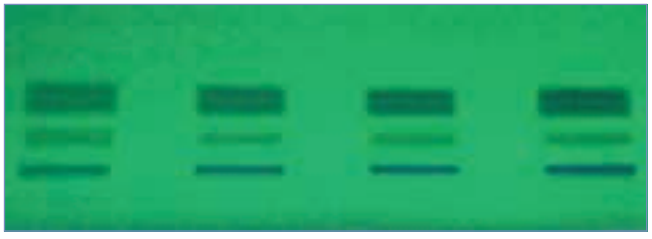
Basic principles of TLC

Qualitative detection

Qualitative evaluation is generally made directly on the TLC plate via the characteristic R_f values of substances, i.e. the ratio of distance start – substance zone to distance start – solvent front and specific chemical reactions.

Visualisation of separated substances

First of all it is necessary to recognise the position of a substance spot. Only in very few cases the sample is a dye which can be seen with the naked eye. Much more often for unspecific visualisation substances can be viewed under UV light, since many substances show a UV absorption. If a fluorescent indicator is added to the layer, all substances absorbing in the respective region of wave length cause a quenching of the fluorescence, i.e. they appear as dark spots on the fluorescent layer. Customary fluorescent indicators are excited at 254 nm or (less frequently) at 366 nm with a mercury lamp. For our programme of fluorescent indicators for TLC please see page 210.



Identification of separated substances is possible via the R_f value compared to the pure compound, which is often applied simultaneously on the same plate.

For a number of compounds their native fluorescence can be used for visualisation, which is excited by UV light (mostly long-wave UV) (e.g. aflatoxins). This allows not only determination of the R_f value, but often enables a further qualitative assignment.

If these methods do not allow localisation or characterisation of a substance, post-chromatographic detection methods can be applied, chemical reactions on the TLC plate [H. Jork et al., Dünnschicht-Chromatographie, VCH Verlagsgesellschaft, 1989]. Quite unspecific reactions are iodine adsorption and the charring technique (spraying with sulphuric acid and heat treatment).

More reliable results are possible with specific reagents for spraying or dipping, which form coloured or fluorescent compounds with the substances to be detected. Depending on the sensitivity of these reactions they are not only used for group or substance specific characterisation (in addition to the R_f value) but also for quantification down to trace levels. As example take the ninhydrin reaction. Formation of a (usually red) zone with this detection method yields the information, that a certain group of substances, e.g. α-amino acids, are present. The R_f value allows further assignment to one or several single compounds.

For identification of a substance a combination of different detection methods can be useful. Thus almost all lipids can be converted to products with light green fluorescence by reaction with 2',7'-dichlorofluorescein. Adsorption of iodine vapour enables a differentiation between saturated and unsaturated lipids or lipids containing nitrogen. And finally the R_f value is a third means of identification.

Here are some general remarks concerning spraying: use all spray reagents under a fume hood. The developed, dried TLC plate or sheet is placed on a sheet of filter paper for spraying. Usually it is sufficient to fill the sprayer with about 5 – 10 ml solution. Spray from a distance of about 15 cm with the aid of a rubber ball or – if available – with pressurised air. It is always better to spray a layer twice very thinly and evenly (with intermediate drying), than to saturate the layer with excessive spray reagent. In the latter case spots tend to become diffuse. After visualisation mark outlines of zones with a lead pencil, because some spots tend to fade after a while.

Especially for quantitative evaluation short dipping of the layer in the respective reagent solution is recommended. For this purpose automatic instruments are commercially available, which allow reproducible dipping.

When a substance is localised on the TLC plate (e.g. in the UV), but not yet identified, TLC scanners allow recording of UV spectra of individual substance zones directly on the layer, or the zone is removed by scratching or cutting (for sheets), eluted and further analysed, e.g. by FT-IR, RAMAN, NMR or mass spectroscopy.

Quantitative evaluation

Often TLC is considered to be only a semiquantitative analytical procedure. This is true for visual evaluation of spots, since the eye can only compare but not measure absolute values. If, however, a direct optical evaluation („in situ" measurement) is performed on the TLC plate with a thin layer scanner, after measurement of calibration functions exact quantitative results are possible. Commercial scanners offer many features such as evaluation in absorption and fluorescence, unattended programmed scanning of lanes, multi-wave length measurement, background correction, selectable base line for integration, recording of spectra, evaluation of circular or anti-circular chromatograms with very high ease of operation. In addition to manual operation control by a computer is possible with respective data collection and storage. Usually wavelengths from 200 to 700 nm are available (visible and UV), e.g. all post-chromatographic (and of course all pre-chromatographic) visualisation procedures are evaluated with the proper wavelength, which is determined with the instrument. Time requirements for all these possibilities are extremely low. Interlaboratory experiments with standard deviations of 2 % show how excellent results are obtainable [Planar Chromatography, Vol. 1, ed. R. E. Kaiser, Dr. Alfred Hüthig Verlag, Heidelberg, 1986].

Overview of MN ready-to-use layers for TLC

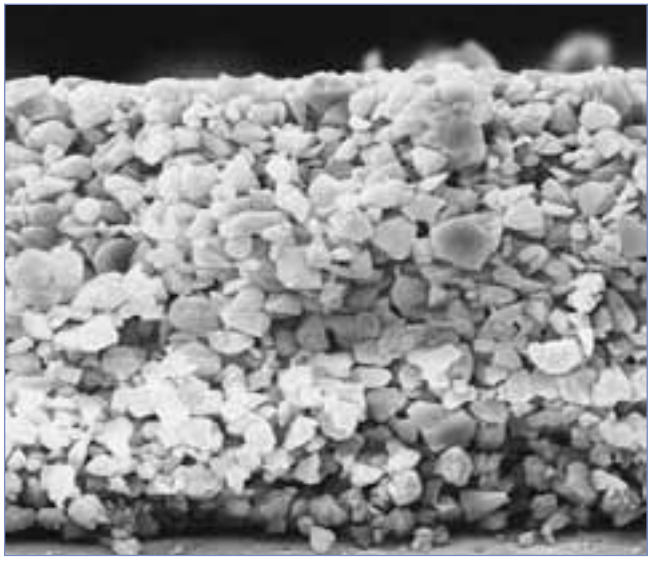
Advantages of MN plates and sheets for TLC

- **continuous high quality**
  guaranteed by stringent production control including standardised lot tests, surface checks for roughness or cracks as well as hardness and adherence checks
- **comprehensive range of phases for TLC / HPTLC**
  there is no universal TLC plate which meets all possible types of analyses. Our versatile range of TLC ready-to-use layers covers many different types of applications.
- **immediately ready for chromatographic separation**
  coatings or impregnations are not necessary
- **homogeneous, smooth, well adhering layers**
  an important criterion especially for reproducible quantitative evaluation

Adsorbents for MN plates and sheets for TLC

- **classical adsorbents**
  for ~ 80 % of all TLC separations silica 60 (mean pore diameter 60 Å = 6 nm) is used. Other classical adsorbents are aluminium oxide, cellulose, kieselguhr, ion exchangers and polyamide.
- **special phases**
  reversed phases, mainly C18 (octadecyl) modified silica, but also cyano-, amino-, diol and RP-2 modified silica are available. Special layers for specific separations, like our CHIRALPLATE for enantiomer separation complete the versatile range of TLC plates.
- **particle size distribution** and **thickness of layer** are chosen to fit the given type of application (e.g. HPTLC, standard or preparative separations)
- most MN ready-to-use layers are available with or without fluorescent indicator

Electron microscope photograph of a cross section through a glass plate with silica layer (magnification x 500)



Electron microscope photograph of a cross section through an aluminium sheet with silica layer (magnification x 500)

Supports for ready to use layers for TLC

	glass plates	POLYGRAM®	ALUGRAM®
Physical properties of support materials			
Material	glass	polyester	aluminium
Thickness (approx.)	1.3 mm	0.2 mm	0.15 mm
Weight, packaging and storage requirements	high	low	low
Torsional strength	ideal	low	relatively high
Temperature stability	high	max. 185 °C	high
Susceptible to breakage	yes	no	no
Can be cut with scissors	no	yes	yes
Chemical resistance of support materials			
against solvents	high	high	high
against mineral acids and conc. ammonia	high	high	low
Stability of the binder system of NP plates in water			
suitability for aqueous detection reagents	depends on the phase	very suitable	limited suitability

Summary of MN ready-to-use layers for TLC

Phase	Layer	Page
Standard silica		
ADAMANT	silica 60, improved binder system, optimized particle size distribution	187
SIL G	silica 60, standard grade, particle size 5 – 17 µm	188
DURASIL	silica 60, special binder system	189
SIL N-HR	high purity silica 60, special binder system, higher gypsum content	190
SILGUR	silica 60 with kieselguhr concentrating zone	190
Unmodified silica for HPTLC		
Nano-SILGUR	nano silica 60, with kieselguhr concentrating zone	190
Nano-ADAMANT	nano silica 60, optimised binder system and particle size distribution	191
Nano-SIL	nano silica 60, standard grade, particle size 2 – 10 µm	192
Nano-DURASIL	nano silica 60, special binder system	192
AMD SIL	nano silica 60, extremely thin layer for AMD procedure	192
Modified silica for HPTLC		
Nano-SIL C18-50/C18-100	nano silica with partial or complete C18 modification	193
RP-18 W/UV_{254}	nano silica with partial octadecyl modification, wettable with water	194
RP-2/UV_{254}	silanised silica = dimethyl-modified silica 60	194
Nano-SIL CN	cyano-modified nano silica	195
Nano-SIL NH_2	amino-modified nano silica	196
Nano-SIL DIOL	diol-modified nano silica	197
Aluminium oxide		
ALOX-25 / ALOX N	aluminium oxide	198
Cellulose, unmodified and modified		
CEL 300	native fibrous cellulose MN 300	199
CEL 400	microcrystalline cellulose MN 400 (AVICEL®)	199
CEL 300 DEAE	diethylaminoethyl-modified cellulose ion exchanger	200
CEL 300 DEAE/HR	mixed layer of cellulose ion exchanger and high purity cellulose	200
CEL 300 PEI	polyethyleneimine-impregnated cellulose ion exchanger	200
CEL 300 AC	acetylated cellulose MN 300	200
Layers for special separations		
POLYAMIDE-6	perlon = ε-aminopolycaprolactame	201
CHIRALPLATE	RP silica with Cu^{2+} ions and chiral reagent, for enantiomer separation	201
SIL G-25 HR	high purity silica 60 with gypsum, recommended for aflatoxin analysis	202
SIL G-25 Tenside	silica G with ammonium sulphate for separation of surfactants	202
GUR N	kieselguhr	202
Nano-SIL PAH	nano silica with special impregnation for PAH analysis	203
IONEX-25 SA-Na	mixed layer of strongly acidic cation exchanger and silica	203
IONEX-25 SB-AC	mixed layer of strongly basic anion exchanger and silica	203
ALOX/CEL-AC-Mix	mixed layer of aluminium oxide and acetylated cellulose	203
SILCEL-Mix	mixed layer of cellulose and silica	203
GURSIL-Mix	mixed layer of kieselguhr and silica	203

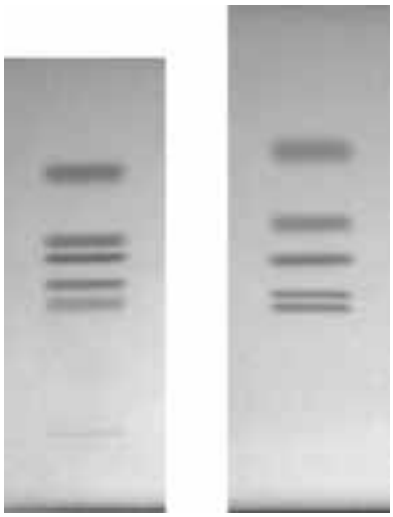
ADAMANT

unmodified standard silica layers

- silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm
- **outstanding hardness** and **abrasion resistance** due to an optimized binder system
- **increased separation efficiency** due to an optimized particle size distribution
- **high suitability for trace analyses** resulting from a UV indicator with increased brilliance and a low-noise background of the layer

Separation of steroids

Layers: ADAMANT UV_{254}, SIL G/UV_{254}
Eluent: chloroform – methanol (97:3)
Developing time: 10 minutes
0.1 % solution in $CHCl_3$



ADAMANT UV $_{254}$ SIL G/UV_{254}

R_f	ADAMANT	SIL G
Cortisone	0.37	0.27
Corticosterone	0.43	0.30
Testosterone	0.50	0.39
Deoxycorticosterone	0.55	0.46
Progesterone	0.73	0.62
Migration distance	5.0 cm	5.7 cm

MN Appl. No. 402930

Separation of barbiturates

Layer: ADAMANT UV254
Eluent: chloroform – acetone (95:5, v/v)
Migration distance: 73 mm in 20 minutes
Sample volume: 1 µl

Substance	R_f
Thiamylal (0.5 %)	0.69
Thiopental (1.0 %)	0.65
Hexobarbital (5.0 %)	0.41
Pentobarbital (1.0 %)	0.26
Phenobarbital (1.0 %)	0.18

MN Appl. No. 402950

For more applications of ADAMANT ready-to-use layers, check our application database at *www.mn-net.com*

Ordering information

Plate size [cm]	2.5 x 7.5	5 x 10		5 x 20	10 x 10	10 x 20	20 x 20	Fluorescent indicator	Thickness of layer
Pack of [plates]	100	50	200	100	25	50	25		
Glass plates									
ADAMANT		**821040**	**821040.200**		**821050**		**821060**	–	0.25 mm
ADAMANT UV_{254}	**821005**	**821010**	**821010.200**	**821015**	**821020**	**821025**	**821030**	UV_{254}	0.25 mm

Standard silica layers for TLC

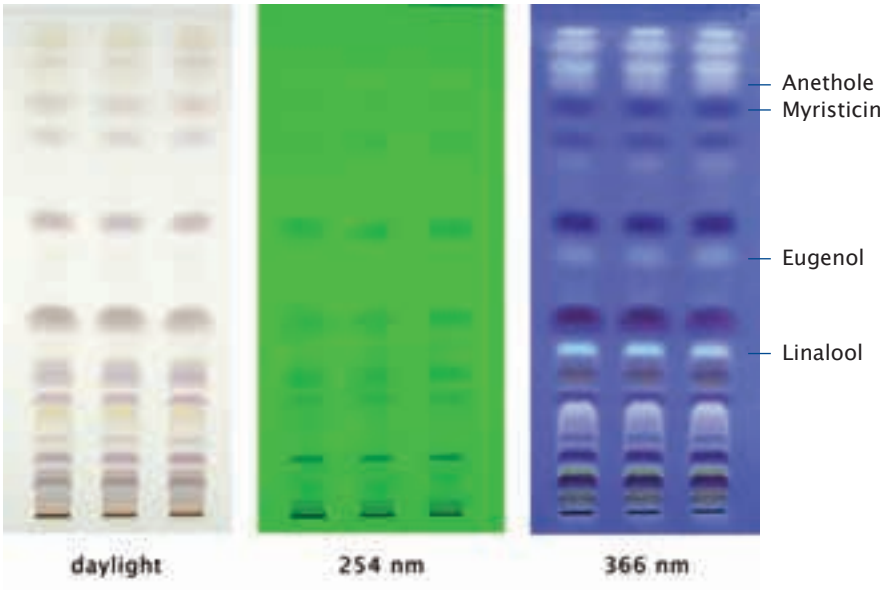
ALUGRAM® Xtra SIL G — unmodified standard silica layers on aluminium

- silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm; standard grade
- **outstanding wettability for precise colorization results,** even with 100 % aqueous eluents
- **excellent separation efficiency** and reproducibilty from lot to lot
- **easy and reliable cutting** due to an optimized binder system, no flaking of silica

NEW!

Binder: highly polymeric product, which is stable in almost all organic solvents and resistant towards aggressive visualisation reagents; also completely stable in purely aqueous eluents

Separation of nutmeg ingredients



Sample solution: shake 1.0 g freshly powdered drug for 3 min with 4 ml methanol and filter; apply 10 µl
Layer: ALUGRAM® Xtra SIL G UV $_{254}$
Eluent: toluene – ethyl acetate (95:5, v/v)
Migration distance: 15 cm
Detection: 254 nm: underivatised
daylight and 366 nm: spray with 5 % ethanolic sulphuric acid, 1 % vanillic acid and heat to 105 °C

The chromatograms show the following zones with increasing R_f values: linalool (bluish grey), eugenol (yellowish brown), myristicin (reddish brown), and anethole (pink-violet). Other coloured zones may appear.

MN Appl. No. 403590

Ordering information

Plate size [cm]	4 x 8	5 x 7.5	5 x 10	5 x 20	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	20	50	50	20	25		
ALUGRAM® Xtra aluminium sheets								
SIL G		**818230.20**	**818261**	**818232**		**818233**	0.20 mm	–
SIL G/UV_{254}	**818331**	**818330.20**	**818360**	**818332**	**818362**	**818333**	0.20 mm	UV_{254}

SIL G

unmodified standard silica layers

- silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm; standard grade
- thickness of layer for analytical plates 0.25 mm, for preparative plates 0.5 and 1 mm; for 2 mm preparative layers a slightly coarser material is used
- indicators: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm); special inorganic fluorescent pigment with blue fluorescence for long-wave UV (366 nm)
- binders: highly polymeric products, which are stable in almost all organic solvents and resistant towards aggressive visualisation reagents; binder system for POLYGRAM® sheets (as for ALUGRAM® Xtra sheets) is also completely stable in purely aqueous eluents

Ordering information

Glass plates

Plate size [cm]	2.5 x 7.5	5 x 10		5 x 20	10 x 10	10 x 20	20 x 20	40 x 20	Thickness
Pack of [plates]	100	50	200	100	25	50	25		of layer
SIL G-25		**809017**	**809017.200**	**809011**		**809012**	**809013**		0.25 mm
SIL G-25 UV_{254}	**809028.100**	**809027**	**809027.200**	**809021**	**809020**	**809022**	**809023**		0.25 mm
SIL G-25 $UV_{254+366}$				**809121**		**809122**	**809123**		0.25 mm
Pack of [plates]							20		
SIL G-50							**809051**		0.50 mm
SIL G-50 UV_{254}							**809053**		0.50 mm
Pack of [plates]							15		
SIL G-100							**809061**		1.00 mm
SIL G-100 UV_{254}							**809063**		1.00 mm
Pack of [plates]							12		
SIL G-200							**809073**		2.00 mm
SIL G-200 UV_{254}							**809083**		2.00 mm

POLYGRAM® polyester sheets

Plate size [cm]	2.5 x 7.5	4 x 8	5 x 20		20 x 20	40 x 20	
Pack of [plates]	200	50	50		25	25	
SIL G	**805902**	**805032**	**805012**		**805013**	**805014**	0.20 mm
SIL G/UV_{254}	**805901**	**805021**	**805022**		**805023**	**805024**	0.20 mm
SIL G/UV_{254}				Roll 500 x 20 cm		**805017**	0.20 mm

ALUGRAM® aluminium sheets

Plate size [cm]	2.5 x 7.5	4 x 8	5 x 7.5	5 x 10	5 x 20	10 x 20	20 x 20		
Pack of [plates]	200	50	20	50	50	20	25		
SIL G			**818030.20**	**818161**	**818032**	**818163**	**818033**		0.20 mm
SIL G/UV_{254}	**818129**	**818131**	**818130.20**	**818160**	**818132**	**818162**	**818133**		0.20 mm

DURASIL

unmodified standard silica layers

- silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm
- hard, water-resistant and wettable layers due to a special binder system
- no reversed phase tendency, more polar than SIL G

Ordering information

Plate size [cm]	5 x 10		5 x 20	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	200	100	50	25		
Glass plates							
DURASIL-25				**812003**	**812004**	0.25 mm	–
DURASIL-25 UV_{254}	**812005**	**812005.200**	**812006**	**812007**	**812008**	0.25 mm	UV_{254}

Silica layers with concentrating zone

SIL N-HR — unmodified standard silica layers

- **high purity** silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm
  different binder system compared to SIL G results in different separation characteristics
- a special feature of the POLYGRAM® SIL N-HR is a **higher gypsum content**

Ordering information

Plate size [cm] Pack of [plates]	5 x 20 50	20 x 20 25	Thickness of layer	Fluorescent indicator
POLYGRAM® polyester sheets				
SIL N-HR		**804013**	0.20 mm	–
SIL N-HR/UV_{254}	**804022**	**804023**	0.20 mm	UV_{254}

For plates SIL G-HR for aflatoxin separation please see page 202.

SILGUR — unmodified standard silica layers with concentrating zone

- silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm
- **kieselguhr zone for rapid sample application:** because kieselguhr is completely inert towards a large number of compounds, the samples always form a narrow band at the interface of the two adsorbents, irrespective of shape, size or position of the spots in the concentrating zone (see page 182). Separation then takes place in the silica layer.

Ordering information

Plate size [cm] Pack of [plates]	10 x 20 50	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates				
SILGUR-25	**810012**	**810013**	0.25 mm	–
SILGUR-25 UV_{254}	**810022**	**810023**	0.25 mm	UV_{254}

Nano-SILGUR — unmodified HPTLC silica layers with concentrating zone

- **nano** silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm**
- narrow fractionation of the silica particles allows sharper separations, shorter developing times, shorter migration distances, lower amount of samples and an increased detection sensitivity compared to standard silica
- with kieselguhr zone for rapid sample application (see SILGUR above)

Ordering information

Plate size [cm] Pack of [plates]	10 x 10 25	Thickness of layer	Fluorescent indicator
Glass plates			
Nano-SILGUR-20	**811032**	0.20 mm	–
Nano-SILGUR-20 UV_{254}	**811042**	0.20 mm	UV_{254}

Nano-ADAMANT

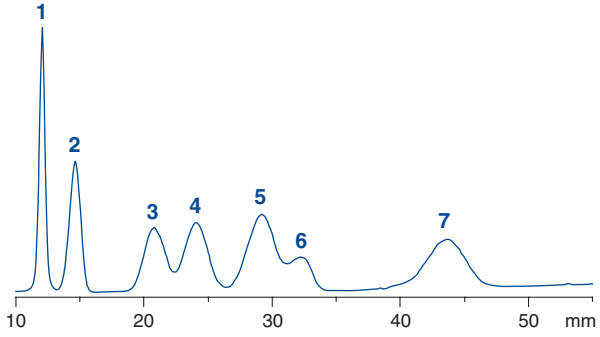
unmodified HPTLC silica layers

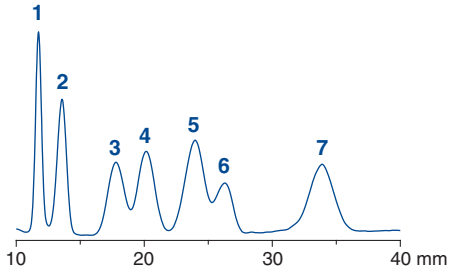
- nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0,75 ml/g, **particle size 2 – 10 µm**
- **outstanding hardness** and **abrasion resistance** due to an optimized binder system
- **increased separation efficiency** due to an optimized particle size distribution
- **high suitability for trace analyses** resulting from a UV indicator with increased brilliance and a low-noise background of the layer
- narrow fractionation of the silica particles allows theoretical plate heights, which are one order of magnitude smaller than on standard silica layers with the advantage of sharper separations, shorter developing times, shorter migration distances, lower amount of samples, and increased detection sensitivity with equal selectivity

Comparison of ADAMANT and Nano-ADAMANT plates for separation of anthraquinone dyes

Layers: A) ADAMANT, B) Nano-ADAMANT
Sample: 1 µl, about 0.1 %
Eluent: toluene – cyclohexane (4:3, v/v)
Migration time: A) 30 min, B) 15 min

Peaks:
1. Blue 3
2. Violet 2
3. Red
4. Green
5. Blue 1
6. Greenish blue
7. Violet 1





A

B

Ordering information

Plate size [cm] Pack of [plates[	5 x 5 100	10 x 10 25	10 x 20 50	Thickness of layer	Fluorescent indicator
Glass plates					
Nano-ADAMANT	**821130**	**821140**	**821150**	0.20 mm	–
Nano-ADAMANT UV_{254}	**821100**	**821110**	**821120**	0.20 mm	UV_{254}

Nano silica layers for HPTLC

Nano-SIL — unmodified HPTLC silica layers

- nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0,75 ml/g, **particle size 2 – 10 µm**
- indicator: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm)
- binder: highly polymeric product, which is stable in almost all organic solvents and resistant towards aggressive visualisation reagents
- narrow fractionation of the silica particles allows sharper separations, shorter developing times, shorter migration distances, smaller samples and an increased detection sensitivity compared to SIL G plates

Ordering information

Plate size [cm] / Pack of [plates]	5 x 5 / 100	5 x 20 / 50	10 x 10 / 25	10 x 20 / 50	20 x 20 / 25	Thickness of layer	Fluorescent indicator
Glass plates							
Nano-SIL-20	**811011**		**811012**	**811013**		0.20 mm	–
Nano-SIL-20 UV_{254}	**811021**		**811022**	**811023**		0.20 mm	UV_{254}
ALUGRAM® aluminium sheets							
Nano-SIL G		**818140**			**818141**	0.20 mm	–
Nano-SIL G/UV_{254}		**818142**			**818143**	0.20 mm	UV_{254}

Nano-DURASIL — unmodified HPTLC silica layers

- nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0,75 ml/g, **particle size 2 – 10 µm**
- indicator: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm)
- hard, water-resistant and wettable layers due to a special binder system
- narrow fractionation of the silica particles allows sharper separations, shorter developing times, shorter migration distances, smaller samples and an increased detection sensitivity compared to DURASIL plates
- different selectivity compared to ADAMANT and SIL-G plates
- no reversed phase tendency, more polar than Nano-SIL

Ordering information

Plate size [cm] / Pack of [plates]	5 x 5 / 100	10 x 10 / 25	10 x 20 / 50	Thickness of layer	Fluorescent indicator
Glass plates					
Nano-DURASIL-20		**812010**	**812011**	0.20 mm	–
Nano-DURASIL-20 UV_{254}	**812012**	**812013**	**812014**	0.20 mm	UV_{254}

AMD SIL — thin unmodified HPTLC silica layers

- nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0,75 ml/g, **particle size 2 – 10 µm**
- very thin nano silica layer for the AMD procedure (automated multiple development), which allows rapid and efficient simultaneous analyses of several active ingredients at ultra trace levels (see page 183)

Ordering information

Plate size [cm]	10 x 20	Pack of [plates]	Thickness of layer	Fluorescent indicator
Glass plates				
AMD SIL G-05 UV_{254}	**811101**	5	0.05 mm	UV_{254}
AMD SIL G-10 UV_{254}	**811103**	25	0.10 mm	UV_{254}

Nano-SIL C 18 — octadecyl-modified HPTLC silica layers

- base material: nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm,** pH stability 2 – 10
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- partial (50 %) or complete (100 %) octadecyl modification, carbon content 7.5 and 14 %, respectively
- order of polarity: silica > DIOL > NH_2 > CN > RP-2 > **C 18-50** > RP-18 W > **C 18-100**
- reversed phase separation mode with eluents from anhydrous solvents to mixtures with high concentrations of water (see table and figure below)
- recommended application: alkaloids, amino acids, preservatives, optical brighteners, barbiturates, polycyclic aromatic hydrocarbons (PAH), drugs, peptides, flavonoids, phenols, indole derivatives, steroids

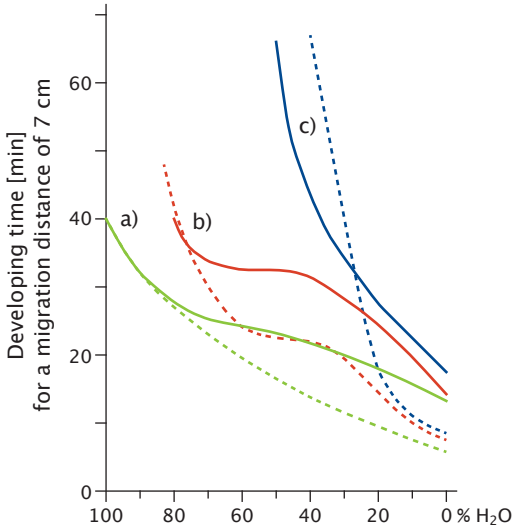
Ordering information

Plate size [cm] / Pack of [plates]		10 x 10 / 25	Thickness of layer	Fluorescent indicator
Glass plates				
Nano-SIL C 18-50	} 50 % silanised	**811054**	0.20 mm	–
Nano-SIL C 18-50 UV_{254}		**811064**	0.20 mm	UV_{254}
Nano-SIL C 18-100	} 100 % silanised	**811052**	0.20 mm	–
Nano-SIL C 18-100 UV_{254}		**811062**	0.20 mm	UV_{254}

Migration of C 18-50 and C 18-100 silica layers as compared to RP-18 W plates

Eluent	v/v	Migration distances [mm/15 min] C 18-50	C 18-100	RP-18 W
methanol/H_2O	2:1	57	45	44
	1:1	52	21	40
	1:2	50	0	43
	1:3	40	0	45
	1:4	30	0	46
	0:1	0	0	54
acetonitrile/H_2O	2:1	62	46	66
	1:1	52	30	54
	1:2	51	27	46
	1:3	48	15	44
	1:9	20	0	42
chloroform		68	64	71

Elution properties of MN RP plates in mixtures of methanol/water and acetonitrile/water



a) RP-18 W, b) Nano-SIL C 18-50, c) Nano-SIL C 18-100
all plates with UV indicator
methanol/water; acetonitrile/water

For numerous separations with MN RP plates please visit our application database at *www.mn-net.com*

Modified RP silica layers for TLC and HPTLC

RP-18 W/UV_{254} — octadecyl-modified HPTLC silica layers

- base material: nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm;** for preparative plates (1 mm thickness of layer) standard silica 60, particle size 5 – 17 µm
  pH stability 2 – 10
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- partial octadecyl (C_{18}) modification, wettable with water, carbon content 14 %
- order of polarity: silica > DIOL > NH_2 > CN > RP-2 > C 18-50 > **RP-18 W** > C 18-100
- normal phase or reversed phase separation modes with eluents from anhydrous solvents to mixtures with high concentrations of water (see table and figure on previous page); the relative polarity of the eluent determines the polarity of the layer
- recommended application: aminophenols, barbiturates, preservatives, nucleobases, polycyclic aromatic hydrocarbons, steroids, tetracyclines, plasticizers (phthalates)

Ordering information

Glass plates							
Plate size [cm]			5 x 20	10 x 10	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]			50	25	50	25		
RP-18 W/UV_{254}			**811073**	**811075**	**811072**	**811071**	0.25 mm	UV_{254}
Pack of [plates]						15		
RP-18 W/UV_{254}						**811074**	1.00 mm	UV_{254}
ALUGRAM® aluminium sheets								
Plate size [cm]	4 x 8	5 x 10	5 x 20	10 x 10		20 x 20		
Pack of [plates]	50	50	50	25		25		
RP-18 W/UV_{254}	**818144**	**818152**	**818145**	**818147**		**818146**	0.15 mm	UV_{254}

RP-2/UV_{254} — "silanised silica" = dimethyl-modified standard silica layers

- base material: silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm, pH stability 2 – 10
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- silanised silica with dimethyl modification, carbon content 4 %
- order of polarity: silica > DIOL > NH_2 > CN > **RP-2** > C 18-50 > RP-18 W > C 18-100
- normal phase or reversed phase separation modes with purely organic, organic – aqueous or purely aqueous eluents
- recommended application: active plant constituents, steroids

Ordering information

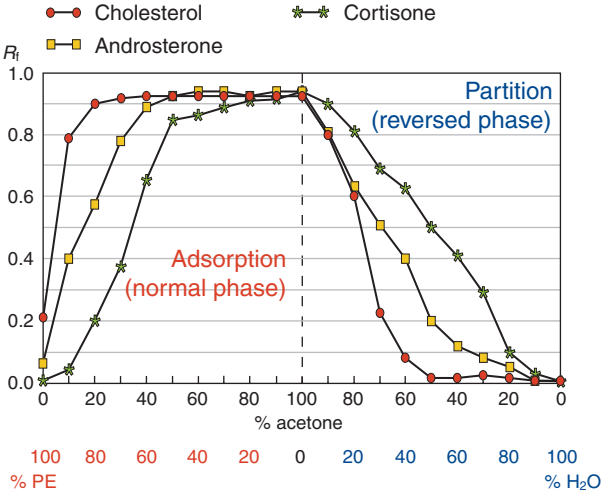
Plate size [cm]	4 x 8	10 x 10	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	25	50	25		
Glass plates						
RP-2/UV_{254}		**811080**	**811081**	**811082**	0.25 mm	UV_{254}
ALUGRAM® aluminium sheets						
RP-2/UV_{254}	**818170**			**818171**	0.15 mm	UV_{254}

Nano-SIL CN

cyano-modified HPTLC silica layers

- base material: nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm,** pH stability 2 – 8
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- cyanopropyl modification, carbon content 5.5 %
- order of polarity: silica > DIOL > NH_2 > **CN** > RP-2 > C 18-50 > RP-18 W > C 18-100
- available as glass plates or ALUGRAM® aluminium sheets
- normal phase or reversed phase separation modes depending on the polarity of the developing solvent (see figure below)
- recommended application: steroid hormones, phenols, preservatives

R_f values of different steroids as a function of eluent composition



Layer: Nano-SIL CN/UV

Polarity of the eluent governs the type of separation mechanism:

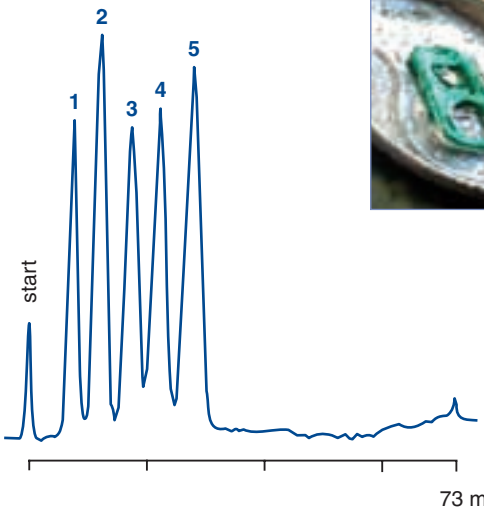
eluent system petroleum ether (PE) – acetone (NP mode)
the higher the concentration of PE, the stronger are the adsorptive interactions of the steroids with the stationary phase

eluent system acetone – water (RP mode)
the sequence of elution of the steroids is reversed, the most nonpolar compounds are most strongly retained

Separation of preservatives

Layer: Nano-SIL CN/UV
Sample volume: 400 nl
Eluent: ethanol – water – glacial acetic acid 20:80:0.2 with 0.1 mol/l tetraethylammonium chloride
Migration distance: 7.3 cm in 30 min
Detection: TLC scanner, UV 254 nm

Peaks:
1. Propyl *p*-hydroxybenzoate
2. Ethyl *p*-hydroxybenzoate
3. Methyl *p*-hydroxybenzoate
4. Benzoic acid
5. Sorbic acid



MN Appl. No. 401440

Ordering information

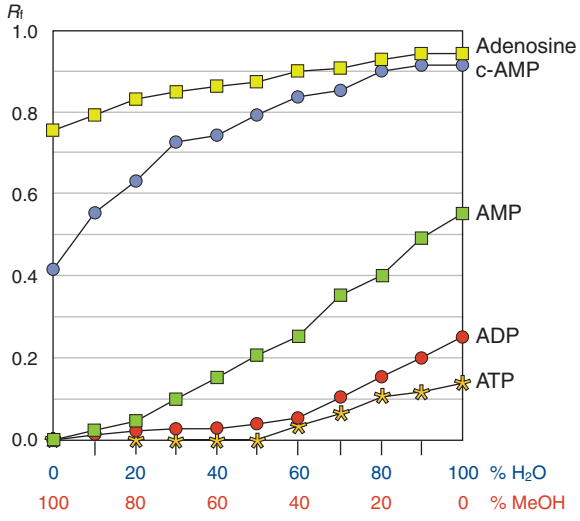
Plate size [cm] Pack of [plates]	4 x 8 50	10 x 10 25	10 x 20 25	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates						
Nano-SIL CN/UV		**811115**	**811116**		0.20 mm	UV_{254}
ALUGRAM® aluminium sheets						
Nano-SIL CN/UV	**818184**			**818185**	0.15 mm	UV_{254}

Modified silica layers for HPTLC

Nano-SIL NH_2 — amino-modified HPTLC silica layers

- base material: nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm,** pH stability 2 – 8
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- aminopropyl modification, carbon content 3.5 %
- order of polarity: silica > DIOL > **NH_2** > CN > RP-2 > C 18-50 > RP-18 W > C 18-100
- available with or without fluorescent indicator, as glass plates or ALUGRAM® aluminium sheets
- layer can be wetted equally well by pure water as by organic solvents
- recommended application: vitamins, sugars, steroids, purine derivatives, xanthines, phenols, nucleotides and pesticides

Influence of eluent composition on the separation of nucleotides

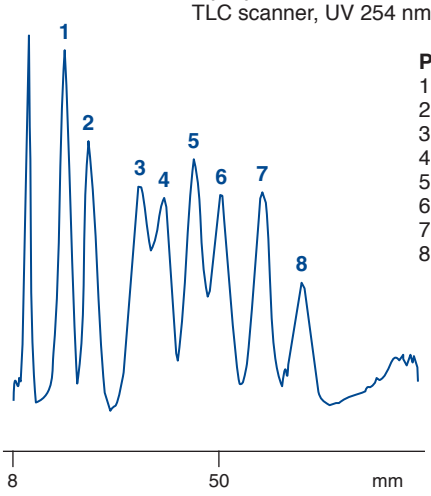


Layer: Nano-SIL NH_2/UV
Eluent: MeOH – H_2O according to fig. + 0.18 M NaCl
Migration distance: 7 cm

c-AMP, AMP: adenosine monophosphate
ADP: adenosine diphosphate
ATP: adenosine triphosphate

Separation of sugars

Layer: Nano-SIL NH_2/UV
Eluent: ethyl acetate – pyridine – water – glacial acetic acid (60:30:10:5, v/v/v/v)
Migration distance: 8 cm in 45 min, double development
Sample volume: 500 nl
Detection: dry layer at 160 °C for 5 min, TLC scanner, UV 254 nm



Peaks (0.1 % each):
1. Lactose
2. Saccharose
3. Galactose
4. Glucose
5. Fructose
6. Arabinose
7. Xylose
8. Ribose

MN Appl. No. 401590

Ordering information

Plate size [cm] / Pack of [plates]	4 x 8 / 50	10 x 10 / 25	10 x 20 / 25	20 x 20 / 25	Thickness of layer	Fluorescent indicator
Glass plates						
Nano-SIL NH_2		**811109**			0.20 mm	–
Nano-SIL NH_2/UV		**811111**	**811112**		0.20 mm	UV_{254}
ALUGRAM® aluminium sheets						
Nano-SIL NH_2/UV	**818182**			**818183**	0.15 mm	UV_{254}

Nano-SIL DIOL

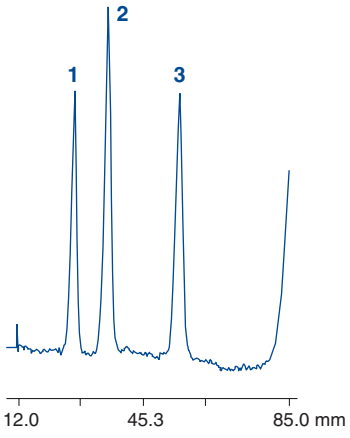
diol-modified HPTLC silica layers

- base material: nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm,** pH stability 2 – 8
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- diol modification, carbon content 5.5 %
- order of polarity: silica > **DIOL** > NH_2 > CN > RP-2 > C 18-50 > RP-18 W > C 18-100
- available as glass plates or ALUGRAM® aluminium sheets
- layer can be wetted equally well by pure water as by organic solvents
- recommended application: steroids, pesticides and plant constituents; for critical separations an alternative to silica, since it is less sensitive to the water content of the environment; leads to more reproducible results compared to silica

Separation of herbicides

Layer: Nano-SIL DIOL/UV
Sampe volume: 2 µl
Eluent: petroleum ether (40-60 °C) – acetone (80 + 20, v/v)
Migration distance: 7 cm
Detection: TLC scanner, 238 nm

Peaks:
(0.07 % each in MeOH)
1. Metoxuron
2. Monuron
3. Metobromuron



MN Appl. No. 402340

Ordering information

Plate size [cm] Pack of [plates]	4 x 8 50	10 x 10 25	10 x 20 25	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates						
Nano-SIL DIOL/UV		**811120**	**811121**		0.20 mm	UV_{254}
ALUGRAM® aluminium sheets						
Nano-SIL DIOL/UV	**818180**			**818181**	0.15 mm	UV_{254}

HPTLC method development kits

for selection of the optimum HPTLC plate for a given separation — REF

- **Glass plates:** **811001**
  3 plates 10 x 10 cm (scored to 5 x 10 cm) each of Nano-SIL C18-100/UV_{254}, RP-18 W/UV_{254}, RP-2/UV_{254}, Nano-SIL CN/UV, Nano-SIL NH_2/UV, Nano-SIL DIOL/UV
- **ALUGRAM® aluminium sheets:** **818001**
  5 sheets 4 x 8 cm each of RP-18 W/UV_{254}, RP-2/UV_{254}, Nano-SIL CN/UV, Nano-SIL NH_2/UV, Nano-SIL DIOL/UV

Aluminium oxide layers for TLC

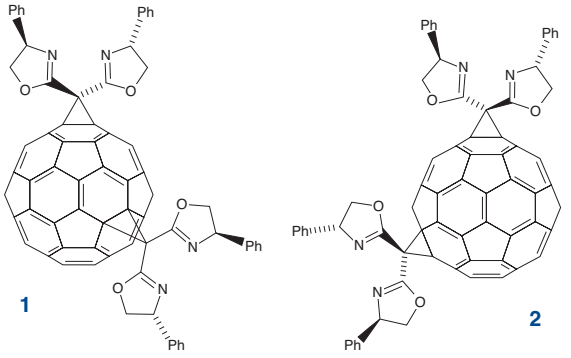
ALOX — aluminium oxide layers for TLC

- aluminium oxide, specific surface (BET) ~ 200 m^2/g, mean pore size 60 Å; inert organic binder
  indicator manganese-activated zinc silicate
  recommended application: terpenes, alkaloids, steroids, aliphatic and aromatic compounds
  We recommend to activate aluminium oxide layers before use by heating 10 minutes at 120 °C.

Separation of bisadducts of fullerenes

F. Djojo, A. Hirsch, Chem. Eur. J. **4** (1998), 344 – 356
Layer: ALUGRAM® ALOX N/UV_{254}
Eluent: toluene – ethyl acetate (95:5, v/v)
Detection: UV, 254 nm

Compound	R_f values:
Bis[bis(4-phenyloxazolin)methan]fullerene 1:	0.14
Bis[bis(4-phenyloxazolin)methan]fullerene 2:	0.26

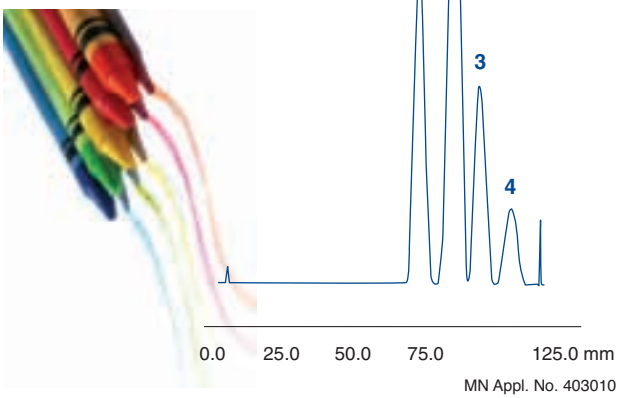


MN Appl. No. 401930

Separation of lipophilic dyes

Layer: ALOX-25 UV_{254}
Sample volume: 1000 nl
Eluent: toluene – cyclohexane (2:1, v/v)
Migration distance: 10.8 cm in 15 min
Detection: TLC scanner, UV 254 nm

Peaks:
1. Indophenol
2. Sudan red G
3. Sudan blue II
4. Butter yellow



MN Appl. No. 403010

Ordering information

Glass plates

Plate size [cm]		5 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]		100	25		
ALOX-25		**807011**	**807013**	0.25 mm	–
ALOX-25 UV_{254}		**807021**	**807023**	0.25 mm	UV_{254}
Pack of [plates]			15		
ALOX-100 UV_{254}			**807033**	1.00 mm	UV_{254}

POLYGRAM® polyester sheets

Plate size [cm]	4 x 8	5 x 20	20 x 20		
Pack of [plates]	50	50	25		
ALOX N		**802012**	**802013**	0.20 mm	–
ALOX N/UV_{254}	**802021**	**802022**	**802023**	0.20 mm	UV_{254}

ALUGRAM® aluminium sheets

Plate size [cm]		5 x 20	20 x 20		
Pack of [plates]		50	25		
ALOX N			**818013**	0.20 mm	–
ALOX N/UV_{254}		**818024**	**818023**	0.20 mm	UV_{254}

Cellulose MN 300

native fibrous cellulose layers for TLC

- fibre length (95 %) 2 – 20 µm, average degree of polymerisation 400 – 500, specific surface acc. to Blaine 15000 cm^2/g
  ≤ 20 ppm Fe, 6 ppm Cu, 7 ppm P; CH_2Cl_2 extract ≤ 0.25 %; residue on ignition at 850 °C ≤ 1500 ppm
  recommended application: partition chromatography of polar substances such as amino acids, carboxylic acids or carbohydrates

Ordering information

Plate size [cm] / Pack of [plates]	4 x 8	5 x 20	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Glass plates		100	50	25		
CEL 300-10		**808011**	**808012**	**808013**	0.10 mm	–
CEL 300-10 UV_{254}		**808021**	**808022**	**808023**	0.10 mm	UV_{254}
CEL 300-25			**808032**	**808033**	0.25 mm	–
CEL 300-25 UV_{254}			**808042**	**808043**	0.25 mm	UV_{254}
Pack of [plates]				20		
CEL 300-50				**808053**	0.50 mm	–
CEL 300-50 UV_{254}				**808063**	0.50 mm	UV_{254}
POLYGRAM® polyester sheets						
Plate size [cm]	4 x 8	5 x 20		20 x 20		
Pack of [plates]	50	50		25		
CEL 300	**801011**	**801012**		**801013**	0.10 mm	–
CEL 300 UV_{254}		**801022**		**801023**	0.10 mm	UV_{254}
ALUGRAM® aluminium sheets						
Plate size [cm]	4 x 8	5 x 20		20 x 20		
Pack of [plates]	50	50		25		
CEL 300	**818155**	**818154**		**818153**	0.10 mm	–
CEL 300 UV_{254}		**818157**		**818156**	0.10 mm	UV_{254}

Cellulose MN 400 (AVICEL®)

microcrystalline cellulose layers for TLC

- prepared by hydrolysis of high purity cellulose with HCl; mean degree of polymerisation 40 – 200
  recommended application: carboxylic acids, lower alcohols, urea and purine derivatives

Ordering information

Plate size [cm] / Pack of [plates]	5 x 20	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
	50	50	25		
Glass plates					
CEL 400-10		**808072**	**808073**	0.10 mm	–
CEL 400-10 UV_{254}		**808082**	**808083**	0.10 mm	UV_{254}
POLYGRAM® polyester sheets					
CEL 400	**801112**		**801113**	0.10 mm	–
CEL 400 UV_{254}	**801122**		**801123**	0.10 mm	UV_{254}

Cellulose layers for TLC

Cellulose MN 300 DEAE — DEAE-modified cellulose ion exchange layers

- fibrous cellulose modified with diethylaminoethyl groups: R – O – C_2H_4 – $N(C_2H_5)_2$

  mixed layers of cellulose MN 300 DEAE and high purity cellulose MN 300 HR are recommended for separation of mono- and oligonucleotides in nucleic acid hydrolysates

Separation of mono- and oligonucleotides in nucleic acid hydrolysates on layers of MN 300 DEAE/HR

The Medical Research Council Laboratory of Molecular Biology in Cambridge (UK) has developed a special procedure for the separation of radioactively labelled mono- and oligonucleotides in hydrolysates of ribonucleic acid. It is a 2-dimensional procedure, in which mononucleotides and oligonucleotides are separated up to n = 50. The separation process consists of 2 stages, first a high voltage electrophoretic group fractionation on acetate sheets in the 1st dimension and then a TLC separation in the 2nd dimension after blotting of the preseparated substances onto a mixed layer of DEAE cellulose and HR cellulose in the ratio 2:15.

As eluent concentrated urea solutions with addition of homomix solutions are used, which consist of ribonucleic acid hydrolysates and dialysates. Mononucleotides move up to the front, and depending on chain length the oligonucleotides appear between the R_f values 1 and 0. The evaluation of chromatograms is by autoradiography after treatment with red ink, which contains radioactive sulphur ^{35}S.

References

G. G. Brownlee et al., European J. Biochem. **11** (1969) 395
B. E. Griffin, FEBS Letters **15** (1971) 165
F. Sanger et al., J. Mol. Biol. **13** (1965) 373 – 398.

Ordering information

Plate size [cm]	5 x 20	20 x 20	40 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	25	25		
POLYGRAM® polyester sheets					
CEL 300 DEAE	**801072**	**801073**	**801074**	0.10 mm	–
CEL 300 DEAE/HR-2/15			**801084**	0.10 mm	–

Cellulose MN 300 PEI — PEI-impregnated cellulose ion exchange layers

- fibrous cellulose **impregnated** with polyethyleneimine

  recommended application: analysis of nucleic acids, and of mutagenic substances with the ^{32}P postlabelling procedure (see application 402260 at *www.mn-net.com*)

Ordering information

Plate size [cm]	5 x 20	20 x 20	40 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	25	25		
POLYGRAM® polyester sheets					
CEL 300 PEI	**801052**	**801053**	**801054**	0.10 mm	–
CEL 300 PEI/UV_{254}	**801062**	**801063**		0.10 mm	UV_{254}

Acetylated cellulose MN 300

- fibrous cellulose with 10 or 20 % content of acetylated cellulose

  recommended application: reversed phase chromatography

Ordering information

Plate size [cm]	Acetyl content	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]		25		
Glass plates				
CEL 300-10/AC-10 %	10 %	**808113**	0.10 mm	–
CEL 300-10/AC-20 %	20 %	**808123**	0.10 mm	–
POLYGRAM® polyester sheets				
CEL 300 AC-10 %	10 %	**801033**	0.10 mm	–

Polyamide-6

ε-aminopolycaprolactame layers for TLC

- polyamide 6 = Nylon 6 = perlon = ε-aminopolycaprolactame

  separation mechanism based on hydrogen bonds to amide groups of the polymer matrix as well as on ionic, dipol and electron donor/acceptor interactions

  recommended application: natural compounds, phenols, carboxylic acids, aromatic nitro compounds and especially amino acids

Ordering information

Plate size [cm]	5 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	25		
POLYGRAM® polyester sheets				
POLYAMIDE-6	**803012**	**803013**	0.10 mm	-
POLYAMIDE-6 UV_{254}	**803022**	**803023**	0.10 mm	UV_{254}

CHIRALPLATE

special layer for TLC enantiomer separation

- reversed phase nano silica impregnated with Cu^{2+} ions and a chiral selector (a proline derivative, DP 31 43 726 and EP 0 143 147)

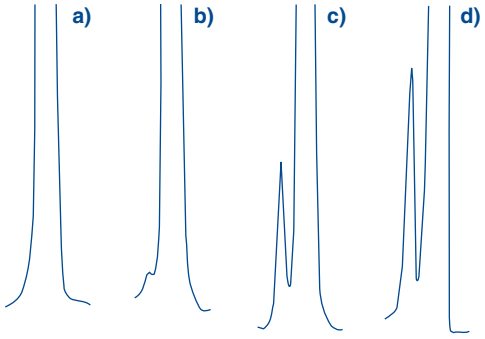
  separation based on ligand exchange, i.e. formation of ternary mixed-ligand complexes with the Cu(II) ions; differences in the stability of the diastereomeric complexes cause chromatographic separation

  recommended application: enantiomer separation of amino acids, *N*-methylamino acids, *N*-formylamino acids, α-alkylamino acids, thiazolidine derivatives, dipeptides, lactones, α-hydroxycarboxylic acids

  A review on the application of CHIRALPLATE has been given by K. Günther [J. Chromatogr. 448 (1988) 11 – 30].

Enantiomer separation of amino acids

Quantitative determination (remission location curves) of TLC-separated enantiomers of *tert.*-leucine:
Layer: CHIRALPLATE
Eluent: methanol – water (10:80, v/v)
Detection: dip in 0.3% ninhydrin solution
quantification with scanner, 520 nm
a) L-*tert.*-leucine
b) L-*tert.*-leucine + 0.1 % D-*tert.*-leucine
c) L-*tert.*-leucine + 1 % D-*tert.*-leucine
d) external reference sample



Ordering information

Plate size [cm]	5 x 20	10 x 10	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Glass plates						
Pack of [plates]			4			
CHIRALPLATE			**811056**		0.25 mm	UV_{254}
Pack of [plates]	50	25	25	25		
CHIRALPLATE	**811057**	**811059**	**811055**	**811058**	0.25 mm	UV_{254}

Layers for special TLC separations

SIL G-25 HR

special layer for aflatoxin separation

- high purity silica 60 **with gypsum** and a very small quantity of a polymeric organic binder
  softer than the standard silica layer, i.e. spots can be scratched and the layer absorbs faster
  recommended for the separation of aflatoxins

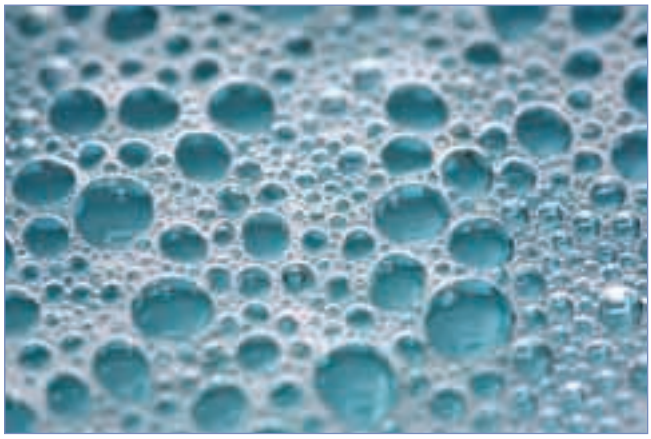
Ordering information

Plate size [cm] Pack of [plates]	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates			
SIL G-25 HR	**809033**	0.25 mm	-
SIL G-25 HR/UV_{254}	**809043**	0.25 mm	UV_{254}

SIL G-25 Tenside

special layer for separation of surfactants

- silica G impregnated with ammonium sulphate
  recommended for the separation of detergents, alkanesulphonates, polyglycols etc.



Ordering information

Plate size [cm] Pack of [plates]	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates			
SIL G-25 Tenside	**810063**	0.25 mm	-

GUR N

TLC layers with kieselguhr

- kieselguhr is completely inactive and mostly used for special separations after suitable impregnation

Ordering information

Plate size [cm] Pack of [plates]	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates			
GUR N-25	**810074**	0.25 mm	-
GUR N-25 UV_{254}	**810073**	0.25 mm	UV_{254}

Nano-SIL PAH

special HPTLC silica layer for PAH analysis

- base material: nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm;** impregnated with caffeine, an electron acceptor for PAH analysis based on charge-transfer complexes

  recommended for determination of the six PAH according to German drinking water specifications (TVO) in accordance with German standard DIN 38407 part 7 (see application 402400 at *www.mn-net.com*)

Ordering information

Plate size [cm] Pack of [plates]	10 x 10 25	10 x 20 50	Thickness of layer	Fluorescent indicator
Glass plates				
Nano-SIL-PAH	**811050**	**811051**	0.20 mm	–

IONEX

special mixed layers of silica with ion exchange resins

- IONEX-25 SA-Na: mixture of silica and a strongly acidic cation exchanger coated to polyester sheets
- IONEX-25 SB-AC: mixture of silica and a strongly basic anion exchanger coated to polyester sheets

  both layers contain an inert organic binder

  recommended application: amino acids, e.g. in protein and peptide hydrolysates, in seeds and fodder, in biological fluids; for racemate separation in peptide syntheses, for the separation of nucleic acid hydrolysates, aminosugars, aminocarboxylic acids, antibiotics, inorganic phosphates, cations and other compounds with ionic groups

Ordering information

		Plate size [cm] Pack of	20 x 20 25	Thickness of layer	Fluorescent indicator
POLYGRAM® polyester sheets					
IONEX-25 SA-Na	strongly acidic cation exchanger		**806013**	0.20 mm	–
IONEX-25 SB-AC	strongly basic anion exchanger		**806023**	0.20 mm	–

Mixed layers for TLC

- **ALOX/CEL-AC-Mix-25:** mixed layer of aluminium oxide G and acetylated cellulose
  recommended for separation of PAH (see application 401040 at *www.mn-net.com*)
- **SILCEL-Mix-25:** mixed layer of cellulose and silica
  recommended for separation of preservatives and other antimicrobial compounds (see application 401420 at *www.mn-net.com*)
- **GURSIL-Mix-25:** mixed layer of kieselguhr and silica
  recommended for separation of carbohydrates, antioxidants, steroids and photographic developer solutions

Ordering information

Plate size [cm] Pack of [plates]	10 x 20 50 / pack	20 x 20 25 / pack	Thickness of layer	Fluorescent indicator
Glass plates				
ALOX/CEL-AC-Mix-25	**810054**	**810053**	0.25 mm	–
SILCEL-Mix-25 UV_{254}		**810043**	0.25 mm	UV_{254}
GURSIL-Mix-25 UV_{254}	**810076**		0.25 mm	UV_{254}

Chromatography papers

- paper chromatography is the oldest chromatographic technique
  separation due to partition of the analytes between special paper grades and the mobile phase, which penetrates the paper by capillary action
  ascending, descending and circular techniques are possible
- *please note:* always treat chromatography papers with care:
  never touch them with fingers, because this will contaminate the surface
  do not bend them sharply, because this will decrease the capillary action (preferably store them flat)

  Chromatography papers possess a preferred direction of the fibres with higher absorption properties (with our sheets 58 x 60 cm, the longer edge). We recommend to use them in the direction of higher absorption.

Ordering information

Code	Weight [g/m²]	Thickness [mm]	Description	Flow rate	Size [cm]	Pack of	REF
MN 214	140	0.28	smooth	90 – 100 mm/30 min	58 x 60	100 sheets	**817001**
MN 218	180	0.36	smooth	90 – 100 mm/30 min	58 x 60	100 sheets	**817002**
MN 260	90	0.20	smooth	120 – 130 mm/30 min	58 x 60	100 sheets	**817003**
MN 261	90	0.18	smooth	90 – 100 mm/30 min	58 x 60	100 sheets	**817004**
MN 827	270	0.70	soft carton	130 – 140 mm/10 min	58 x 60	100 sheets	**817005**
MN 866	650	1.70	soft carton	100 – 120 mm/10 min	38 x 38	100 sheets	**817006**
MN 866	650	1.70	soft carton	100 – 120 mm/10 min	80 x 80	100 sheets	**817007**
MN 214 ff	140	0.28	MN 214 defatted *	90 – 100 mm/30 min	56 x 58	100 sheets	**817008**

*) This paper is extracted with organic solvents

For further papers, filters and membranes, feel free to ask for our catalogue "Filtration"

Introductory kits for TLC

TLC micro-sets — introductory kits for science education

- **Beginner's set**
  features separations with simple developing solvents; samples are coloured thus eliminating the need for visualisation. All equipment needed is contained in the set.
- **Advanced sets**
  require some experience and skill from the user: some of the samples have to be pretreated before separation, and for identification of substances spray reagents have to be used
- **TLC wine set**
  chromatographic rapid test for evaluating the conversion of malic acid to lactic acid in wine (2nd fermentation), i.e. the optimum time for bottling of a wine

TLC micro-set A for beginners

This kit contains all chemicals and accessories for the following separations:

- ✓ separation of the fat-soluble (lipophilic) dye mixture 1: butter yellow, indophenol, sudan blue II, sudan red G
- ✓ separation of a mixture of anthraquinone dyes (test dye mixture 2): blue 1, blue 3, green, green blue, red, violet 1, violet 2
- ✓ separation of a mixture of food dyes (test dye mixture 3): brilliant black BN (E151), fast red E, erythrosine (E127), yellow orange S (sunset yellow CFC, E110), naphthol red S, ponceau 4 R (E124), tartrazine (E102)
- ✓ separation of dyes from felt tip pens

Contents of TLC micro-set A for beginners

1	manual
3	developing chambers
50	glass capillaries 1 µl
1	spotting guide
1	measuring cylinder10 ml
50	polyester sheets 4 x 8 cm each of POLYGRAM® SIL G/UV$_{254}$, ALOX N/UV$_{254}$ and CEL 300
8 ml	each of test dye mixture 1 (4 lipophilic dyes), test dyes sudan red G, and sudan blue II
8 ml	each of test dye mixture 2 (7 anthraquinone dyes), test dyes blue 1 and violet 2
8 ml	each of test dye mixture 3 (7 food dyes), test dyes yellow orange S, and brilliant black BN
100 ml	each of toluene, toluene/cyclohexane (2:1, v/v) chloroform/acetone (1:1, v/v) 2.5 % sodium citrate solution 25 % ammonia/2-propanol (5:3, v/v)
2	felt tip pens

TLC micro-set M

This kit is prerequisite for the separations with kits F 1 to F 3. In addition, it serves as basic equipment for the individual study of further thin layer chromatographic experiments.

Contents of TLC micro-set M (materials kit)

2 x 50 glass capillaries 1 µl, 2 spotting guides
1 rubber cap for capillaries, 1 measuring cylinder 10 ml,
1 beaker 25 ml, 2 developing chambers
1 glass laboratory sprayer with rubber bulb
1 plastic syringe 1 ml, 20 sheets filter paper MN 713 (15 x 21 cm)
50 polyester sheets 4 x 8 cm each of POLYGRAM® SIL G/UV$_{254}$, ALOX N/UV$_{254}$ and CEL 300

Ordering information

Designation	Pack of	REF
TLC micro-set A for beginners	1 kit	**814000**
Replacement parts for TLC micro-set A		
Test dye mixture 1, solution of 4 lipophilic dyes in toluene (components see above)	8 ml	**814001**
Test dye mixture 2, solution of 7 anthraquinone dyes in chloroform (components see above)	8 ml	**814002**
Test dye mixture 3, aqueous solution of 7 food dyes (components see above)	8 ml	**814003**
Collection of 4 individual components of test dye mixture 1	4 x 8 ml	**814011**
Collection of 7 individual components of test dye mixture 2	7 x 8 ml	**814012**
Collection of 7 individual components of test dye mixture 3	7 x 8 ml	**814013**
Sodium citrate, 2.5 g in 100 ml bottles to fill up with distilled water	2.5 g	**814029**
TLC micro-set M (materials kit)	1 kit	**814100**

Introductory kits for TLC

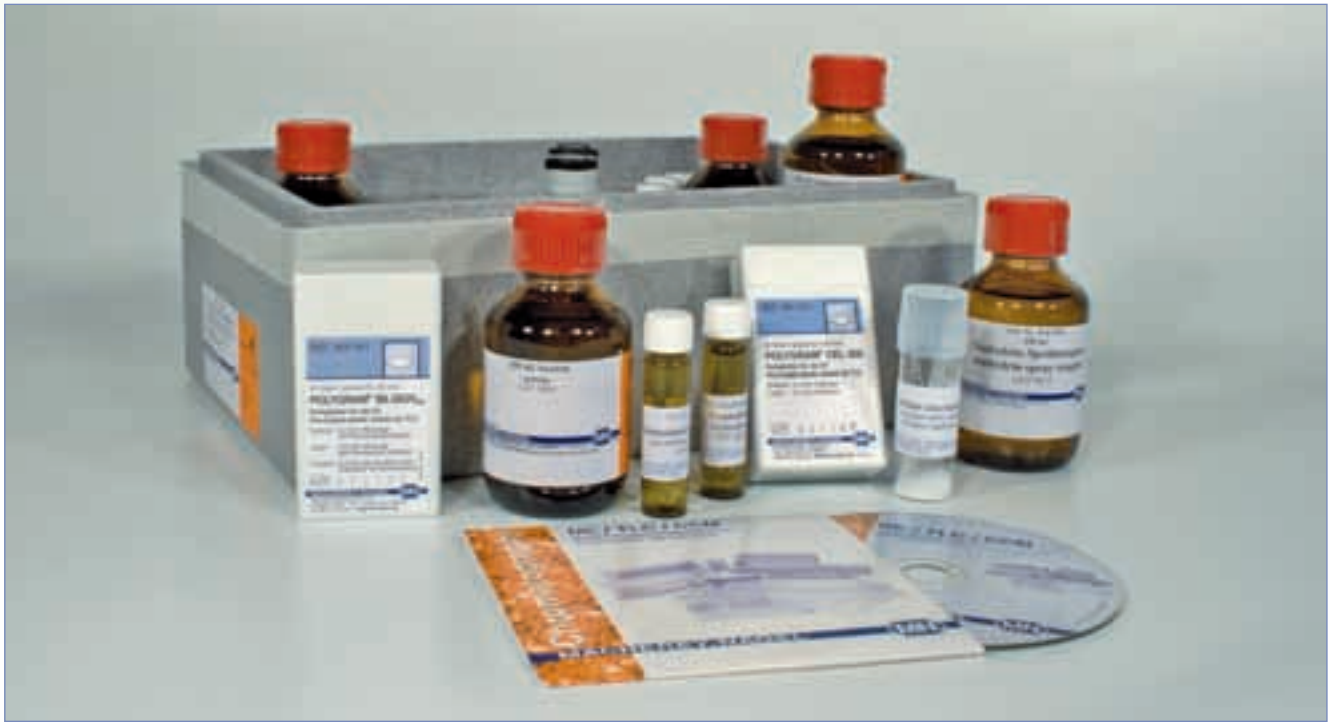
TLC micro-set F 1

This kit contains all chemicals required for the separation of

- ✓ amino acids (test mixture, consisting of alanine, arginine, tryptophan and valine)
- ✓ amino acids in urine
- ✓ the heavy metal cations copper(II), manganese(II), and nickel(II)

Contents of TLC micro-set F 1

1 manual; 50 glass capillaries 1 µl
50 polyester sheets 4 x 8 cm each of POLYGRAM® SIL G/UV$_{254}$ and CEL 300
100 ml each of *n*-butanol, ninhydrin spray reagent (0.2 % in ethanol), acetone, 25 % ammonia, rubeanic acid spray reagent
50 ml each of 50 % acetic acid, 18 % hydrochloric acid
8 ml each of the amino acid test mixture (see left), tryptophan and arginine reference solutions
8 ml each of the heavy metal cation test mixture (see left), Mn^{2+}, and Ni^{2+} reference solution



TLC micro-set F 2

This kit contains all chemicals required

- ✓ for the analysis of edible fats
- ✓ as well as for analysis of fats and cholesterol in blood

Contents of TLC micro-set F 2

1 manual; 50 glass capillaries 1 µl
50 polyester sheets 4 x 8 cm POLYGRAM® SIL G/UV$_{254}$
5 blood lancets, 5 disposable pipettes 25 µl, 5 alcoholic pads,
5 sample vials N 11-1 (2 ml) with PE caps and seals,
3 sample vials 30 ml (for butter, margarine and edible oil)
100 ml each of chloroform, dichloromethane, toluene and molybdatophosphoric acid spray reagent
50 ml acetone with calibrated pipette
8 ml cholesterol reference solution

TLC micro-set F 3

This kit contains all chemicals required

- ✓ for the separation of analgetics (pain relievers)
- ✓ and for drug analysis as shown for cinchona bark

Contents of TLC micro-set F 3

1 manual, 50 glass capillaries 1 µl
50 polyester sheets 4 x 8 cm POLYGRAM® SIL G/UV$_{254}$
5 Aspirin® tablets, 5 Thomapyrin® tablets, 20 folded filters MN 615 1/4, 11 cm diameter, 3 sample vials 8 ml (for Aspirin sample, Thomapyrin sample, cinchona bark extract), 5 g cinchona bark,
100 ml each of chloroform, methanol, toluene/diethyl ether (55:35, v/v), spray reagent for caffeine and Dragendorff-Munier spray reagent, 50 ml each of iron(III) chloride solution and potassium hexacyanoferrate solution, 30 ml glacial acetic acid/ethyl acetate (6 : 2,5, v/v), 25 ml each of 12.5% ammonia and diethylamine
8 ml each of caffeine, paracetamol, quinine reference solutions

Ordering information

Designation	Pack of	REF
TLC micro-set F 1	1 kit	**814200**
Replacement parts for TLC micro-set F 1		
Amino acid test mixtures (components see above)	8 ml	**814201**
Collection of 4 individual components of the amino acid test mixture	4 x 8 ml	**814202**
Cation test mixture (Cu^{2+}, Mn^{2+}, Ni^{2+})	8 ml	**814204**
Collection of 2 individual components of the cation test mixture	2 x 8 ml	**814205**
TLC micro-set F 2	1 kit	**814300**
Replacement parts for TLC micro-set F 2		
Cholesterol reference solution	8 ml	**814301**
TLC micro-set F 3	1 kit	**814400**
Replacement parts for TLC micro-set F 3		
Quinine reference solution	8 ml	**814405**
Paracetamol reference solution	8 ml	**814406**
Caffeine reference solution	8 ml	**814407**
Replacement parts for all TLC micro-sets		
TLC polyester sheets POLYGRAM® SIL G/UV_{254}, 4 x 8 cm	4 x 50	**814025**
TLC polyester sheets POLYGRAM® ALOX N/UV_{254}, 4 x 8 cm	4 x 50	**814026**
TLC polyester sheets POLYGRAM® CEL 300, 4 x 8 cm	4 x 50	**814027**
TLC polyester sheets POLYGRAM® 4 x 8 cm: 100 x SIL G/UV_{254}; 50 x ALOX N/UV_{254}; 50 x CEL 300	1 set	**814028**

TLC wine set

This kit contains all chemicals and equipment required for determination of malic, lactic, and tartaric acid in wine (evaluation of the conversion of malic to lactic acid, 2nd fermentation)

Contents of the TLC wine set
detailed instruction leaflet
50 polyester sheets 4 x 8 cm POLYGRAM® CEL 300
cation exchanger, eluent, reference substances
developing chamber, capillaries, spotting guide

Ordering information

Designation	Pack of	REF
TLC wine set		
	1 set	**814500**

Accessories for TLC

TLC accessories

Designation		Pack of	REF
Simultaneous developing chamber for TLC, 20 x 20 cm, for up to 5 plates		1	**814019**
Simultaneous developing chamber for TLC, 10 x 10 cm, for up to 2 plates		1	**814018**
Developing chambers for TLC micro-sets		4	**814021**
Glass laboratory sprayer with rubber bulb		1	**814101**
Glass capillaries 1 µl		3 x 50	**814022**
Rubber caps for capillaries		2	**814102**
Plastic syringe, 1 ml content with graduation		1	**814104**
Spotting guides		2	**814023**
Measuring cylinders, glass, 10 ml content		2	**814024**
MN ALUGRAM® scissors, ground blade, black handle	*NEW!*	1	**818666**
Filter paper MN 713, 15 x 21 cm		100	**814103**
Folded filters MN 615 1/4, 11 cm diameter		100	**531011**
Chromatography paper MN 260, 7.5 x 17 cm (for chamber saturation)		100	**814030**

Visualisation reagents

- a small selection of frequently used spray reagents for postchromatographic detection reactions in TLC suited for spraying or dipping TLC plates

  a detailed description of many more detection procedures for TLC is available on request

Ordering information

Spray reagent	Solvent	Detection of	Pack of	REF
Aniline phthalate	2-propanol / ethanol (1:1)	reducing sugars, oxohalic acids	100 ml	**814919**
Bromocresol green	2-propanol	organic acids	100 ml	**814920**
Caffeine reagent	water/acetone	caffeine	100 ml	**814401**
2',7'-Dichlorofluorescein	2-propanol	lipids (saturated, unsaturated)	100 ml	**814921**
4-(Dimethylamino)-benzaldehyde	2-propanol	terpenes, sugars, steroids	100 ml	**814922**
Dragendorff-Munier	water	alkaloids and other nitrogen compounds	100 ml	**814402**
Iron(III) chloride	water	acetylsalicylic acid, paracetamol	100 ml	**814403**
Potassium hexacyanoferrate(III)	water		100 ml	**814404**
Molybdatophosphoric acid	ethanol	lipids, sterols, steroids, reducing compounds	100 ml	**814302**
Ninhydrin	ethanol	amino acids, amines and amino sugars	100 ml	**814203**
Rhodamin B	ethanol	lipids	100 ml	**814923**
Rubeanic acid	ethanol	heavy metal cations	100 ml	**814206**

Silica

adsorbents for TLC

pore size 60 Å, pore volume 0.75 ml/g, specific surface (BET) ~ 500 m^2/g, pH of a 10 % aqueous suspension 7.0

- **Silica G**
  standard grade, particle size 2 – 20 µm, Fe < 0.02 %, Cl < 0.02 %, 13 % gypsum as binder, supplied with or without fluorescence indicator UV_{254}
- **Silica N**
  standard grade, particle size 2 – 20 µm, Fe < 0.02 %, Cl < 0.02 %, no binder, supplied with or without fluorescence indicator UV_{254}
- **Silica G-HR**
  high purity grade, particle size 3 – 20 µm, Fe < 0.002 %, Cl < 0.008 %, gypsum as binder, supplied without fluorescence indicator
- **Silica P**
  preparative grade, particle size 5 – 50 µm, Fe < 0.02 %, Cl < 0.02 %, organic binder, supplied with fluorescence indicator UV_{254}
- **Silica P with gypsum**
  preparative grade, particle size 5 – 50 µm, Fe < 0.02 %, Cl < 0.02 %, gypsum as binder, supplied with fluorescence indicator UV_{254}

Ordering information

Designation	Fluorescent indicator	1 kg	5 kg
Silica G	–	**816310.1**	**816310.5**
Silica G/UV_{254}	UV_{254}	**816320.1**	**816320.5**
Silica N	–	**816330.1**	**816330.5**
Silica N/UV_{254}	UV_{254}	**816340.1**	**816340.5**
Silica G-HR	–	**816410.1**	**816410.5**
Silica P/UV_{254}	UV_{254}	**816380.1**	**816380.5**
Silica P/UV_{254} with gypsum	UV_{254}	**816400.1**	**816400.5**

Aluminium oxide

adsorbents for TLC

pore size 60 Å, specific surface (BET) ~ 200 m^2/g

- **Aluminium oxide G**
  ~ 10 % gypsum as binder, supplied with or without fluorescence indicator
- **Aluminium oxide N**
  no binder, supplied without fluorescence indicator

Ordering information

Designation	Fluorescent indicator	1 kg	5 kg
Aluminium oxide G	–	**816010.1**	**816010.5**
Aluminium oxide G/UV_{254}	UV_{254}	**816020.1**	**816020.5**
Aluminium oxide N	–	**816030.1**	**816030.5**

Adsorbents for TLC

Polyamide

adsorbents for TLC

- Polyamide 6 = nylon 6 = perlon = ε-aminopolycaprolactame

Ordering information

Designation	Fluorescent indicator	1 kg
Polyamide TLC 6	–	**816610.1**
Polyamide TLC 6 UV_{254}	UV_{254}	**816620.1**

Cellulose MN 301

native fibrous cellulose

- fibre length (95 %) 2 – 20 µm, average degree of polymerisation 400 – 500, specific surface acc. to Blaine 15000 cm^2/g
- **Cellulose MN 301:** native fibrous cellulose, standard grade
  ≤ 20 ppm Fe, 6 ppm Cu, 7 ppm P, CH_2Cl_2 extract ≤ 0.25 %, residue on ignition at 850 °C ≤ 1500 ppm
- **Cellulose MN 301 HR:** fibrous cellulose, high purity grade, acid-washed and defatted
  ≤ 2 ppm Fe, 1 ppm Cu, CH_2Cl_2 extract ≤ 0.025 %, residue on ignition at 850 °C ≤ 200 ppm
  recommended for quantitative investigations, e. g. for separation of carbohydrates with subsequent IR spectroscopy or separation of phosphoric acids, phosphates etc.
- **Cellulose MN 301 A:** special grade for the ^{32}P postlabelling procedure
  ≤ 20 ppm Fe, ≤ 6 ppm Cu, ≤ 7 ppm P, CH_2Cl_2 extract ≤ 0.01 %, residue on ignition at 850 °C ≤ 500 ppm
  free of lactobacili contaminations; **not** impregnated with PEI, but designed for impregnation and coating by the user

Ordering information

Designation	Fluorescent indicator	1 kg	5 kg
Cellulose MN 301	–	**816250.1**	**816250.5**
Cellulose MN 301 UV_{254}	UV_{254}	**816260.1**	**816260.5**
Cellulose MN 301 HR	–	**816270.1**	**816270.5**
Cellulose MN 301 A	–	**816300.1**	**816300.5**

Fluorescent indicators

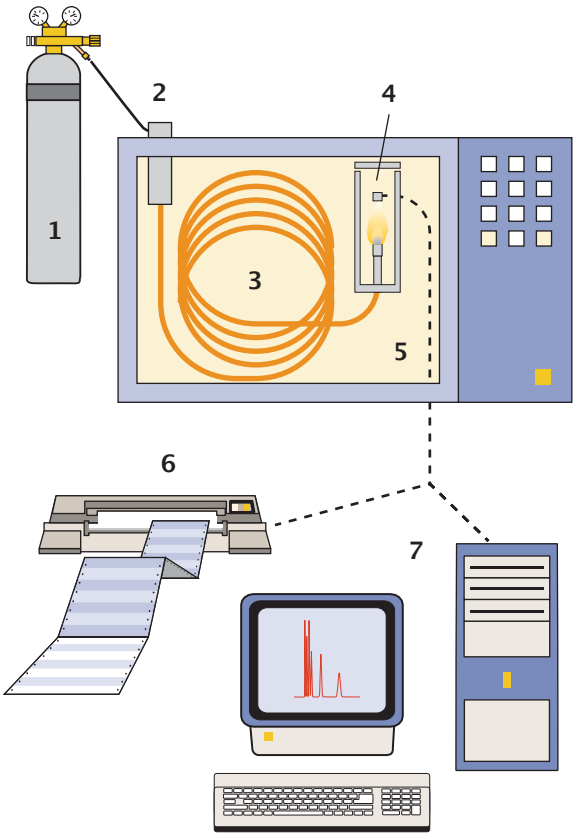
- UV indicators with efficient radiation for short-wave as well as long-wave UV ranges
  UV_{254}: manganese activated zinc silicate with absorption maximum at 254 nm; green fluorescence; relatively susceptible towards acids; thus its fluorescence can be completely quenched by acidic solvents
  UV_{366}: inorganic fluorescent pigment with absorption maximum at 366 nm; blue fluorescence

Ordering information

	Composition	Absorption maximum	Colour of fluorescence	Pack of 100 g
Fluorescent indicator UV_{254}	manganese-activated zinc silicate	254 nm	green	**816710.01**
Fluorescent indicator UV_{366}	inorganic fluorescent pigment	366 nm	blue	**816720.01**

Basic principles of capillary GC

The GC system



1 – 5 compose the chromatograph:

1. **gas supplies:** carrier gas and e.g. burner gases for a flame ionisation detector (FID)
2. **sample injector:**
   with ***direct injection*** the sample is introduced into the column without contact with other parts from glass or metal (on-column injection);
   with ***indirect injection*** the sample is introduced into an evaporator, and the vapour is then transferred into the column either completely or partially (split technique);
   both techniques allow low temperatures, high temperatures or temperature programming
3. **capillary column:** the heart of the GC system
4. **detector:** indicates a substance by generation of an electrical signal (response). Some detectors are specific for certain classes of substances or for certain elements (P, N, etc.).
5. **oven** with temperature control

6 and/or 7 serve for evaluation of the separation

6. **recorder** for analogue plotting of chromatograms
7. **data station** for digital evaluation of chromatograms

The separation process

Chromatographic separation is achieved by repeated distribution of each sample component between two phases:

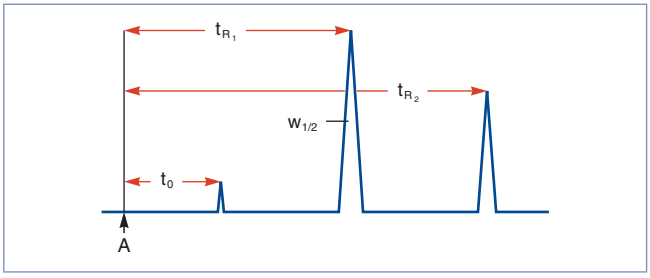
In GC, the **mobile phase** is always a gas (mostly N_2, H_2, He).

The **stationary phase** is a mostly viscous gumlike liquid coated to the inner wall of a capillary column (WCOT = Wall Coated Open Tubular).

Transport of the components is achieved exclusively in the gas phase, separation is accomplished in the stationary phase. The quality of a separation (resolution) depends on how long the components to be separated stay in the stationary phase and on how often they interact with this phase. The type of interaction between component and phase (selectivity) is determined by the functional groups. The polarity of the phase is a function of stationary phase substituents.

The chromatogram

A chromatogram consists of a base line and a number of peaks. The area of a peak allows quantitative determinations:



A: starting point of a chromatogram = time of injection of a dissolved solute

A component can be identified by its **retention time** (qualitative determination):

$$t_{R_i} = t_0 + t_{R_i}'$$

t_0: dead time = residence time of a solute in the mobile phase (time required by a component to migrate through the chromatographic system without any interaction with the stationary phase)

t_{R_i}: retention time = time interval between peak i and the point of injection

t_{R_i}': net retention time = difference between total retention time and dead time t_0. It indicates how long a substance stays in the stationary phase.

Other terms characterising a separation:

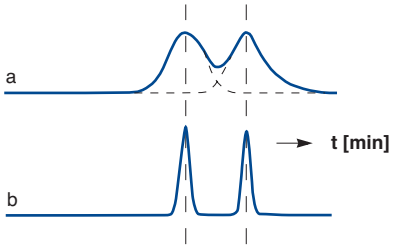
k': capacity factor: a measure for the position of a sample peak in the chromatogram. The capacity factor is specific for a given compound and constant under constant conditions.

$$k'_i = \frac{t_{R_i} - t_0}{t_0}$$

α: relative retention, also called separation factor or selectivity coefficient, is the ratio of two capacity factors, the reference substance always being in the denominator.

$$\alpha = \frac{k'_2}{k'_1}$$

The relative retention does not provide any information on the quality of a separation, since for equal values of α two very broad peaks may overlap, (as shown in trace a), or may be completely resolved (as in trace b), if they are correspondingly narrow.



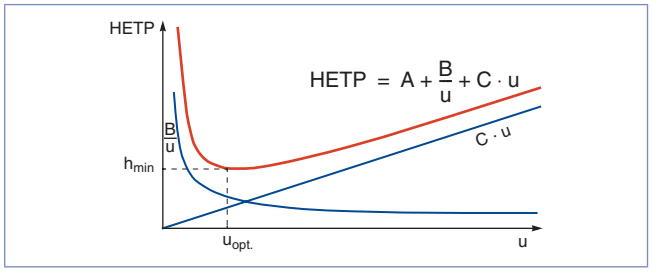
R: resolution: a measure for the quality of a separation, taking the peak width at half height ($w_{1/2}$) into account according to

$$R = \frac{t_{R_2} - t_{R_1}}{(w_{1/2})_2 + (w_{1/2})_1}$$

N_{th}: number of theoretical plates: characterises the quality of a column (should be determined for k' > 5). The height equivalent to a theoretical plate (h, HETP) is calculated by dividing the length L of the column by the number of theoretical plates N_{th}. The smaller this value the better works the column.

$$N_{th} = 5.54 \cdot \left(\frac{t_{R_i}}{w_{1/2}}\right)^2 \qquad h = HETP = \frac{L}{N_{th}}$$

The Van Deemter equation shows how the plate height h depends on the flow velocity u:



A Eddy diffusion; for WCOT capillary columns A = 0
B molecular axial diffusion; B is a function of the diffusion coefficient of the component in the respective carrier gas
C resistance to mass transfer

In practice often higher velocities than $u_{opt.}$ are chosen, if separation efficiency is sufficient, since higher carrier velocities mean shorter retention times.

Parameters characterising a capillary column

OPTIMA® 5,	1.0 µm film	30 m x	0.32 mm ID
A	B	C	D

A. Stationary phase

Different chemical structures of stationary phases are responsible for the type of interaction (selectivity) between the phase and the analytes. The stationary phase also limits the temperature range for chromatography. For a detailed summary of MN phases for GC please see the following chapter.

B. Film thickness

reaches from 0.1 to 5.0 µm. The standard film thickness is 0.25 µm. Thin films (0.1 – 0.2 µm) are very well suited for high-boiling compounds, temperature labile or very closely eluting substances.

Increasing film thickness will increase the capacity, the retention time for low boiling compounds and improve inertness. This is especially useful for samples with widely differing concentrations, or for the separation of volatile polar substances.

Better coverage of the column wall by a thicker film and a reduction of the column surface due to a reduced length are favourable for extremely active substrates, which in many cases cause noticeable tailing, if they come in contact with uncoated spots of the column wall.

Thick films also mean more phase in the column, and consequently higher bleeding. This results in lower maximum operating temperatures for thick film columns. In addition, thick film columns may have a lower efficiency.

C. Column length

column length is directly proportional to the separation efficiency (number of plates N). Routine separations are most frequently performed on 25 or 30 m columns, while complex mixtures may require 50 or 60 m columns. 10 m columns with 0.1 mm ID are used for fast GC (see page 240)

D. Inner diameter (ID)

the lower the ID, the higher is the theoretically possible number of plates per meter;
0.1 – 0.2 mm ID: for high resolution and short retention times with low carrier gas flows
0.25 mm ID: for analyses of complex mixtures
0.32 mm ID: for routine analyses with short retention times, but increased capacity
0.53 mm ID: for rapid separations with inert surface and highest capacity

Summary of MN phases for GC

MN offers more than 40 different phases for gas chromatography from very nonpolar to polar columns.

Nonpolar stationary phases (e.g. 100 % dimethylpolysiloxane phases) separate by volatility (i.e. boiling point) only. Typical analytes are linear hydrocarbons (*n*-alkanes).

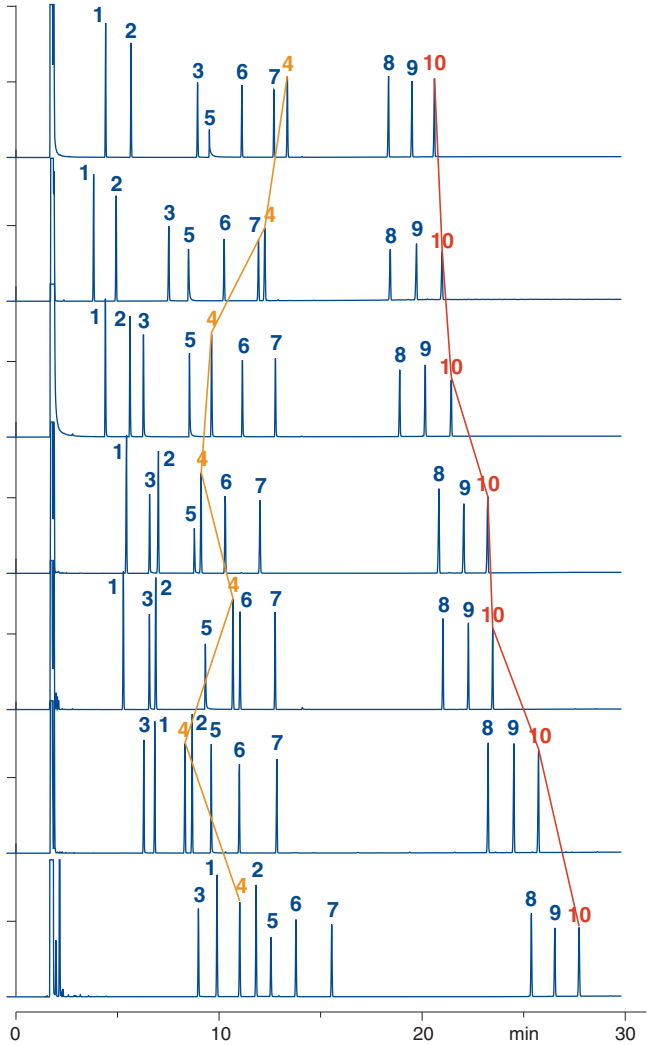
Polar phases offer additional interactions, which may improve a separation. When increasing the polarity, e.g. by introducing phenyl and / or cyanopropyl groups, separation is increasingly influenced by differences in dipole moment and by charge transfer (e.g. for 5 – 50 % diphenylpolysiloxane phases). Typical analytes are hydrocarbons, which contain oxygen, sulphur, nitrogen, phosphorus or halogen atoms, unsaturated molecules which can be polarised and aromatics.

For components featuring different hydrogen bonding capacities and the ability to form strong hydrogen bonds, polyethylene glycol phases (WAX) are the best choice for a separation. Typical analytes are alcohols and carboxylic acids.

Selectivity has to be optimised for the critical pair of components or the main component. You should always select the least polar column which solves your separation task. About 70 % of all separations can be performed on non- to midpolar columns. These columns generally feature high temperature stability.

For columns for special separations please see page 239.

Comparison of separation properties of selected OPTIMA® phases



OPTIMA® 240
max. temp. 260/280 °C
REF 726096.30

OPTIMA® 225
max. temp. 260/280 °C
REF 726084.30

OPTIMA® 210
max. temp. 260/280 °C
REF 726880.30

OPTIMA® 1701
max. temp. 320/340 °C
REF 726320.30

OPTIMA® 17
max. temp. 320/340 °C
REF 726744.30

OPTIMA® 5
max. temp. 340/360 °C
REF 726316.30

OPTIMA® 1
max. temp. 340/360 °C
REF 726304.30

increasing polarity

All columns:	0.5 µm film, 30 m x 0.32 mm ID
Sample:	MN-OPTIMA® test mixture (REF 722316)
Injection:	1.0 µl, split 1:50
Carrier gas:	80 kPa N_2
Temperature:	80 °C → T_{max} (isothermal), 8 °C/min
Detector:	FID, 260 – 300 °C, 2^6

Peaks:
1. Undecane
2. Dodecane
3. Octanol
4. Dimethylaniline
5. Decylamine
6. Methyl decanoate
7. Methyl undecanoate
8. Henicosane
9. Docosane
10. Tricosane

Summary of MN phases for GC

Phase	Composition	max. Temp. [1]	USP	Similar phases [2]	Page
OPTIMA® 1	100 % dimethylpolysiloxane	340/360 °C	G1 G2 G38	PERMABOND® SE-30 (page 237), OV-1, DB-1, SE-30, HP-1, SPB™-1, CP-Sil 5 CB, Rtx®-1, 007-1, BP1, MDN-1, AT™-1, ZB-1, OV-101	216
OPTIMA® 1 MS	100 % dimethylpolysiloxane	340/360 °C	G1 G2 G38	Ultra-1, DB-1MS, HP-1MS, Rxi®-1MS, Rtx®-1MS, Equity™-1, AT™-1MS, VF-1MS, CP-Sil 5 CB MS	217
OPTIMA® 1 MS Accent					218
OPTIMA® 5	5 % phenyl – 95 % methylpolysiloxane	340/360 °C	G27 G36	PERMABOND® SE-52 (page 237), SE-54, SE-52, HP-5, SPB™-5, CP-Sil 8, Rtx®-5, 007-5, BP5, MDN-5, AT™-5, ZB-5	219
OPTIMA® 5 MS	5 % diphenyl – 95 % dimethylpolysiloxane	340/360 °C	G27 G36	DB-5, DB-5MS, HP-5MS, Ultra-2, Equity™-5, CP-Sil 8CB low bleed/MS, Rxi®-5MS, Rtx®-5SIL-MS, Rtx®-5MS, 007-5MS, BPX™5, MDN-5S, AT™-5MS, VF-5MS	220
OPTIMA® 5 MS Accent	silarylene phase with selectivity similar to 5 % diphenyl – 95 % dimethylpolysiloxane	340/360 °C	G27 G36		221
OPTIMA® XLB	silarylene phase as above, optimised silarylene content	340/360 °C	–	DB-XLB, Rxi®-XLB, Rtx®-XLB, MDN-12, VF-XMS	222
OPTIMA® δ-3	phase with autoselectivity [3]	340/360 °C	G49	no similar phases	224
OPTIMA® δ-6	phase with autoselectivity [3]	340/360 °C	–	no similar phases	225
OPTIMA® 1301	6 % cyanopropylphenyl – 94 % dimethylpolysiloxane	300/320 °C	G43	HP-1301, DB-1301, SPB™-1301, Rtx®-1301, CP-1301, 007-1301	226
OPTIMA® 624	6 % cyanopropylphenyl – 94 % dimethylpolysiloxane	280/300 °C	G43	HP-624, HP-VOC, DB-624, DB-VRX, SPB™-624, CP-624, Rtx®-624, Rtx®-Volatiles, 007-624, BP624, VOCOL	227
OPTIMA® 624 *LB*	as above, low bleed phase	280/300 °C	G43		
OPTIMA® 1701	14 % cyanopropylphenyl – 86 % dimethylpolysiloxane	300/320 °C	G46	OV-1701, DB-1701, CP-Sil 19 CB, HP-1701, Rtx®-1701, SPB™-1701, 007-1701, BP10, ZB-1701	228
OPTIMA® 35 MS	silarylene phase with selectivity similar to a 35 % diphenyl – 65 % dimethylpolysiloxane phase	360/370 °C	G42	DB-35 MS, HP-35, SPB™-35, Rxi®-35SIL MS, Rtx-35, 007-35, BPX™-35, MDN-35, AT™-35 MS, ZB-35, OV-11, VF-35 MS	229
OPTIMA® 17	phenylmethylpolysiloxane, 50 % phenyl	320/340 °C	G3	OV-17, DB-17, HP-50+, HP-17, SPB™-50, SP-2250, Rxi®-17, Rtx®-50, CP-Sil 24 CB, 007-17, ZB-50	230
OPTIMA® 17 MS	silarylene phase with selectivity simar to 50 % phenyl, 50 % methylpolysiloxane	340/360 °C	G3	OV-17, AT™-50, BPX™-50, DB-17, DB-18ms, HP-50+, HP-17, SPB™-50, SPB™-17, SP-2250, Rtx®-50, CP-Sil 24 CB, 007-17, VF-17ms, ZB-50	231
OPTIMA® 210	trifluoropropylmethylpolysiloxane (50 % trifluoropropyl)	260/280 °C	G6	OV-210, DB-210, Rtx®-200, 007-210	232
OPTIMA® 225	50 % cyanopropylmethyl – 50 % phenylmethylpolysiloxane	260/280 °C	G7 G19	DB-225, HP-225, OV-225, Rtx®-225, CP-Sil 43, 007-225, BP225	233
OPTIMA® 240	33 % cyanopropylmethyl – 67 % dimethylpolysiloxane	260/280 °C	–	no similar phases	234
OPTIMA® WAX	polyethylene glycol 20 000 daltons	250/260 °C	G16	PERMABOND® CW 20 M (page 238), DB-Wax, Supelcowax™, HP-Wax, HP-INNOWax, Rtx®-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT™-Wax, ZB-Wax	235
OPTIMA® FFAP	polyethylene glycol 2-nitroterephthalate	250/260 °C	G25 G35	PERMABOND® FFAP (page 238), DB-FFAP, HP-FFAP, CP-SIL 58 CB, 007-FFAP, CP-FFAP CB, Nukol	236

1 first temperature for isothermal operation, second value for short isotherms in a temperature programme
Please note, that for columns with 0.53 mm ID and for columns with thicker films temperature limits are generally lower. For details refer to the description of individual phases.

2 phases which provide a similar selectivity based on chemical and physical properties

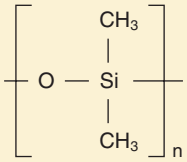
3 see description on page 223

OPTIMA® high performance capillary columns

OPTIMA® 1

100 % dimethylpolysiloxane

- nonpolar phase



similar phases: PERMABOND® SE-30 (page 237), OV-1, DB-1, SE-30, HP-1, SPB-1, CP-Sil 5 CB, Rtx-1, 007-1, BP1, MDN-1, AT-1, ZB-1, OV-101

- for columns with 0.1 – 0.32 mm ID and films < 3 µm the max. temperature for isothermal operation is 340 °C, the max. temperature for short isotherms in a temperature programme is 360 °C
  for 0.53 mm ID columns with films < 3 µm the max. temperatures are 320 and 340 °C, resp.
  for thick film columns with films ≥ 3 µm the max. temperatures are 300 and 320 °C, resp.
- separation of components according to boiling points
  thick film columns ≥ 3 µm film are especially recommended for solvent analysis
- USP G1 / G2 / G38

Ordering information

Length →	10 m	12 m	15 m	20 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)								
0.10 µm film	**726024.10**			**726024.20**				
0.40 µm film				**726025.20**				
0.2 mm ID (0.4 mm OD)								
0.10 µm film					**726832.25**			
0.20 µm film		**726834.12**			**726834.25**		**726834.50**	
0.35 µm film		**726837.12**			**726837.25**		**726837.50**	
0.50 µm film							**726839.50**	
0.25 mm ID (0.4 mm OD)								
0.10 µm film	**726038.10**		**726038.15**		**726038.25**	**726038.30**		**726038.60**
0.25 µm film	**726050.10**		**726050.15**		**726050.25**	**726050.30**	**726050.50**	**726050.60**
0.50 µm film	**726081.10**				**726081.25**	**726081.30**	**726081.50**	**726081.60**
1.00 µm film					**726802.25**	**726802.30**	**726802.50**	**726802.60**
0.32 mm ID (0.5 mm OD)								
0.10 µm film	**726301.10**				**726301.25**	**726301.30**	**726301.50**	**726301.60**
0.25 µm film	**726302.10**		**726302.15**		**726302.25**	**726302.30**	**726302.50**	**726302.60**
0.35 µm film					**726821.25**	**726821.30**	**726821.50**	**726821.60**
0.50 µm film	**726304.10**				**726304.25**	**726304.30**	**726304.50**	**726304.60**
1.00 µm film	**726323.10**		**726323.15**		**726323.25**	**726323.30**	**726323.50**	**726323.60**
3.00 µm film					**726805.25**	**726805.30**	**726805.50**	**726805.60**
5.00 µm film	**726931.10**				**726931.25**	**726931.30**	**726931.50**	
0.53 mm ID (0.8 mm OD)								
0.50 µm film					**726519.25**	**726519.30**		
1.00 µm film	**726529.10**		**726529.15**		**726529.25**	**726529.30**		
2.00 µm film	**726521.10**				**726521.25**	**726521.30**		
5.00 µm film	**726926.10**				**726926.25**	**726926.30**	**726926.50**	

In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Column ends are melted or closed with septa, and thus protected from atmospheric oxygen. Additionally, we supply the corresponding test mixture with each column.

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. For ordering, please add an E at the end of the REF number (e.g. 726470.30E)

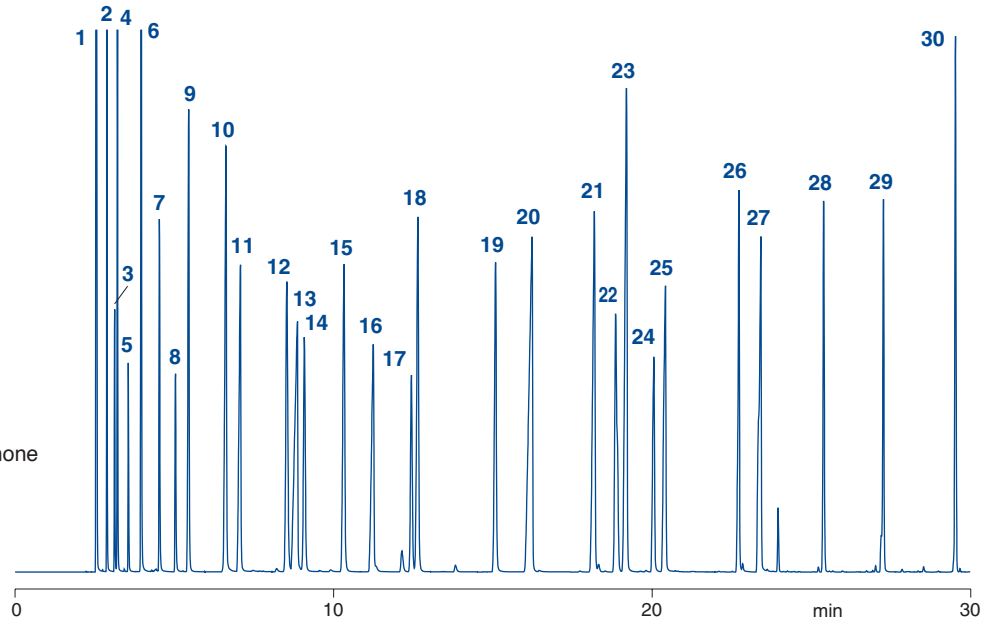
For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of **integrated precolumns**. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

Solvent analysis

Column: OPTIMA® 1, 1.0 µm film, 60 m x 0.32 mm ID, max. temperature 340/360 °C, REF 726323.60
Sample: solvent mixture, courtesy of J. Lutz, Alcan Rorschach, Switzerland
Injection volume: 0.4 µl, split 1:60
Carrier gas: H_2, 120 KPa
Temperature: 50 °C (9 min) → 90 °C, 4 °C/min → 280 °C (2 min), 14 °C/min
Detector: FID 300 °C, 2^6

Peaks:

1. Methanol
2. Ethanol
3. Acetone
4. 2-Propanol
5. Methyl acetate
6. *n*-Propanol
7. Methyl ethyl ketone
8. Ethyl acetate
9. Isobutanol
10. *n*-Butanol
11. 1-Methoxy-2-propanol
12. Isooctane
13. Ethyl glycol
14. Isoheptane
15. Methyl isobutyl ketone
16. 1-Ethoxy-2-propanol
17. Toluene
18. Isobutyl acetate
19. Butyl acetate
20. 4-Hydroxy-4-methyl-2-pentanone
21. 1-Methoxy-2-propyl acetate
22. Xylene
23. Cyclohexanone
24. Ethyl glycol acetate
25. Butyl glycol
26. Heptanol
27. Ethyl diglycol
28. Butyl diglycol
29. Butyl glycol acetate
30. Butyl diglycol acetate

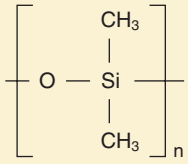


MN Appl. No. 201390

OPTIMA® 1 MS

100 % dimethylpolysiloxane

- selectivity identical to OPTIMA® 1



similar phases: Ultra-1, DB-1MS, HP-1MS, Rxi-1MS, Rtx-1MS, Equity-1, AT-1MS, VF-1MS, CP-Sil 5 CB MS

- max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature programme 360 °C
- phase with low bleeding
  suited for GC/MS and ECD applications and general analyses at trace level
- USP G1 / G2 / G38

Ordering information

Length →	12 m	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)						
0.20 µm film			726201.25		726201.50	
0.35 µm film	726203.12					
0.25 mm ID (0.4 mm OD)						
0.25 µm film		726205.15		726205.30		726205.60
0.32 mm ID (0.5 mm OD)						
0.25 µm film				726202.30		726202.60

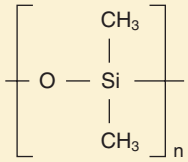
In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

OPTIMA® high performance capillary columns

OPTIMA® 1 MS Accent

100 % dimethylpolysiloxane

- selectivity identical to OPTIMA® 1



increased sensitivity due to an unmatched low background level

- USP G1 / G2 / G38

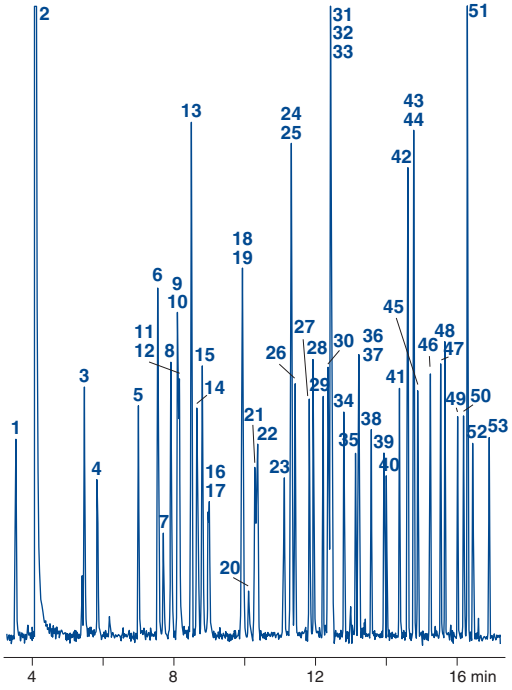
- max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature programme 360 °C
- **lowest column bleed,** nonpolar phase, ideal for ion trap and quadrupol MS detectors
- perfect inertness for basic compounds
- solvent rinsing for removal of impurities applicable
- application areas: all-round phase for environmental analyses, trace analyses, EPA methods, pesticides, PCB, food and drug analyses
- similar phases: Ultra-1, DB-1 MS, HP-1 MS, Rxi-1 MS, Rtx-1 MS, Equity-1, AT-1 MS, VF-1 MS, CP-Sil 5 CB MS

EPA 8140 / 8141 / 8141 A Organophosphorus pesticides

Column:	OPTIMA® 1 MS Accent, 0.50 µm film, 30 m x 0.32 mm ID, REF 725807.30
Sample:	0.2 µg/ml in hexane, 8140/8141 OP pesticides calibration mix A and 8141 OP pesticides calibration mix B; IS triphenyl phosphate and tributyl phosphate
Injection:	splitless (hold 1 min)
Inj. temperature:	250 °C
Carrier gas:	He, 1 ml/min, constant pressure
Temperature:	100 °C → 180 °C, 10 °C/min (2 min) → 300 °C, 18 °C/min (3 min)
Detector:	FPD (Flame Photometric Detector), 280 °C

Peaks:
1. Dichlorvos, 2. Hexamethylphosphoramide, 3. Mevinphos, 4. Trichlorfon, 5. TEPP, 6. Thionazin, 7. Demeton-O, 8. Ethoprop 9. Tributyl phosphate (IS), 10. Dicrotophos, 11. Monocrotophos, 12. Naled, 13. Sulfotepp, 14. Phorate, 15. Dimethoate, 16. Demeton-S, 17. Dioxathion, 18. Terbufos, 19. Fonophos, 20. Phosphamidon isomer, 21. Diazinon, 22. Disulfoton, 23. Phosphamidon, 24. Dichlorofenthion, 25. Parathion-methyl, 26. Chlorpyrifos methyl, 27. Ronnel, 28. Fenitrothion, 29. Malathion, 30. Fenthion, 31. Aspon, 32. Parathion-ethyl, 33. Chlorpyrifos, 34. Trichloronate, 35. Chlorfenvinphos, 36. Merphos, 37. Crotoxyphos, 38. Stirofos, 39. Tokuthion, 40. Merphos oxidation product, 41. Fensulfothion, 42. Famphur, 43. Ethion, 44. Bolstar, 45. Carbophenothion, 46. Triphenyl phosphate (IS), 47. Phosmet, 48. EPN, 49. Azinphos-methyl, 50. Leptophos, 51. Tri-*o*-cresyl phosphate, 52. Azinphos-ethyl, 53. Coumaphos

MN Appl. No. 213030



Ordering information

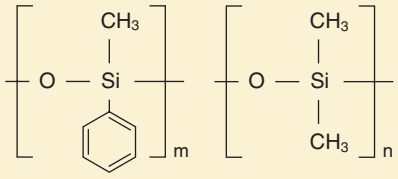
Length →	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)					
0.20 µm film		725801.25		725801.50	
0.25 mm ID (0.4 mm OD)					
0.25 µm film	725805.15		725805.30		725805.60
0.50 µm film			725806.30		725806.60
0.32 mm ID (0.5 mm OD)					
0.25 µm film			725802.30		725802.60
0.50 µm film			725807.30		725807.60

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Column ends are melted or closed with septa, and thus protected from atmospheric oxygen. Additionally, we supply the corresponding test mixture with each column.

OPTIMA® 5

5 % phenyl – 95 % methylpolysiloxane

- nonpolar phase



similar phases: PERMABOND® SE-52 (page 237), SE-54, SE-52, DB-5, HP-5, SPB-5, CP-Sil 8, Rtx-5, 007-5, BP5, MDN-5, AT-5, ZB-5

- for columns with 0.1 – 0.32 mm ID and films < 3 µm the max. temperature for isothermal operation is 340 °C, the max. temperature for short isotherms in a temperature programme is 360 °C
  for 0.53 mm ID columns with films < 3 µm the max. temperatures are 320 and 340 °C, resp.
  for thick film columns with films ≥ 3 µm the max. temperatures are 300 and 320 °C, resp.
- standard phase with large range of application
- USP G27 / G36

Ordering information

Length →	10 m	15 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)						
0.10 µm film	**726846.10**					
0.20 mm ID (0.4 mm OD)						
0.10 µm film			**726854.25**			
0.20 µm film			**726857.25**		**726857.50**	
0.35 µm film			**726860.25**		**726860.50**	
0.50 µm film			**726863.25**		**726863.50**	
0.25 mm ID (0.4 mm OD)						
0.10 µm film			**726911.25**	**726911.30**	**726911.50**	**726911.60**
0.25 µm film	**726056.10**	**726056.15**	**726056.25**	**726056.30**	**726056.50**	**726056.60**
0.35 µm film			**726623.25**	**726623.30**	**726623.50**	**726623.60**
0.50 µm film			**726099.25**	**726099.30**	**726099.50**	**726099.60**
1.00 µm film			**726807.25**	**726807.30**	**726807.50**	**726807.60**
0.32 mm ID (0.5 mm OD)						
0.10 µm film	**726313.10**	**726313.15**	**726313.25**	**726313.30**	**726313.50**	**726313.60**
0.25 µm film		**726314.15**	**726314.25**	**726314.30**	**726314.50**	**726314.60**
0.35 µm film			**726628.25**	**726628.30**	**726628.50**	**726628.60**
0.50 µm film			**726316.25**	**726316.30**	**726316.50**	**726316.60**
1.00 µm film		**726325.15**	**726325.25**	**726325.30**	**726325.50**	**726325.60**
3.00 µm film			**726809.25**	**726809.30**	**726809.50**	**726809.60**
5.00 µm film		**726934.15**	**726934.25**	**726934.30**		
0.53 mm ID (0.8 mm OD)						
0.50 µm film	**726523.10**		**726523.25**	**726523.30**		
1.00 µm film	**726541.10**	**726541.15**	**726541.25**	**726541.30**		
2.00 µm film	**726525.10**		**726525.25**	**726525.30**	**726525.50**	**726525.60**
5.00 µm film	**726916.10**		**726916.25**	**726916.30**	**726916.50**	

In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. For ordering, please add an E at the end of the REF number (e.g. 726470.30E)

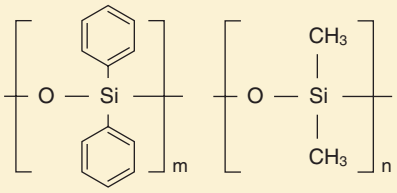
For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of **integrated precolumns**. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

OPTIMA® high performance capillary columns

OPTIMA® 5 MS

5 % diphenyl – 95 % dimethylpolysiloxane

- selectivity identical to OPTIMA® 5



- max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature programme 360 °C
- phase with low bleeding
  suited for GC/MS and ECD applications and general analyses at trace level
  perfect inertness for basic compounds
- USP G27 / G36

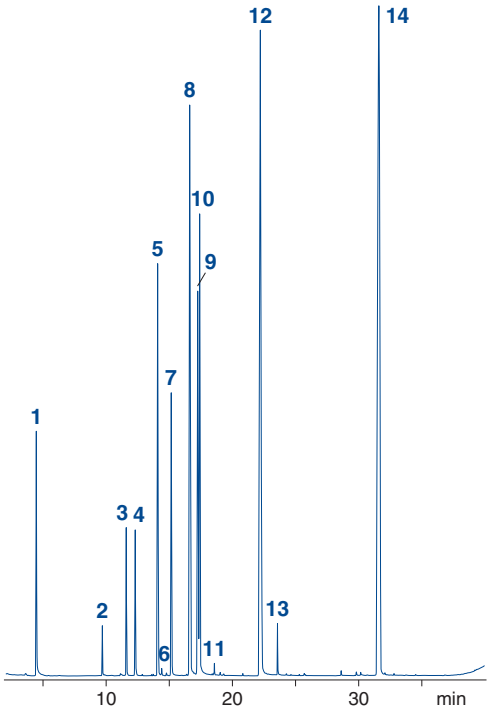
similar phases see OPTIMA® 5 MS Accent page 221

Analysis of various phenols

Column: OPTIMA® 5 MS, 30 m x 0.25 mm ID, 0.25 µm film, REF 726220.30, max. temperature 340/360 °C
Sample: 5 ppm of each compound except *N*-*i*-propylaniline (9.4 ppm)
Method: SPME
Temperature: 40 °C (2 min) → 240 °C, 6 °C/min → 320 °C, 20 °C/min
Detector: MSD

Peaks:
1. Toluene-D_8
2. Phenol
3. 2-Methylphenol (*o*-Cresol)
4. Nitrobenzene-D_5
5. *N*-*i*-Propylaniline
6. 2,4-Dichlorophenol
7. 4-Chlorophenol
8. 4-Bromo-2-chlorophenol
9. 3-Bromophenol
10. 4-Chloro-3-methylphenol
11. 2,4-Dibromophenol
12. 2-Hydroxybiphenyl
13. 2-Cyclohexylphenol
14. Hexafluorobisphenol A

Courtesy of Riedel-de-Haën, Seelze, Germany



MN Appl. No. 210110

Ordering information

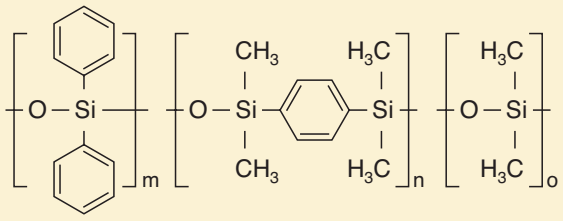
Length →	12 m	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)						
0.20 µm film	726210.12		726210.25		726210.50	
0.35 µm film	726215.12		726215.25		726215.50	
0.25 mm ID (0.4 mm OD)						
0.25 µm film		726220.15		726220.30		726220.60
0.50 µm film				726225.30		726225.60
1.00 µm film				726226.30		
0.32 mm ID (0.5 mm OD)						
0.25 µm film				726211.30		
0.50 µm film				726213.30		
1.00 µm film			726212.25		726212.50	726212.60

In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

OPTIMA® 5-MS Accent

silarylene phase

chemically bonded, cross-linked silarylene phase with polarity similar to a 5 % diphenyl – 95 % dimethylpolysiloxane phase



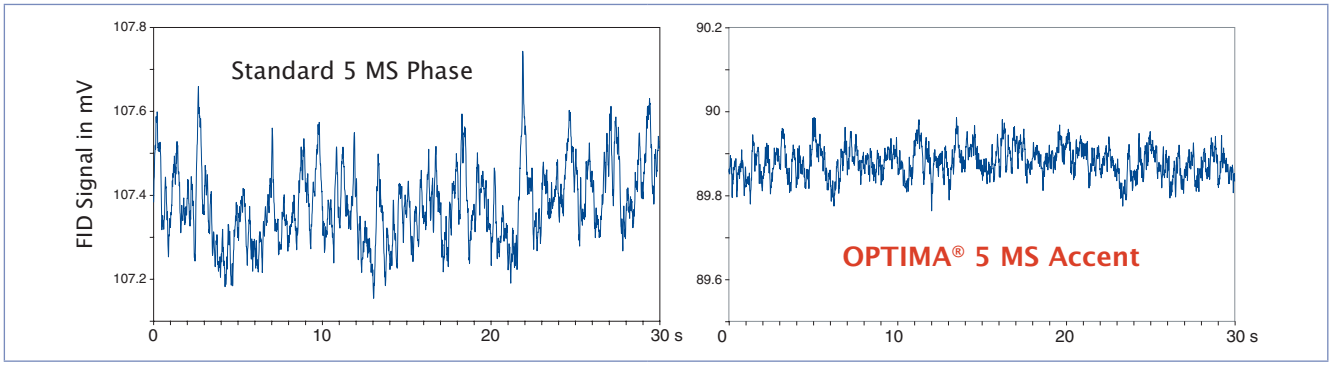
increased sensitivity due to an unmatched low background level

- max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature programme 360 °C, for columns with films > 0.5 µm max. temperatures are 320 and 340 °C, respectively
- **lowest column bleed,** nonpolar phase, ideal for ion trap and quadrupol MS detectors
  solvent rinsing for removal of impurities applicable
  application areas: all-round phase for environmental analyses, trace analyses, EPA methods, pesticides, PCB, food and drug analyses
  similar phases: DB-5 MS, HP-5 MS, Ultra-2, Equity-5, CP-Sil 8 CB low bleed/MS, Rxi-5 MS, Rtx-5SIL-MS, Rtx-5 MS, 007-5 MS, BPX5, MDN-5S, AT-5 MS, VF-5 MS
- USP G27 / G36

The bleed comparison test of the OPTIMA® 5-MS Accent with a conventional 5-MS phase shows the outstanding performance of the silarylene phase.

Background noise at 340 °C

The unmatched low background level of the OPTIMA® 5 MS Accent, which is approximately three times lower compared to a 5 MS brand column, provides significantly increased sensitivity and allows the application in trace analyses particularly of high-boiling compounds.



Ordering information

Length →	12 m	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)						
0.20 µm film			**725810.25**		**725810.50**	
0.35 µm film	**725815.12**				**725815.50**	
0.25 mm ID (0.4 mm OD)						
0.25 µm film		**725820.15**		**725820.30**		**725820.60**
0.50 µm film				**725825.30**		**725825.60**
1.00 µm film				**725826.30**		**725826.60**
0.32 mm ID (0.5 mm OD)						
0.25 µm film				**725811.30**		**725811.60**
0.50 µm film				**725813.30**		
1.00 µm film			**725812.25**			**725812.60**

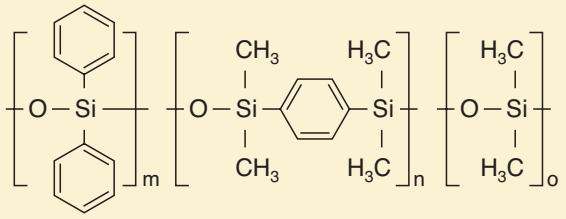
Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Column ends are melted or closed with septa, and thus protected from atmospheric oxygen. Additionally, we supply the corresponding test mixture with each column.

OPTIMA® high performance capillary columns

OPTIMA® XLB

silarylene phase

chemically bonded, cross-linked silarylene phase, optimised silarylene content for lowest column bleed



similar phases: DB-XLB, Rxi-XLB, Rtx-XLB, MDN-12, VF-XMS

max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature programme 360 °C,

lowest column bleed, nonpolar phase, ideal for ion trap and quadrupol MS detectors

perfect inertness for basic compounds

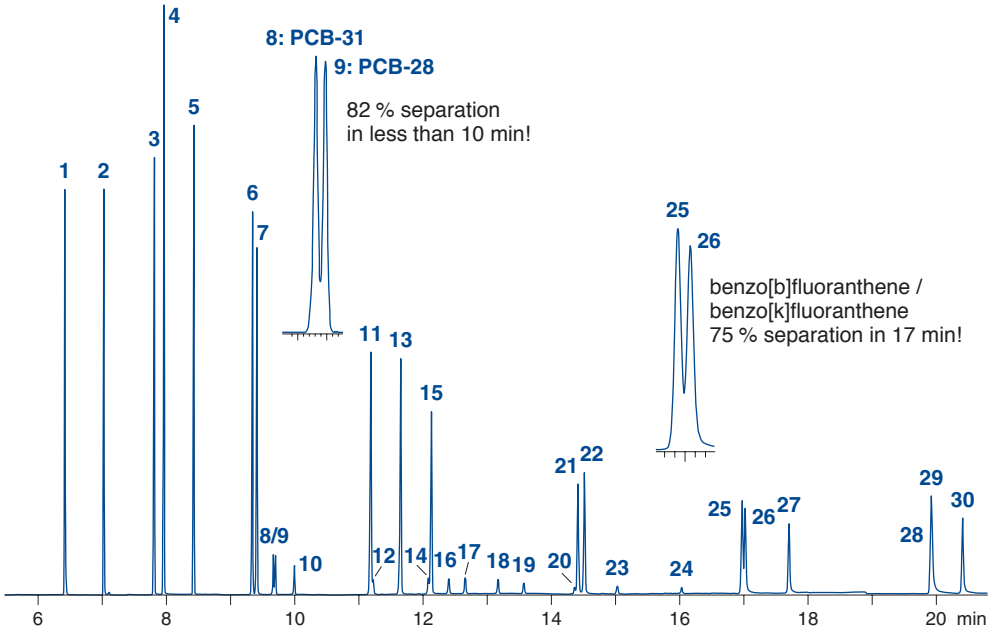
solvent rinsing for removal of impurities applicable

application areas: ultra low bleed phase, highly selective for environmental and trace analyses, pesticides

recommended phase for PCB separations

Rapid separation of PCB and PAH

Column: OPTIMA® XLB, 0.25 µm film, 30 m x 0.25 mm ID, REF 725850.30
Injection volume: 1 µl, standard 0.005 ng/µl
Injection: 250 °C, pulsed, splitless, pulse 1.38 bar in 1 min
Carrier gas: 60 ml/min He
Temperature: 40 °C (2 min) → 240 °C (2 min), 30 °C/min → 340 °C (5 min), 10 °C/min
Detection: MS source 230 °C, interface 280 °C, quadrupol 150 °C



Courtesy of Centre d'Analyses de Recherche, Lab. d'Hydrologie, F-65400 Illkirch, France

MN Appl. No. 212920

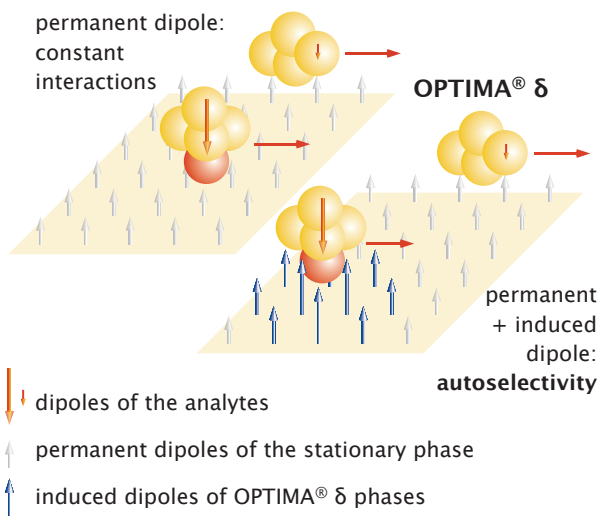
Peaks:
1. Naphthalene
2. 2-Methylnaphthalene
3. Acenaphthylene
4. Acenaphthene
5. Fluorene
6. Phenanthrene
7. Anthracene
8. PCB-31
9. PCB-28
10. PCB-52
11. Fluoranthene
12. PCB-101
13. Pyrene
14. PCB-77
15. 2-Methylfluoranthene
16. PCB-118
17. PCB-153
18. PCB-138
19. PCB-126
20. PCB-180
21. Benz[a]anthracene
22. Chrysene
23. PCB-169
24. PCB-194
25. Benzo[b]fluoranthene
26. Benzo[k]fluoranthene
27. Benzo[a]pyrene
28. Dibenz[ah]anthracene
29. Indeno[1,2,3-cd)pyrene
30. Benzo[ghi]perylene

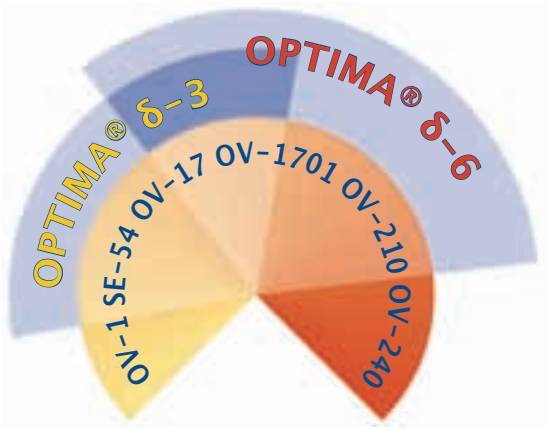
Ordering information

Length →	30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	**725850.30**	**725850.60**

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. For ordering, please add an E at the end of the REF number (e.g. 725850.60E).

OPTIMA® δ · unique phases with autoselectivity





range of polarities covered by OPTIMA® δ phases

Key features of the OPTIMA® δ are:

- wide range of applications due to autoselectivity
- outstanding thermal stability similar to nonpolar phases
- low bleed levels
- extremely inert
- medium polar without CN groups

All stationary phases in GC offer a selectivity, called polarisability, that is influenced by the sample, but OPTIMA® δ-3 and OPTIMA® δ-6 offer this valuable feature to a greater extent than any other phase. The polymers consist of cross-linked polysiloxane block polymers with defined composition, and extremely narrow molecular weight distribution, which are exclusively produced for MACHEREY-NAGEL. Especially polar analytes are able to induce a dipole moment in the stationary phase, so that the molecules show stronger interactions with the phase. This enhanced interaction is maintained at higher temperatures, where normally interactions between molecule and phase become reduced due to the Brownian movement. We call this phenomenon "autoselectivity", because the stationary phase adjusts itself to the polarity of the analytes. Thus OPTIMA® δ phases cover broad ranges of polarities. Compared with conventional phases, OPTIMA® δ-3 polarity ranges from approximately the nonpolar OPTIMA® 5 to the midpolar OPTIMA® 1701, while for OPTIMA® δ-6 the polarity covers a range from about the midpolar OPTIMA® 17 to the polar OPTIMA® 210.

Due to this feature, the OPTIMA® δ columns show interesting patterns of selectivity. For example, inversions in the sequence of peak elution may occur, which recommends the columns for reference use (e.g. in combination with OPTIMA® 5).

In conventional midpolar phases the polarity is induced by phenyl, but especially by cyano and trifluoromethyl groups. The two latter often cause bleeding, which results in severe problems with some detectors. In contrast, the OPTIMA® δ phases show very high temperature limits (340/360 °C), as well as low bleed levels, which makes them ideal for the use with mass selective (MSD) or phosphorus/nitrogen detectors (PND) in the field of environmental trace analysis.

Isomeric phenols, such as chloro- and nitrophenols, are difficult to analyse with standard GC phases (e.g. OPTIMA® 5 or OPTIMA® 17) because of coelutions. The autoselective OPTIMA® δ-3 is able to separate all 22 phenols due to stronger interactions occurring with more polar molecules, because polar analytes induce a dipole moment in the phase of the OPTIMA® δ-3 (see chromatogram next page).

References

W. Röder, D. Lennartz, GIT 3/99, p. 226

R. Looser, K. Ballschmiter, J. Chromatogr. 836 (1999), 271-284

R. Baycan-Keller, M. Oehme, J. Chromatogr. 837 (1999), 201 – 210

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Column ends are melted or closed with septa, and thus protected from atmospheric oxygen. Additionally, we supply the corresponding test mixture with each column.

For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of **integrated precolumns**. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

OPTIMA® δ · unique phases with autoselectivity

OPTIMA® δ-3

polysiloxane phase with autoselectivity

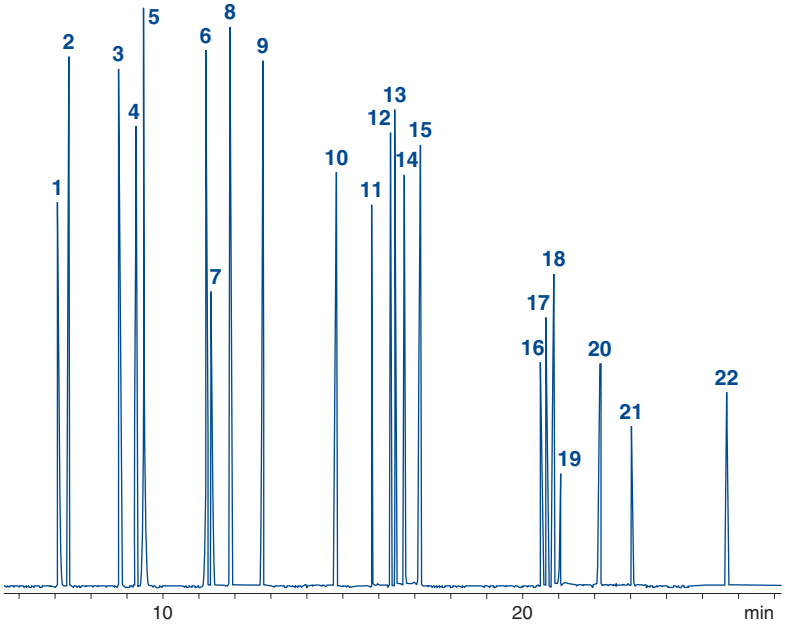
- medium polar without CN groups
  analytes determine the polarity of the phase
  unique from MN, no similar phase
  ideal for MSD and PND detectors
- USP G49

- max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature programme 360 °C
  for 0.53 mm ID columns the max. temperatures are 320 and 340 °C, resp.
- autoselectivity resulting in a wide range of polarities from approximately the non-polar OPTIMA® 5 to the midpolar OPTIMA® 1701

Analysis of isomeric phenols

Column: OPTIMA® δ-3, 0.25 µm film, 60 m x 0.25 mm ID, max. temperature 340/360 °C, REF 726420.60
Injection: 1.0 µl, split 1:80
Carrier gas: He, 1.3 bar
Temperature: 60 °C (3 min) → 320 °C, 6 °C/min
Detector: MSD HP 5971

Peaks:
1. Phenol
2. 2-Chlorophenol
3. 2-Methylphenol
4. 4-Methylphenol
5. 3-Methylphenol
6. 2,4-Dimethylphenol
7. 2-Nitrophenol
8. 2,4-Dichlorophenol
9. 2,6-Dichlorophenol
10. 4-Chloro-3-methylphenol
11. 2,3,5-Trichlorophenol
12. 2,4,6-Trichlorophenol
13. 2,4,5-Trichlorophenol
14. 2,3,4-Trichlorophenol
15. 2,3,6-Trichlorophenol
16. 2,3,5,6-Tetrachlorophenol
17. 2,3,4,5-Tetrachlorophenol
18. 2,3,4,6-Tetrachlorophenol
19. 2,4-Dinitrophenol
20. 3,4,5-Trichlorophenol
21. 2-Methyl-4,6-dinitrophenol
22. 2-Isopropyl-4,6-dinitrophenol



MN Appl. No. 250060

Ordering information

Length →	10 m	20 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)						
0.10 µm film	**726410.10**	**726410.20**				
0.2 mm ID (0.4 mm OD)						
0.20 µm film			**726400.25**		**726400.50**	
0.25 mm ID (0.4 mm OD)						
0.25 µm film				**726420.30**		**726420.60**
0.50 µm film				**726421.30**		
0.32 mm ID (0.5 mm OD)						
0.25 µm film				**726440.30**		**726440.60**
0.35 µm film				**726441.30**		**726441.60**
1.00 µm film				**726442.30**		**726442.60**
0.53 mm ID (0.8 mm OD)						
1.00 µm film				**726443.30**		

In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

OPTIMA® δ-6

polysiloxane phase with autoselectivity

- medium polar without CN groups
  analytes determine the polarity of the phase
  unique from MN, no similar phase
  ideal for MSD and PND detectors

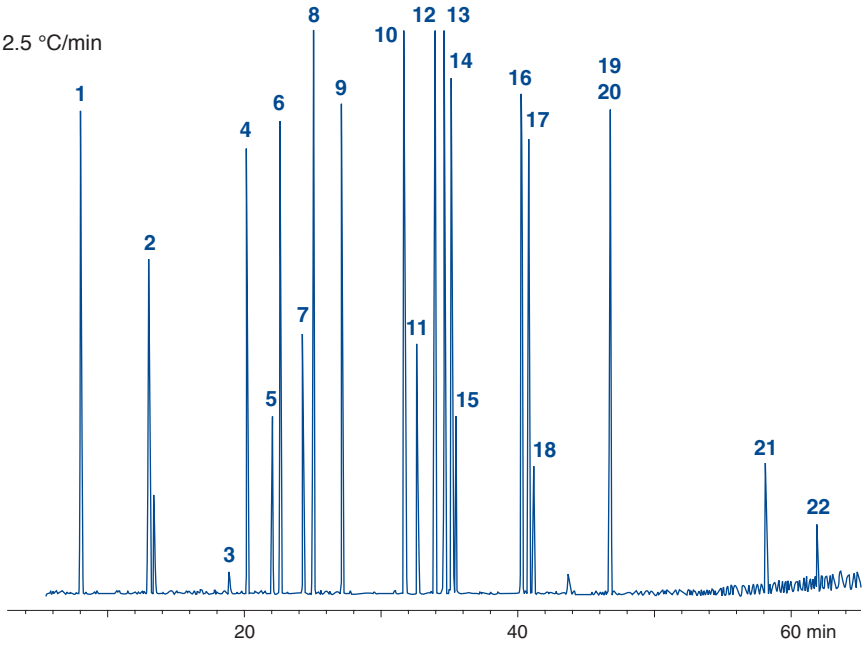
- max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature programme 360 °C
  for 0.53 mm ID columns the max. temperatures are 320 and 340 °C, resp.
- **autoselectivity resulting in a wide range of polarities from approximately the mid-polar OPTIMA® 17 to the polar OPTIMA® 210**

Separation of organophosphorus pesticides (EPA 8140/8141)

Column: OPTIMA® δ-6, 0.2 µm film, 50 m x 0.2 mm ID, max. temperature 340/360 °C, REF 726465.50
Sample: EPA 8140 OP pesticide calibration mix (Restek), 200 µg/ml each in hexane – acetone (95:5)
Injection volume: 1 µl, split 1:30
Carrier gas: 2.0 bar He
Temperature: 150 °C → 300 °C (10 min), 2.5 °C/min
Detector: MSD HP 5971

Peaks:
1. Dichlorvos
2. Mevinphos
3. Demeton-s
4. Ethoprop
5. Naled
6. Phorate
7. Demeton-o
8. Diazinon
9. Disulfoton
10. Ronnel
11. Parathion-methyl
12. Chlorpyrifos
13. Trichloronate
14. Fenthion
15. Merphos
16. Stirofos
17. Tokuthion
18. Merphos oxidation product
19. Fensulfothion
20. Bolstar
21. Azinphos-methyl
22. Coumaphos

MN Appl. No. 250420



Ordering information

Length →	10 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)					
0.10 µm film	**726490.10**				
0.2 mm ID (0.4 mm OD)					
0.20 µm film		**726465.25**		**726465.50**	
0.25 mm ID (0.4 mm OD)					
0.25 µm film			**726470.30**		**726470.60**
0.32 mm ID (0.5 mm OD)					
0.25 µm film			**726480.30**		**726480.60**
0.35 µm film			**726481.30**		**726481.60**
1.00 µm film			**726482.30**		**726482.60**
0.53 mm ID (0.8 mm OD)					
1.00 µm film			**726483.30**		

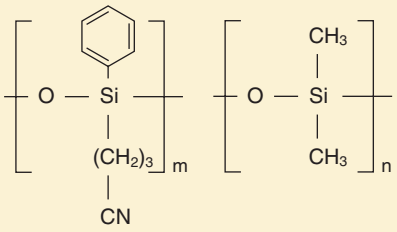
In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

OPTIMA® high performance capillary columns

OPTIMA® 1301

6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane

- medium polar phase



similar phases: HP-1301, DB-1301, SPB-1301, Rtx-1301, CP-1301, 007-1301

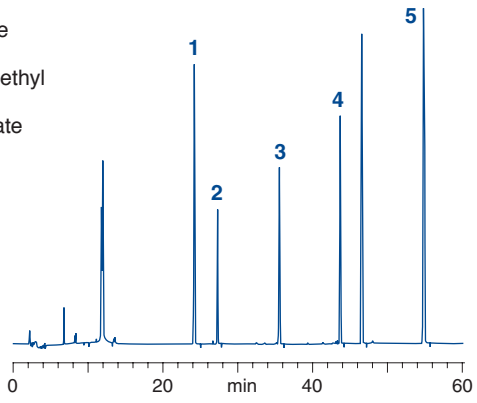
- max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature programme 320 °C
- ideal for pesticide analyses

  for corresponding columns with higher film thickness see OPTIMA® 624
- USP G43

Analysis of a pesticide mixture

Column: OPTIMA® 1301, 0.25 µm film, 60 m x 0.25 mm ID, max. temperature 300/320 °C, REF 726 771.60
Injection: 3 µl (0.1 ng/µl), 80 °C (1 min) → 250 °C (1 min) pulsed splitless
Carrier gas: He, 54 ml/min
Temperature: 80 °C (2 min) → 190 °C, 20 °C/min (12 min) → 240 °C, 2 °C/min (23 min) → 260 °C, 10 °C/min (20 min)
Detector: ECD

Peaks :
1. Propyzamide
2. Vinclozolin
3. Bromophos-ethyl
4. 2,4-DDT
5. Brompropylate

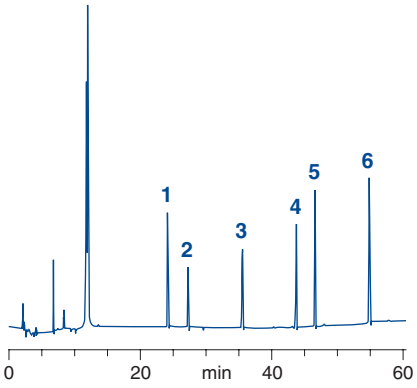


MN Appl. No. 210620

Analysis of a PCB mixture

Column: OPTIMA® 1301, 0.25 µm film, 60 m x 0.25 mm ID, max. temperature 300/320 °C, REF 726 771.60
Injection: 3 µl (0.1 ng/µl), 80 °C (1 min) → 250 °C (1 min) pulsed splitless
Carrier gas: He, 54 ml/min
Temperature: 80 °C (2 min) → 190 °C, 20 °C/min (12 min) → 240 °C, 2 °C/min (23 min) → 260 °C, 10 °C/min (20 min)
Detector: ECD

Peaks :
1. PCB-28
2. PCB-52
3. PCB-128
4. PCB-153
5. PCB-138
6. PCB-180



MN Appl. No. 210650

Ordering information

Length →	25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)				
0.25 µm film	**726771.25**	**726771.30**	**726771.50**	**726771.60**
0.32 mm ID (0.5 mm OD)				
0.25 µm film	**726777.25**	**726777.30**		**726777.60**
1.00 µm film		**726780.30**	**726780.50**	**726780.60**
0.53 mm ID (0.8 mm OD)				
1.00 µm film	**726783.25**			

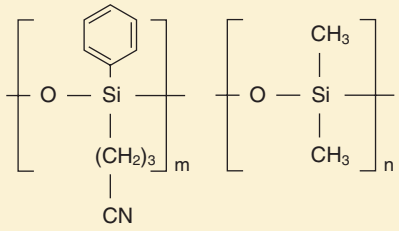
In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Column ends are melted or closed with septa, and thus protected from atmospheric oxygen. Additionally, we supply the corresponding test mixture with each column.

OPTIMA® 624

6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane

- medium polar phase



similar phases: HP-624, HP-VOC, DB-624, DB-VRX, SPB-624, CP-624, Rtx-624, Rtx-Volatiles, 007-624, BP624, VOCOL

- max. temperature for isothermal operation 280 °C, max. temperature for short isotherms in a temperature programme 300 °C
- recommended for environmental analyses

  for corresponding columns with lower film thickness see OPTIMA® 1301
- USP G43

OPTIMA® 624 *LB*

6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane

- excellent Low Bleed columns for halogenated hydrocarbons, volatiles, aromatic compounds, solvents etc.

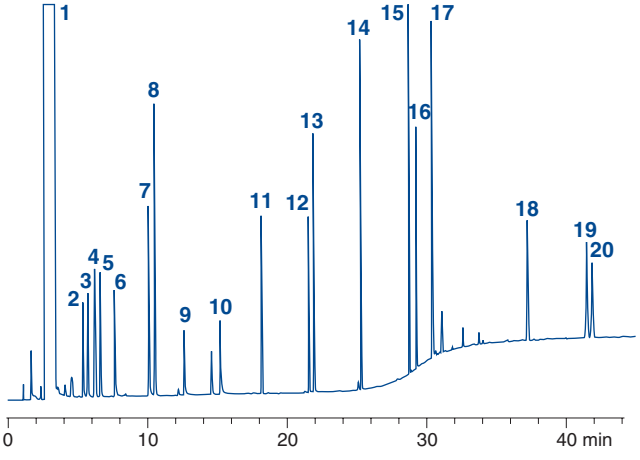
Solvents and semi-volatiles

Column: OPTIMA® 624 *LB*, 1.8 µm film, 30 m x 0.32 mm ID, REF 726786.30; retention gap Phe-Sil 0.5 m x 0.53 mm, Cat. No. 723711.10
Carrier gas: 1.1 bar He
Temperature: 45 °C (3 min) → 150 °C (6 °C/min) → 300 °C (18 °C/min), 20 min 300 °C
Injection: 1 µl (10 ppm per substance in acetone), cold on-column
Detection: FID 280 °C

Peaks:

1. Acetone
2. Ethyl acetate
3. Tetrahydrofuran
4. Cyclohexane
5. Methyl-2-butanol-2
6. Butanol-1
7. Pyridine
8. Toluene
9. Dimethylformamide
10. Dimethylsulfoxide
11. Decane
12. Octanol-1
13. Acetophenone
14. Butyrophenone
15. Heptanophenone
16. Methoxy-5-indole
17. Dibenzylamine
18. Methyl eicosanoate
19. Methyl *cis*-13-docosenoate
20. Methyl docosanoate

MN Appl. No. 212520



Ordering information

Length →	25 m	30 m	50 m	60 m
OPTIMA® 624				
0.2 mm ID (0.4 mm OD)				
1.10 µm film	726784.25			
0.25 mm ID (0.4 mm OD)				
1.40 µm film	726785.25	726785.30	726785.50	726785.60
0.32 mm ID (0.5 mm OD)				
1.80 µm film	726787.25	726787.30	726787.50	726787.60
0.53 mm ID (0.8 mm OD)				
3.00 µm film	726789.25	726789.30		
OPTIMA® 624 *LB*				
0.32 mm ID (0.5 mm OD)				
1.80 µm film		726786.30	726786.50	

In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

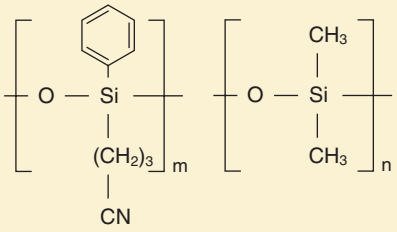
On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. For ordering, please add an E at the end of the REF number (e.g. 726470.30E)

OPTIMA® high performance capillary columns

OPTIMA® 1701

14 % cyanopropyl-phenyl – 86 % dimethylpolysiloxane

- medium polar phase



similar phases: OV-1701, DB-1701, CP-Sil 19 CB, HP-1701, Rtx-1701, SPB-1701, 007-1701, BP10, ZB-1701

- max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature programme 320 °C
  for 0.53 mm ID columns the max. temperatures are 280 and 300 °C, resp.
- special selectivity due to high cyanopropyl content
  reference column for structure identification, e.g. in combination with OPTIMA® 5
  film thickness ≥ 1 µm for solvent analyses
- USP G46

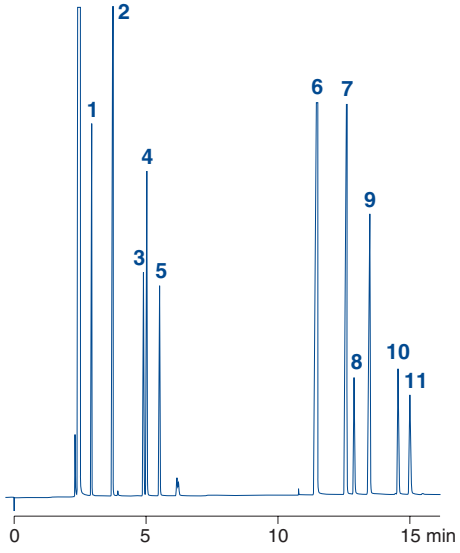
Analysis of aromatic hydrocarbons

Column: OPTIMA® 1701, 0.25 µm film, 25 m x 0.32 mm ID, REF 726318.25, max. temperature 300/320 °C
Injection volume: 1 µl
Carrier gas: 0.6 bar N_2
Split: 1:40
Temperature: 60 °C → 120 °C, 4 °C/min
Detector: FID 260 °C

Peaks:

1. Benzene
2. Toluene
3. Ethylbenzene
4. *p*-Xylene
5. *o*-Xylene
6. Phenol
7. 2-Methylphenol
8. 2,6-Dimethylphenol
9. 4-Methylphenol
10. 2,4-Dimethylphenol
11. 2,4,6-Trimethylphenol

MN Appl. No. 200400



Ordering information

Length →	10 m	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)						
0.20 µm film			**726841.25**		**726841.50**	
0.25 mm ID (0.4 mm OD)						
0.25 µm film	**726058.10**	**726058.15**	**726058.25**	**726058.30**	**726058.50**	**726058.60**
0.50 µm film				**726064.30**		**726064.60**
1.00 µm film				**726965.30**		
0.32 mm ID (0.5 mm OD)						
0.25 µm film	**726318.10**	**726318.15**	**726318.25**	**726318.30**	**726318.50**	**726318.60**
0.35 µm film			**726824.25**	**726824.30**	**726824.50**	**726824.60**
0.50 µm film			**726320.25**	**726320.30**	**726320.50**	**726320.60**
1.00 µm film			**726929.25**	**726929.30**	**726929.50**	**726929.60**
0.53 mm ID (0.8 mm OD)						
1.00 µm film	**726545.10**	**726545.15**	**726545.25**	**726545.30**		
2.00 µm film		**726735.15**	**726735.25**	**726735.30**	**726735.50**	

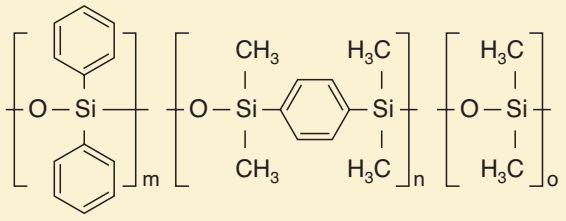
In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

OPTIMA® 35 MS

NEW!

silarylene phase

chemically bonded cross-linked silarylene phase with selectivity similar to 35 % phenyl / 65 % methyl polysiloxane

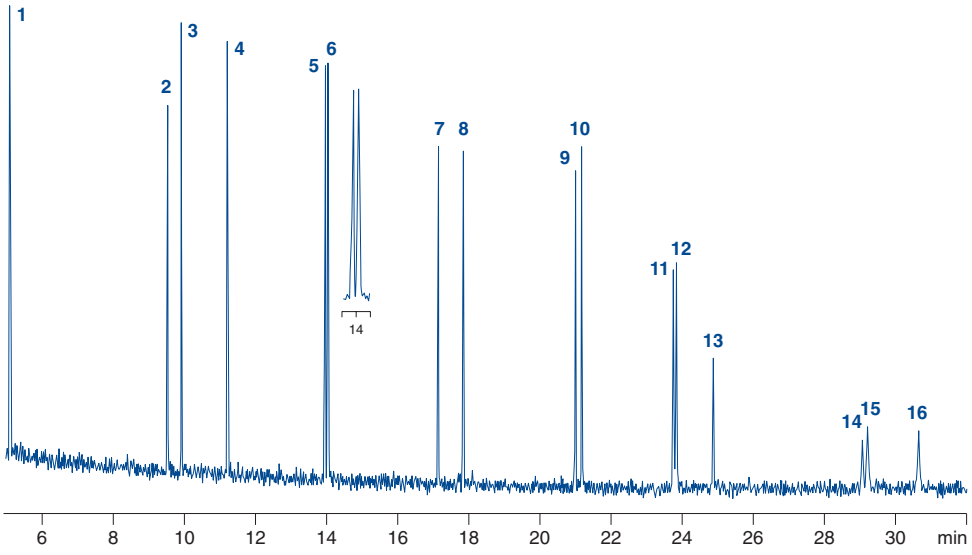


similar phases: DB-35 MS, HP-35, SPB-35, Rxi-35SIL MS, Rtx-35, 007-35, BPX-35, MDN-35, AT-35 MS, ZB-35, OV-11, VF-35 MS

- max. temperature for isothermal operation 360 °C, max. temperature for short isotherms in a temperature programme 370 °C,
- **very low column bleeding,** midpolar phase, recommended for ion-trap detectors
- optimum column for confirmation of analytical results in combination with a 1 MS or 5 MS
- polymer without CN groups
- recommended application: allround phase for environmental analyses, ultra trace analyses, EPA methods, pesticides, PCBs, food and drug analyses
- USP G42

PAH in accordance with EPA 610

Column: OPTIMA® 35 MS, 0.25 µm film, 30 m x 0,25 mm ID, REF 726154.30
Injection volume: 1 µl
Carrier gas: 0.6 bar H_2, split 1:10
Temperature: 100 °C (3 min) → 300 °C (10 min), 6 °C/min
Detector: MSD



Peaks
1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Phenanthrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[a]anthracene
10. Chrysene
11. Benzo[b]fluoranthene
12. Benzo[k]fluoranthene
13. Benzo[a]pyrene
14. Indeno[1,2,3-cd]pyrene
15. Dibenz[ah]anthracene
16. Benzo[ghi]perylene

MN Appl. No. 213190

Ordering information

Length →	30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	**726154.30**	**726154.60**
0.32 mm ID (0.5 mm OD)		
0.25 µm film	**726157.30**	**726157.60**

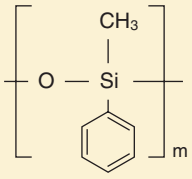
Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Column ends are melted or closed with septa, and thus protected from atmospheric oxygen. Additionally, we supply the corresponding test mixture with each column.

OPTIMA® high performance capillary columns

OPTIMA® 17

phenylmethylpolysiloxane (50 % phenyl)

- medium polar phase

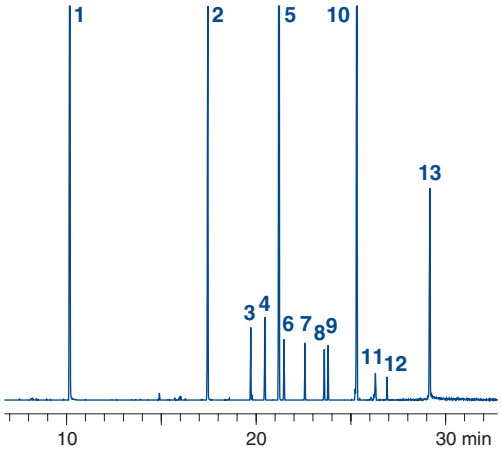


similar phases: OV-17, DB-17, HP-50+, HP-17, SPB-50, SP-2250, Rxi-17, Rtx-50, CP-Sil 24 CB, 007-17, ZB-50

- max. temperature for isothermal operation 320 °C, max. temperature for short isotherms in a temperature programme 340 °C
  for 0.53 mm ID columns the max. temperatures are 300 and 320 °C, resp.
- preferred applications: steroids, pesticides, drug analyses
- USP G3

Analysis of pesticides

Column:	OPTIMA® 17, 0.20 µm film, 25 m x 0.20 mm ID, max. temperature 320/340 °C, REF 726065.25
Samples:	pesticides, standard of the cantonal laboratory Schaffhausen (Switzerland), 0.1 mg/ml or 0.01 mg/ml each
Injection volume:	1.0 µl
Carrier gas:	He, 25 cm/s, 3 sec without split
Temperature:	100 °C (3 min), 8 °C/min → 250 °C, 10 °C/min → 320 °C
Detector:	MSD HP 5971



Peaks:
1. Dichlorvos
2. Naled
3. Vinclozolin
4. Chlorthalonil
5. Chlorpyrifos
6. Dichlofluanid
7. Procymidon
8. Captan
9. Folpet
10. Carbophenothion
11. Iprodion
12. Captafol
13. Coumaphos

MN Appl. No. 200930

Ordering information

Length →	10 m	12 m	15 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)							
0.10 µm film	**726848.10**						
0.2 mm ID (0.4 mm OD)							
0.20 µm film		**726065.12**		**726065.25**		**726065.50**	
0.50 µm film				**726066.25**		**726066.50**	
0.25 mm ID (0.4 mm OD)							
0.15 µm film				**726742.25**	**726742.30**	**726742.50**	**726742.60**
0.25 µm film			**726022.15**	**726022.25**	**726022.30**	**726022.50**	**726022.60**
0.50 µm film				**726067.25**	**726067.30**	**726067.50**	**726067.60**
0.32 mm ID (0.5 mm OD)							
0.15 µm film					**726755.30**		
0.25 µm film				**726351.25**	**726351.30**	**726351.50**	**726351.60**
0.35 µm film				**726757.25**	**726757.30**	**726757.50**	**726757.60**
0.50 µm film				**726744.25**	**726744.30**	**726744.50**	**726744.60**
0.53 mm ID (0.8 mm OD)							
1.00 µm film	**726747.10**		**726747.15**	**726747.25**	**726747.30**		

In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

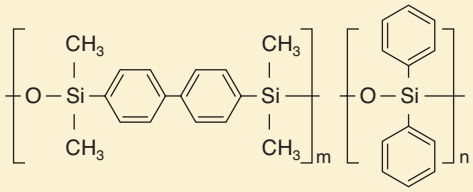
On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. For ordering, please add an E at the end of the REF number (e.g. 726470.30E)

OPTIMA® 17 MS

NEW!

silarylene phase

- medium polar silarylene phase with selectivity analogue to 50 % phenyl – 50 % methylpolysiloxane



similar phases: OV-17, AT-50, BPX-50, DB-17, DB-17ms, HP-50+, HP-17, SPB-50, SPB-17, SP-2250, Rtx-50, CP-Sil 24 CB, 007-17, VF-17ms, ZB-50

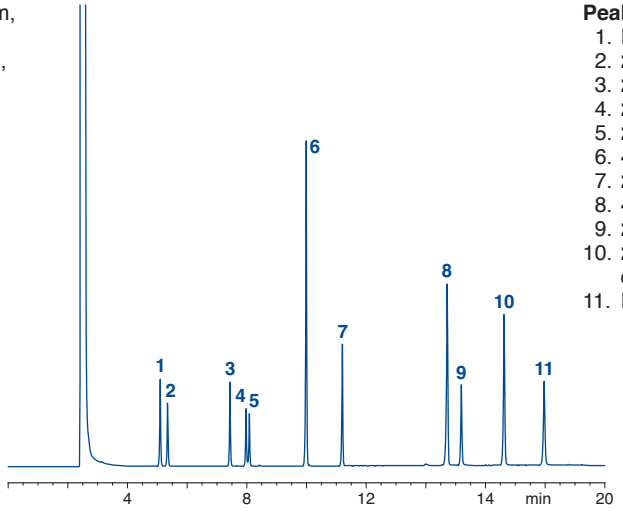
- max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature programme 360 °C
- ideal for ion trap detectors

  optimum reference column in combination with a 1 MS or 5 MS

  no CN groups in the polymer
- recommended applications: all-round phase for environmental analyses, ultra-trace analyses, EPA methods, pesticides, PCBs, food and drug analyses
- USP G3

Analysis of phenols

Column:	OPTIMA® 17 MS, 0.25 µm film, 30 m x 0.25 mm ID, max. temperature 340/360 °C, REF 726162.30
Sample:	phenol mix 604
Injection:	1.0 µl, 230 °C
Carrier gas:	He, 0.8 bar, split 1:30
Temperature:	100 °C, 10 °C/min → 250 °C
Detector:	FID, 280 °C



Peaks:
1. Phenol
2. 2-Chlorophenol
3. 2,4-Dimethylphenol
4. 2-Nitrophenol
5. 2,4-Dichlorophenol
6. 4-Chloro-3-methylphenol
7. 2,4,6-Trichlorophenol
8. 4-Nitrophenol
9. 2,4-Dinitrophenol
10. 2-Methyl-4,6-dinitrophenol
11. Pentachlorophenol

MN Appl. No. 213600

Ordering information

Length →	30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	**726162.30**	**726162.60**
0.32 mm ID (0.5 mm OD)		
0.25 µm film	**726165.30**	**726165.60**

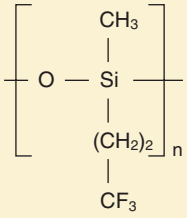
Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Column ends are melted or closed with septa, and thus protected from atmospheric oxygen. Additionally, we supply the corresponding test mixture with each column.

For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of **integrated precolumns**. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

OPTIMA® high performance capillary columns

OPTIMA® 210 — trifluoropropyl-methylpolysiloxane (50 % trifluoropropyl)

- polar phase



- max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature programme 280 °C
- recommended for environmental analyses, especially for *o*-, *m*- and *p*-substituted aromatic hydrocarbons
- close equivalent to USP G6

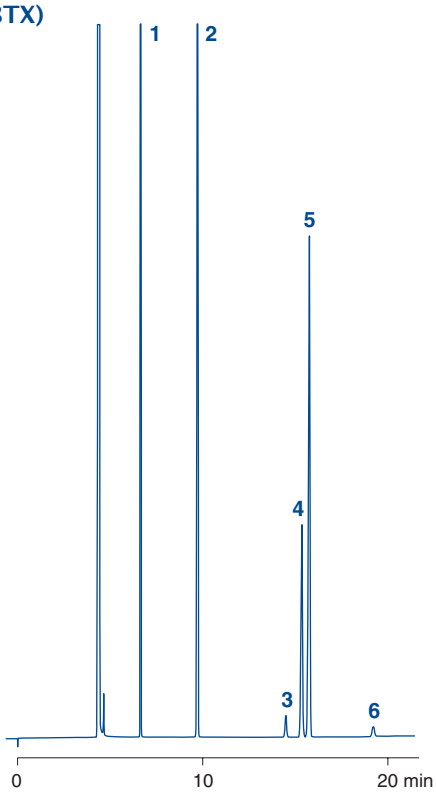
similar phases: OV-210, DB-210, Rtx-200, 007-210

Aromatic hydrocarbons (BTX)

Column:	OPTIMA® 210, 0.5 µm film, 50 m x 0.25 mm ID, max. temperature 240/260 °C, REF 726874.50
Injection volume:	0.5 µl
Carrier gas:	130 kPa N_2 (1.1 ml/min)
Split:	105 ml/min
Temperature:	50 °C
Detector:	FID 250 °C, 2^6

Peaks:
1. Benzene
2. Toluene
3. Ethylbenzene
4. *p*-Xylene
5. *m*-Xylene
6. *o*-Xylene

MN Appl. No. 200230



Ordering information

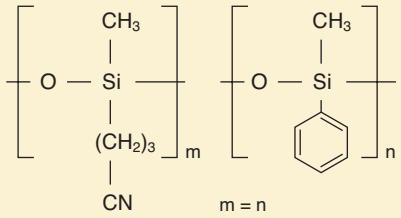
Length →	15 m	25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)					
0.25 µm film	**726871.15**	**726871.25**	**726871.30**	**726871.50**	**726871.60**
0.50 µm film			**726874.30**	**726874.50**	**726874.60**
0.32 mm ID (0.5 mm OD)					
0.25 µm film	**726877.15**		**726877.30**	**726877.50**	**726877.60**
0.50 µm film		**726880.25**	**726880.30**	**726880.50**	**726880.60**

In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of **integrated precolumns**. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

OPTIMA® 225 — 50 % cyanopropyl-methyl – 50 % phenylmethylpolysiloxane

- polar phase



similar phases: DB-225, HP-225, OV-225, Rtx-225, CP-Sil 43, 007-225, BP225

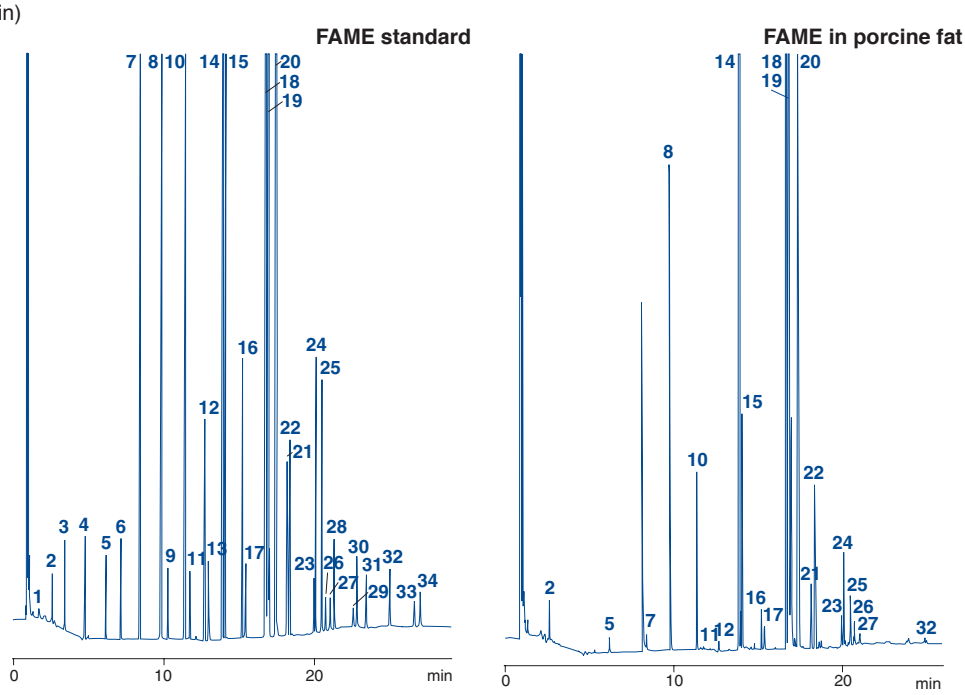
- max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature programme 280 °C
- recommended for fatty acid analyses
- close equivalent to USP G7 / G19

Analysis of FAME in porcine fat

Column: OPTIMA® 225, 0.25 µm film, 25 m x 0.32 mm ID, max. temperature 260/280 °C, REF 726352.25
Injection volume: 1 µl, split 1:40; carrier gas 60 kPa H_2
Temperature: 50 °C (2 min) → 125 °C, 30 °C/min → 160 °C, 5 °C/min → 180 °C, 20 °C/min → 200 °C, 3 °C/min → 220 °C, 20 °C/min (10 min)
Detector: FID 260 °C

Peaks:

1. C4:0	18. C18:0
2. C5:0	19. C18:1
3. C6:0	20. C18:2
4. C8:0	21. C18:3
5. C10:0	22. C19:0
6. C11:0	23. C20:0
7. C12:0	24. C20:1
8. C13:0	25. C20:2
9. C13:1	26. C20:4
10. C14:0	27. C20:3
11. C14:1	28. C20:5
12. C15:0	29. C22:0
13. C15:1	30. C22:1
14. C16:0	31. C22:2
15. C16:1	32. C22:6
16. C17:0	33. C24:0
17. C17:1	34. C24:1



Courtesy of Dr. Bantleon, Mr. Leusche, Mr. Hagemann, VFG-Labor, Versmold, Germany

MN Appl. No. 210060

Ordering information

Length →	10 m	15 m	25 m	30 m	50 m	60 m
0.10 mm ID (0.4 mm OD)						
0.10 µm film	**726080.10**					
0.25 mm ID (0.4 mm OD)						
0.25 µm film		**726118.15**	**726118.25**	**726118.30**	**726118.50**	**726118.60**
0.32 mm ID (0.5 mm OD)						
0.25 µm film			**726352.25**	**726352.30**	**726352.50**	**726352.60**

In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

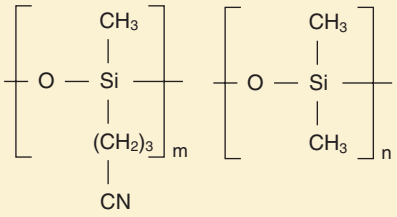
On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. For ordering, please add an E at the end of the REF number (e.g. 726470.30E)

OPTIMA® high performance capillary columns

OPTIMA® 240

33 % cyanopropyl-methyl – 67 % dimethylpolysiloxane

- polar phase



no similar phases

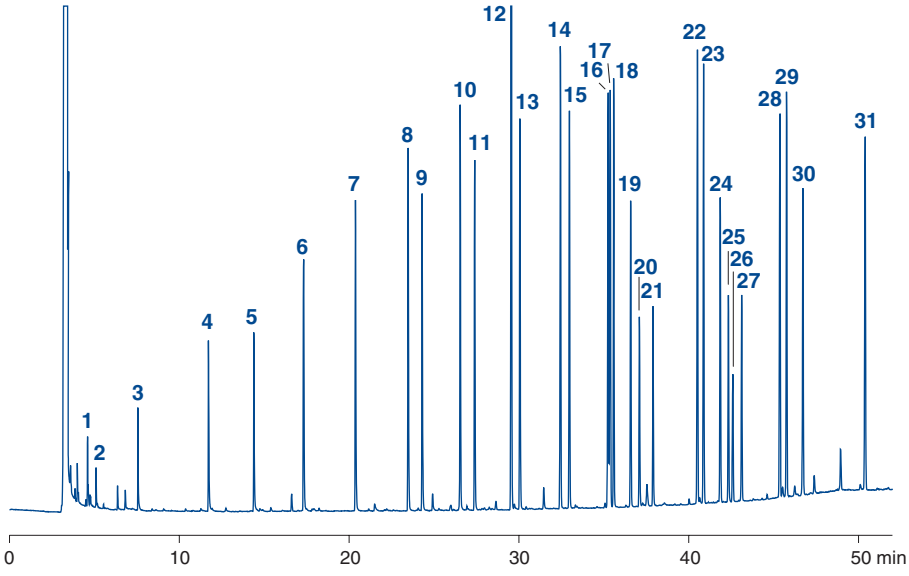
- max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature programme 280 °C
- recommended for FAMEs, dioxins

Fatty acid methyl esters *cis/trans* C 18:1 (FAME)

Column: OPTIMA® 240, 0.25 film, 60 m x 0.25 mm ID, max. temperature 260/280 °C, REF 726089.60
Sample: FAME mixture
Injection volume: 1.0 µl, split 1 : 25
Carrier gas: 150 kPa H_2
Temperature: 80 °C → 120 °C, 20 °C/min → 260 °C (10 min), 3 °C/min
Detector: FID 280 °C

Peaks:

1. C4:0
2. C5:0
3. C8:0
4. C10:0
5. C11:0
6. C12:0
7. C13:0
8. C14:0
9. C14:1
10. C15:0
11. C15:1
12. C16:0
13. C16:1
14. C17:0
15. C17:1
16. C18:0
17. *trans*-C18:1
18. *cis*-C18:1
19. C18:2
20. C18:3
21. C18:3
22. C20:0
23. C20:1
24. C20:2
25. C20:3
26. C20:4
27. C20:3
28. C22:0
29. C22:1
30. C22:3
31. C24:1



MN Appl. No. 201620

Ordering information

Length →	25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)				
0.25 µm film		**726089.30**	**726089.50**	**726089.60**
0.50 µm film		**726090.30**		**726090.60**
0.32 mm ID (0.5 mm OD)				
0.25 µm film	**726091.25**	**726091.30**	**726091.50**	**726091.60**
0.35 µm film		**726095.30**		**726095.60**
0.50 µm film		**726096.30**		**726096.60**

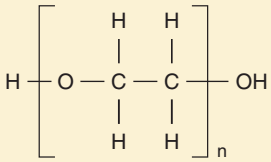
In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Column ends are melted or closed with septa, and thus protected from atmospheric oxygen. Additionally, we supply the corresponding test mixture with each column.

OPTIMA® WAX

polyethylene glycol 20 000 dalton

- polar phase



- USP G16

  similar phases: PERMABOND® CW 20 M (page 238), DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax

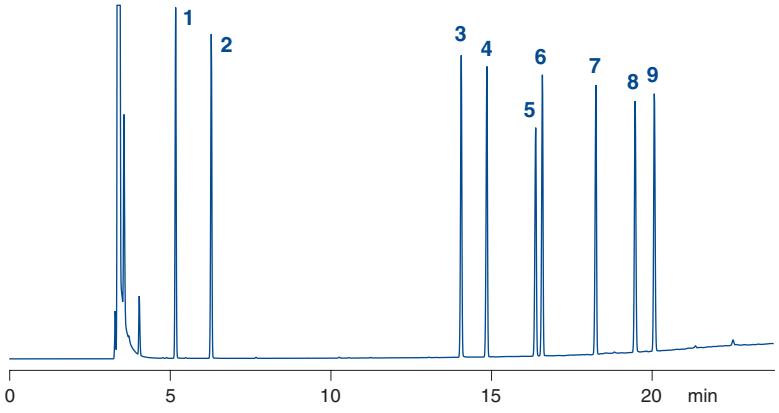
- for columns with 0.25 – 0.32 mm ID the max. temperature for isothermal operation is 250 °C, the max. temperature for short isotherms in a temperature programme is 260 °C; for 0.53 mm ID columns the max. temperatures are 220 and 240 °C, resp.
- recommended for solvent analysis and alcohols, suitable for aqueous solutions

Modified Grob test

Column: OPTIMA® WAX, 0.5 µm film, 50 m x 0.32 mm ID, max. temperature 250/260 °C, REF 726296.50
Injection volume: 1 µl
Carrier gas: 1.2 bar He
Split: 1:20
Temperature: 80 °C → 250 °C, 8 °C/min
Detector: FID 250 °C

Peaks:
1. Decane
2. Undecane
3. Octanol
4. Methyl decanoate
5. Dicyclohexylamine
6. Methyl undecanoate
7. Methyl dodecanoate
8. 2,6-Dimethylaniline
9. 2,6-Dimethylphenol

MN Appl. No. 211170



Ordering information

Length →	25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)				
0.25 µm film	**726600.25**	**726600.30**	**726600.50**	**726600.60**
0.32 mm ID (0.5 mm OD)				
0.25 µm film	**726321.25**	**726321.30**	**726321.50**	**726321.60**
0.50 µm film	**726296.25**	**726296.30**	**726296.50**	**726296.60**
0.53 mm ID (0.8 mm OD)				
1.00 µm film	**726549.25**	**726549.30**		
2.00 µm film		**726548.30**		

In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

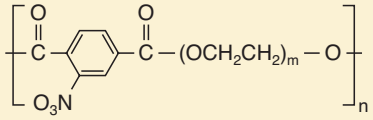
On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. For ordering, please add an E at the end of the REF number (e.g. 726470.30E)

OPTIMA® high performance capillary columns

OPTIMA® FFAP

polyethylene glycol 2-nitroterephthalate

- polar phase



similar phases: PERMABOND® FFAP (page 238), DB-FFAP, HP-FFAP, CP-Sil 58 CB, 007-FFAP, CP-FFAP CB, Nukol, BP21

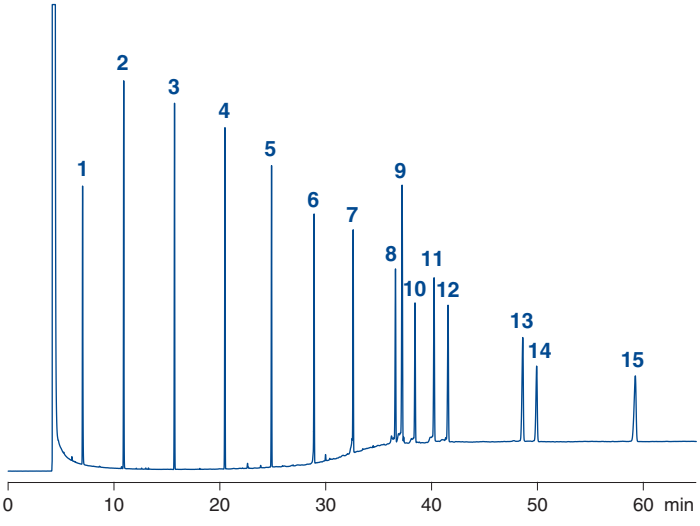
- for columns with 0.10 – 0.32 mm ID the max. temperature for isothermal operation is 250 °C, the max. temperature for short isotherms in a temperature programme is 260 °C for 0.53 mm ID columns the max. temperatures are 220 and 240 °C, resp.
- recommended for FAME, free carboxylic acids
- close equivalent to USP G25 / G35

FAME test

Column: OPTIMA® FFAP, 0.25 µm film, 60 m x 0.32 mm ID, max. temp. 250/260 °C, REF 726341.60
Carrier gas: 1.2 bar He, split
Temperature: 55 °C → 250 °C, 6 °C/min
Injection: 1.0 µl, 220 °C
Detector: FID 220 °C

Peaks:
1. C4
2. C6
3. C8
4. C10
5. C12
6. C14
7. C16
8. C18
9. C18:1 *cis/trans*
10. C18:2
11. C18:3
12. C20
13. C22
14. C22:1
15. C24

MN Appl. No. 211140



Ordering information

Length →	10 m	25 m	30 m	50 m	60 m
0.10 mm ID (0.4 mm OD)					
0.10 µm film	**726180.10**				
0.25 mm ID (0.4 mm OD)					
0.25 µm film		**726116.25**	**726116.30**	**726116.50**	**726116.60**
0.32 mm ID (0.5 mm OD)					
0.25 µm film		**726341.25**	**726341.30**	**726341.50**	**726341.60**
0.50 µm film		**726344.25**	**726344.30**	**726344.50**	
0.53 mm ID (0.8 mm OD)					
0.50 µm film			**726345.30**		
1.00 µm film		**726346.25**			

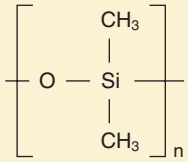
In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of **integrated precolumns**. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

PERMABOND® SE-30

100 % dimethylpolysiloxane

- nonpolar phase



max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature programme 320 °C

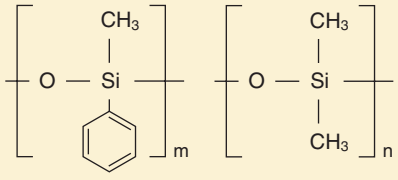
Ordering information

Length →	25 m	50 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	**723052.25**	**723052.50**
0.32 mm ID (0.5 mm OD)		
0.25 µm film	**723306.25**	
0.50 µm film		**723308.50**
In addition to this standard programme we will be happy to supply columns custom-made to your specifications.		

PERMABOND® SE-52

5 % phenyl – 95 % dimethylpolysiloxane

- nonpolar phase



max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature programme 320 °C

Ordering information

Length →	25 m
0.25 mm ID (0.4 mm OD)	
0.25 µm film	**723054.25**
0.32 mm ID (0.5 mm OD)	
0.25 µm film	**723310.25**
0.50 µm film	**723312.25**
In addition to this standard programme we will be happy to supply columns custom-made to your specifications.	

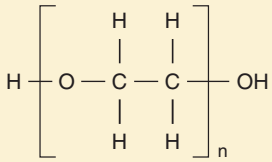
Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Column ends are melted or closed with septa, and thus protected from atmospheric oxygen. Additionally, we supply the corresponding test mixture with each column.

PERMABOND® capillary columns

PERMABOND® CW 20 M

polyethylene glycol 20 000 dalton

- polar phase



similar phases see OPTIMA® WAX page 235

- 0.1 – 0.32 mm ID: max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature programme 240 °C
  0.53 mm ID: max temperatures 200 and 220 °C, resp.
- recommended for solvent analyses and alcohols
- suitable for aqueous solutions
- USP G16

Ordering information

Length →	10 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)					
0.10 µm film	**723064.10**				
0.25 mm ID (0.4 mm OD)					
0.25 µm film	**723060.10**	**723060.25**	**723060.30**	**723060.50**	**723060.60**
0.32 mm ID (0.5 mm OD)					
0.25 µm film	**723321.10**	**723321.25**	**723321.30**	**723321.50**	**723321.60**
0.35 µm film	**723827.10**	**723827.25**		**723827.50**	
0.50 µm film	**723296.10**	**723296.25**	**723296.30**	**723296.50**	**723296.60**
0.53 mm ID (0.8 mm OD)					
0.50 µm film	**723515.10**	**723515.25**			
1.00 µm film	**723549.10**	**723549.25**	**723549.30**		
2.00 µm film	**723517.10**	**723517.25**	**723517.30**		

In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

PERMABOND® FFAP

polyethylene glycol 2-nitroterephthalate

- polar phase

structure and similar phases see OPTIMA® FFAP page 236

- 0.1 – 0.32 mm ID: max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature programme 240 °C; 0.53 mm ID: max temperatures 200 and 220 °C, resp.
- recommended for FAME, free carboxylic acids

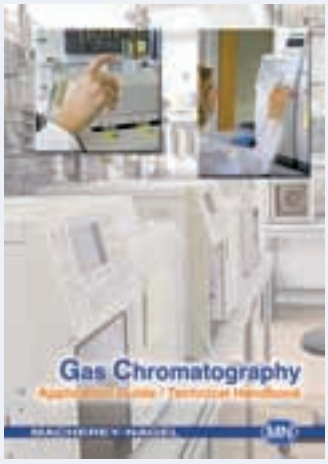
Ordering information

Length →	10 m	20 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)						
0.10 µm film	**723180.10**	**723180.20**				
0.25 µm film	**723181.10**					
0.25 mm ID (0.4 mm OD)						
0.10 µm film			**723936.25**		**723936.50**	
0.25 µm film	**723116.10**		**723116.25**	**723116.30**	**723116.50**	**723116.60**
0.32 mm ID (0.5 mm OD)						
0.10 µm film			**723356.25**		**723356.50**	
0.25 µm film			**723341.25**	**723341.30**	**723341.50**	**723341.60**
0.35 µm film	**723830.10**		**723830.25**		**723830.50**	
0.50 µm film	**723344.10**		**723344.25**	**723344.30**	**723344.50**	**723344.60**
0.53 mm ID (0.8 mm OD)						
1.00 µm film	**723555.10**		**723555.25**		**723555.50**	

In addition to this standard programme we will be happy to supply columns custom-made to your specifications.

GC Application Guide

- explaining basics and principles of GC:
  phase selection by column properties,
  important GC parameters,
  helpful hints for troubleshooting
- **280 selected applications** from the fields
  - ✓ environmental pollutants
  - ✓ solvents · chemicals
  - ✓ fragrances · food and cosmetic components
  - ✓ drugs · pharmaceutical ingredients
  - ✓ petrochemical products
  - ✓ chiral separations
- latest and more applications at ***www.mn-net.com/apps***

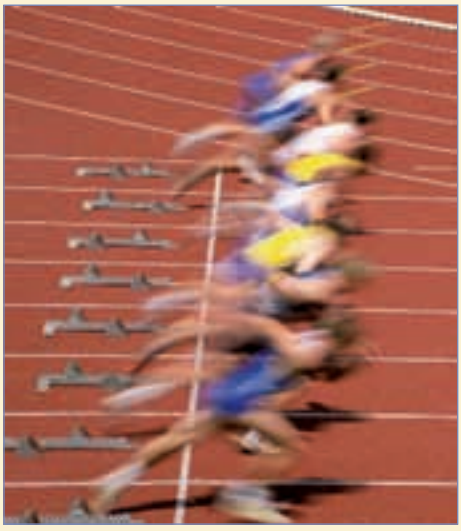


Capillary columns for special GC separations

- Certain analytical separations can be performed more easily with chromatographic columns, which have been especially developed for the respective task. The following table summarises our programme of GC speciality capillaries, the individual column types are described in detail on the following pages.

Separation / special application		Recommended capillary column	Page
Fast GC		OPTIMA® δ-3, OPTIMA® δ-6 OPTIMA® 1, OPTIMA® 5, OPTIMA® 17, OPTIMA® 225, OPTIMA® FFAP PERMABOND® CW 20 M, FFAP all 0.10 mm ID	240
Enantiomer separation	cyclodextrin phases	FS-LIPODEX® A, FS-LIPODEX® B FS-LIPODEX® C, FS-LIPODEX® D FS-LIPODEX® E, FS-LIPODEX® G	242
		FS-HYDRODEX β-PM, FS-HYDRODEX β-3 P FS-HYDRODEX β-6TBDM FS-HYDRODEX β-TBDAc, FS-HYDRODEX γ-TBDAc	244
Biodiesel	methanol analysis	OPTIMA® BioDiesel M	246
	FAME analysis	OPTIMA® BioDiesel F	246
	glycerol and triglycerides	OPTIMA® BioDiesel G	246
Triglycerides		OPTIMA® 1-TG OPTIMA® 17-TG	248
High temperature GC		OPTIMA® 5 HT	249
Amines	polyfunctional amines	OPTIMA® 5 Amine	250
	amine separations	FS-CW 20 M-AM	251
Petrochemical products (complex hydrocarbon mixtures)		PERMABOND® P-100	251
Environmental analyses	volatile halogenated hydrocarbons	PERMABOND® SE-54 HKW	252
Silanes (monomeric, e.g. chlorosilanes)		PERMABOND® Silane	253
Diethylene glycol, e.g. for the quality control of wine		PERMABOND® CW 20 M-DEG	253

Columns for Fast GC



- characteristics of **Fast GC**: decreased column diameters, high heating rates and decreased column lengths for faster GC separations with high resolution efficiency
- small inner diameters combined with very fast temperature programmes can reduce the analysis time by up to 80 %
- high heating rates place special demands on stationary phases: OPTIMA® columns meet exactly this requirement, as they show very low bleeding and provide long lifetimes, even when continuously subjected to high heating rates
- small inner diameters result in high column inlet pressures and a lower volume flow of the mobile phase, which as a consequence require very fast injection of very small samples against a high pressure
- the amount of sample, which can be injected, is limited by the inner diameter and the thin film
- high sensitivity detectors with small volume and extremely short response time, as well as a very rapid data acquisition and processing are required

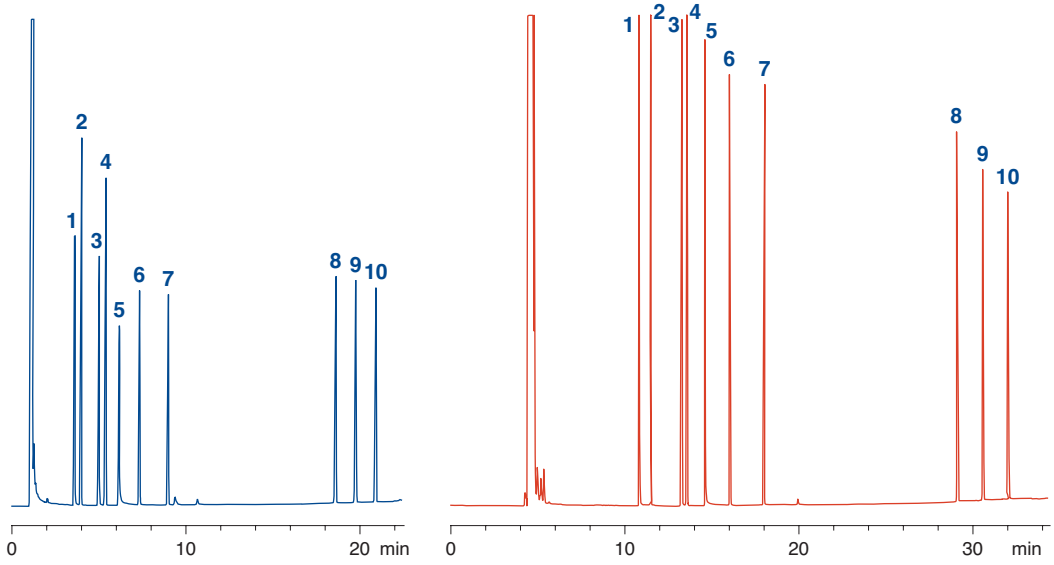
Comparison of a separation on a 50 m standard capillary with separation on a 10 m fast GC column

A) Fast GC column
Column: OPTIMA® 5, 0.1 µm film, 10 m x 0.1 mm ID,
max. temperature 340/360 °C, REF 726846.10
injection 1 µl, split 1 : 40, carrier gas 0.75 bar He

B) standard GC column
Column: OPTIMA® 5, 0.25 µm film, 50 m x 0.25 mm ID,
max. temperature 340/360 °C, REF 726056.50
injection 1 µl, split 1 : 35, carrier gas 1.5 bar He

both separations: temperature: 80 °C → 320 °C (10 min), 8 °C/min, detector: FID
While maintaining the temperature programme and halving the pressure a time saving of 30 % results with identical separation efficiency.

Peaks:
1. Octanol
2. Undecane
3. Dimethylaniline
4. Dodecane
5. Decylamine
6. Methyl decanoate
7. Methyl undecanoate
8. Henicosane
9. Docosane
10. Tricosane



MN Appl. No. 211260

Capillary columns for Fast GC

Ordering information

Phase	max. temperature	ID [mm]	film thickness [µm]	REF (10 m)	REF (20 m)
OPTIMA® 1	340/360 °C	0.10	0.10	**726024.10**	**726024.20**
		0.10	0.40		**726025.20**
OPTIMA® 5	340/360 °C	0.10	0.10	**726846.10**	
OPTIMA® δ-3	340/360 °C	0.10	0.10	**726410.10**	**726410.20**
OPTIMA® δ-6	340/360 °C	0.10	0.10	**726490.10**	
OPTIMA® 17	320/340 °C	0.10	0.10	**726848.10**	
OPTIMA® 225	260/280 °C	0.10	0.10	**726080.10**	
OPTIMA® FFAP	250/260 °C	0.10	0.10	**726180.10**	
PERMABOND® CW 20 M	220/240 °C	0.10	0.10	**723064.10**	
PERMABOND® FFAP	220/240 °C	0.10	0.10	**723180.10**	**723180.20**
		0.10	0.25	**723181.10**	
OPTIMA® 5 Amine	300/320 °C	0.10	0.40	**726361.10**	
FS-CW 20 M-AM	220/240 °C	0.10	0.20	**733111.10**	
FS-LIPODEX® E	200/220 °C	0.10	0.10	**723382.10**	
FS-HYDRODEX β-6TBDM	230/250 °C	0.10	0.10	**723383.10**	

In addition to this standard programme, all MN GC phases can be custom-made as fast GC columns.

For description of individual phases see chapters “OPTIMA® high performance capillary columns” from page 215, PERMABOND® columns page 238 and “Capillary columns for enantiomer separation” page 242–245.

Capillary columns for enantiomer separation

LIPODEX® — cyclodextrin phases for enantiomer separation

- base material: cyclic oligosaccharides consisting of six (α-cyclodextrin), seven (β-cyclodextrin) or eight (γ-cyclodextrin) glucose units bonded through α-1,4-linkages

  regioselective alkylation and/or acylation of the hydroxyl groups leads to lipophilic phases with varying enantioselectivity, which are well suited for GC enantiomer analyses

  important advantage: many compounds can be analysed without derivatisation (however, for certain substances enantioselectivity can be favourably influenced by formation of derivatives)
- A large number of separations have been achieved, however, it is not possible to make a general prediction, which phase could solve a given separation task. Even for compounds with small structural differences or within homologous series the enantiodifferentiation can be quite different. The descriptions below list some of the typical separations possible with individual phases.
- Water as solvent is strictly forbidden for all cyclodextrin phases. We recommend to dry the sample with our CHROMAFIX® Dry cartridges (page 45) and to dissolve it in an appropriate nonpolar solvent in any case.

LIPODEX® A — hexakis-(2,3,6-tri-O-pentyl)-α-cyclodextrin

- recommended for carbohydrates, polyols, diols, hydroxycarboxylic acid esters, (epoxy-) alcohols, glycerol derivatives, spiroacetals, ketones, alkyl halides

max. temperature for isothermal operation 200 °C, max. temperature for short isotherms in a temperature programme 220 °C

LIPODEX® B — hexakis-(2,6-di-O-pentyl-3-O-acetyl)-α-cyclodextrin

- recommended for lactones, diols (cyclic carbonates), aminols, aldols (O-TFA), glycerol derivatives (cyclic carbonates)

max. temperature for isothermal operation 200 °C, max. temperature for short isotherms in a temperature programme 220 °C

LIPODEX® C — heptakis-(2,3,6-tri-O-pentyl)-β-cyclodextrin

- recommended for alcohols, cyanhydrins, olefins, hydroxycarboxylic acid esters, alkyl halides

max. temperature for isothermal operation 200 °C, max. temperature for short isotherms in a temperature programme 220 °C

LIPODEX® D — heptakis-(2,6-di-O-pentyl-3-O-acetyl)-β-cyclodextrin

- recommended for amines (TFA), aminols (TFA), *trans*-cycloalkane-1,2-diols, *trans*-cycloalkane-1,3-diols (TFA), β-amino acid esters

max. temperature for isothermal operation 200 °C, max. temperature for short isotherms in a temperature programme 220 °C

LIPODEX® E — octakis-(2,6-di-O-pentyl-3-O-butyryl)-γ-cyclodextrin

- recommended for α-amino acids, α- and β-hydroxycarboxylic acid esters, alcohols (TFA), diols (TFA), ketones, pheromones (cyclic acetals), amines, alkyl halides, lactones

max. temperature for isothermal operation 200 °C, max. temperature for short isotherms in a temperature programme 220 °C

LIPODEX® G — octakis-(2,3-di-O-pentyl-6-O-methyl)-γ-cyclodextrin

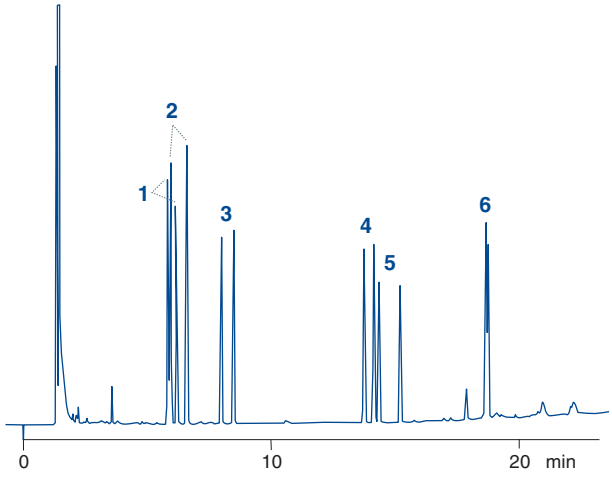
- recommended for menthol isomers, ketones, alcohols, carboxylic acid esters, terpenes

max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature programme 240 °C

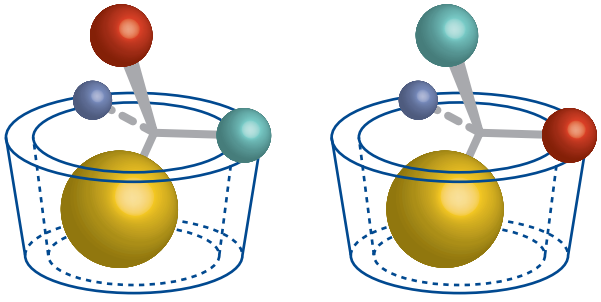
Enantiomer separation of amino acid methyl esters (TFA)

Column: FS-LIPODEX® E, 25 m x 0.25 mm ID, max. temp. 200/220 °C, REF 723368.25
Volume: 1 µl
Carrier gas: 60 kPa H_2
Split: about 1:100
Temperature: 90 → 190 °C, 4 °C/min
Detector: FID, 250 °C, AT 2

Peaks:
(D is eluted before L except for proline: L before D)
1. Alanine
2. Valine
3. Leucine
4. Proline
5. Aspartic acid
6. Phenylalanine



MN Appl. No. 202592

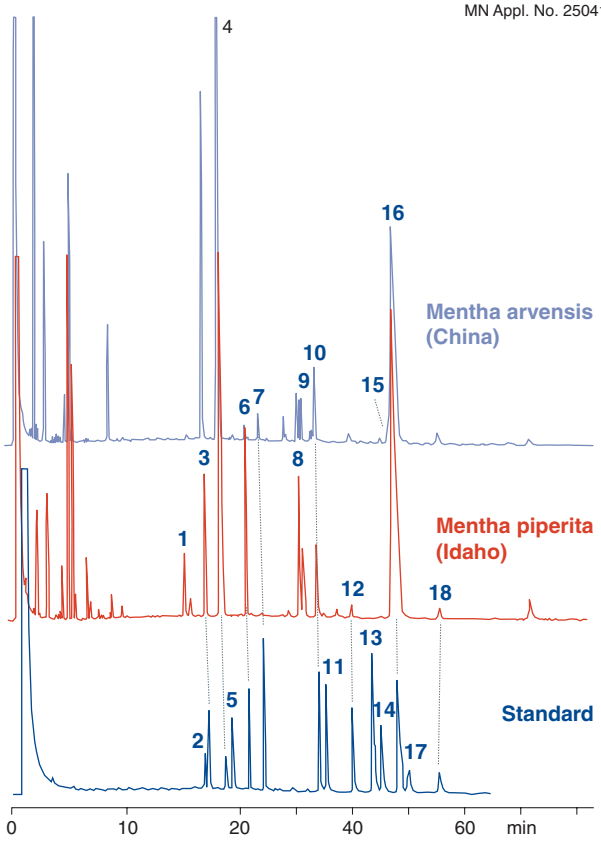


Separation of chiral constituents of peppermint oil

W. A. König et al., High Resol. Chromatogr. **20** (1997) 55 – 61
Column: FS-LIPODEX® G, 25 m x 0.25 mm ID, max. temp. 220/240 °C, REF 723379.25
Carrier gas: 50 kPa H_2
Temperature: 75 °C, isothermal
Detector: FID

Peaks:
1. (+)-*trans*-Sabinene hydrate
2. (+)-Menthone
3. (+)-Isomenthone
4. (–)-Menthone
5. (–)-Isomenthone
6. (+)-Menthofuran
7. (–)-Isopulegol
8. (–)-Menthyl acetate
9. (+)-Pulegone
10. (+)-Neomenthol
11. (–)-Neomenthol
12. (+)-Neoisomenthol
13. (+)-Menthol
14. (–)-Neoisomenthol
15. (+)-Piperitone
16. (–)-Menthol
17. (+)-Isomenthol
18. (–)-Isomenthol

MN Appl. No. 250410



Ordering information

Length → all columns 0.4 mm OD	10 m 0.10 mm ID	25 m 0.25 mm ID	50 m 0.25 mm ID
FS-LIPODEX® A		723360.25	723360.50
FS-LIPODEX® B		723362.25	723362.50
FS-LIPODEX® C		723364.25	723364.50
FS-LIPODEX® D		723366.25	723366.50
FS-LIPODEX® E	723382.10	723368.25	723368.50
FS-LIPODEX® G		723379.25	723379.50

Capillary columns for enantiomer separation

HYDRODEX — cyclodextrin phases for enantiomer separation

- cyclodextrin derivatives with high melting point: for GC enantiomer separation diluted with polysiloxanes

HYDRODEX β-PM — heptakis-(2,3,6-tri-O-methyl)-β-cyclodextrin (CD)

phase diluted with optimised polysiloxane

- recommended for hydroxycarboxylic acid esters, alcohols, diols, olefins, lactones, acetals

max. temperature for isothermal operation 230 °C, max. temperature for short isotherms in a temperature programme 250 °C

HYDRODEX β-3P — heptakis-(2,6-di-O-methyl-3-O-pentyl)-β-CD

phase diluted with optimised polysiloxane

- recommended for terpenes, dienes, allenes, terpene alcohols, 1,2-epoxyalkanes, carboxylic acids (esters), hydroxycarboxylic acid esters, pharmaceutics, pesticides

max. temperature for isothermal operation 230 °C, max. temperature for short isotherms in a temperature programme 250 °C

HYDRODEX β-6TBDM — heptakis-(2,3-di-O-methyl-6-O-*t*-butyldimethyl-silyl)-β-CD

phase diluted with optimised polysiloxane

- recommended for γ-lactones, cyclopentanones, terpenes, esters, tartrates

max. temperature for isothermal operation 230 °C, max. temperature for short isotherms in a temperature programme 250 °C

HYDRODEX β-TBDAc — heptakis-(2,3-di-O-acetyl-6-O-*t*-butyldimethyl-silyl)-β-CD

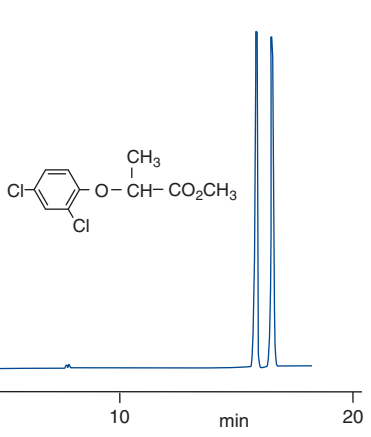
phase diluted with optimised polysiloxane

- recommended for alcohols, esters, ketones, aldehydes, δ-lactones etc.

max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature programme 240 °C

Enantiomer separation of dichlorprop methyl ester

Column: HYDRODEX β-3P, 25 m x 0.25 mm ID, max. temperature 250 °C, REF 723358.25
Injection volume: 0.1 µl (~1% in CH_2Cl_2)
Carrier gas: 60 kPa H_2 (1.9 ml/min)
Split: 130 ml/min
Temperature: 160 °C
Detector: FID, 250 °C, 2^7



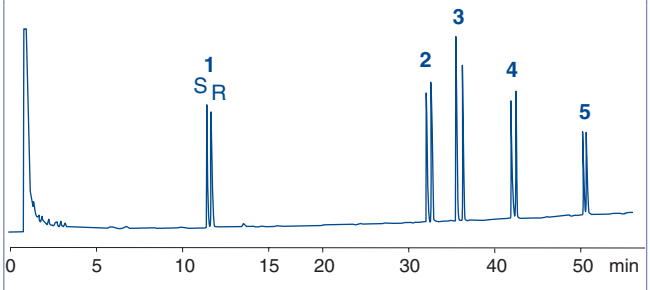
MN Appl. No. 202542

Separation of isomeric antiinflammatory drugs

Courtesy of Prof. W.A. König, Hamburg, Germany
Column: HYDRODEX β-6TBDM, 25 m x 0.25 mm ID, max. temperature 250 °C, REF 723381.25
Carrier gas: He
Temperature: 135 °C → 200 °C, 1 °C/min
Detector: FID

Peaks:

1. Ibuprofen
2. Flurbiprofen
3. Fenoprofen
4. Naproxen
5. Ketoprofen



MN Appl. No. 250180

HYDRODEX γ-TBDAc — octakis-(2,3-di-O-acetyl-6-O-*t*-butyldimethyl-silyl)-γ-CD

phase diluted with optimised polysiloxane

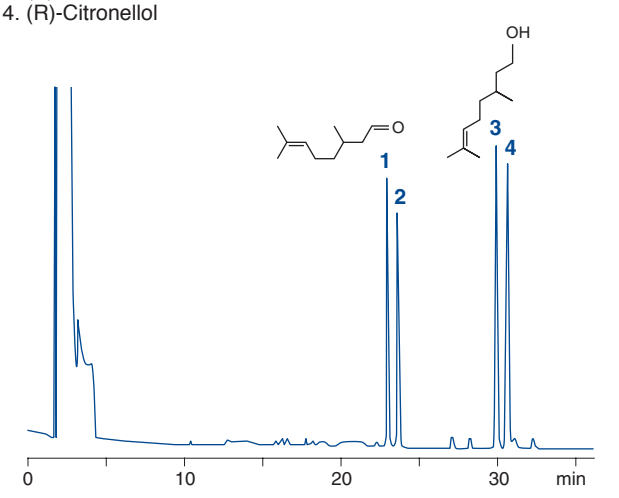
- recommended for cyclic ketones, aromatic ketones, oxiranes, aromatic esters, aromatic amides etc.

max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature programme 240 °C

Separation of (R/S) citronellol + citronellal

Column: FS-HYDRODEX β-TBDAc, 50 m x 0.25 mm ID, max. temp. 220/240 °C, REF 723384.50
Carrier gas: 1.5 bar H_2, split 25 ml/min
Temperature: 100 °C
Injection: 1 µl, 1:1000 in CH_2Cl_2
Detector: FID, 220 °C

Peaks:
1. (R)/(S)-Citronellal
2. (S)/(R)-Citronellal
3. (S)-Citronellol
4. (R)-Citronellol

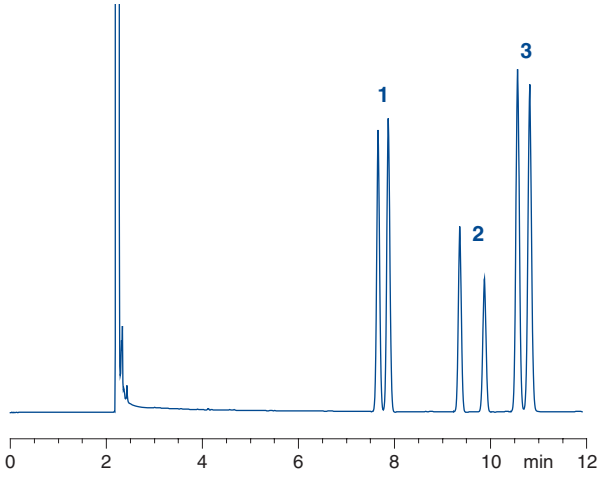


MN Appl. No. 212440

Separation of essential oils

Column: FS-HYDRODEX γ-TBDAc, 50 m x 0.25 mm ID, max. temp. 220/240 °C, REF 723387.50
Carrier gas: 1.2 bar H_2
Temperature: 125 °C
Injector: 220 °C
Detector: FID, 220 °C

Peaks:
1. Fenchone (1.5 mg/ml)
2. Menthone (0.5 mg/ml)
3. Menthol (2 mg/ml)



MN Appl. No. 212980 / 212990 / 213000

Ordering information

Length →	10 m	25 m	50 m
all columns 0.4 mm OD	0.10 mm ID	0.25 mm ID	0.25 mm ID
FS-HYDRODEX β-PM		**723370.25**	**723370.50**
FS-HYDRODEX β-3P		**723358.25**	**723358.50**
FS-HYDRODEX β-6TBDM	**723383.10**	**723381.25**	**723381.50**
FS-HYDRODEX β-TBDAc		**723384.25**	**723384.50**
FS-HYDRODEX γ-TBDAc		**723387.25**	**723387.50**

Test mixtures for chiral GC capillary columns

Test mixture for	test compound (enantiomer mixture)	pack of	REF
LIPODEX® A, HYDRODEX β-PM, β-3P, β-6TBDM, β-TBDAc, γ-TBDAc	1 vol-% phenylethanol in CH_2Cl_2	1 ml	**722321**
LIPODEX® B	methylbutyrolactone	1 ml	**722322**
LIPODEX® C, D	phenylethylamine (TFA)	1 ml	**722323**
LIPODEX® E, G	phenylethanol (TFA)	1 ml	**722319**

OPTIMA® BioDiesel

for the analysis of biodiesel (DIN EN 14214 / ASTM D 6751)

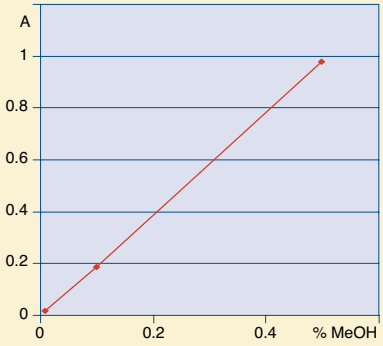
OPTIMA® BioDiesel M

for analysis of methanol in accordance with DIN EN 14110

The methanol content in biodiesel as specified in DIN EN 14110 must not exceed 0.2 %. The column OPTIMA® BioDiesel M allows the GC headspace analysis of the methanol content in biodiesel in the concentration range from 0.01 to 0.5% with 2-propanol as internal standard. The graph on the right shows the linearity of the determination in the required range (A = area[methanol]/area[2-propanol]).

similar phases: Select™ Biodiesel for Methanol, Trace TR-BioDiesel (M)

max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature programme 360 °C



OPTIMA® BioDiesel F

for analysis of FAMEs in accordance with DIN EN 14103

The standard DIN EN 14103 specifies the separation of typical FAMEs between myristic acid (C14) and nervonic acid (C24:1) methyl esters and the determination of linolenic acid methyl ester in biodiesel. This analysis is possible on OPTIMA® BioDiesel F in only 25 min with baseline separation of lignoceric (C24:0) and nervonic acid (C24:1) methyl esters, also allowing quantification of linolenic acid methyl ester (see chromatogram below).

similar phases: Select™ Biodiesel for FAME, Trace TR-BioDiesel (F)

max. temperature for isothermal operation 250 °C, max. temperature for short isotherms in a temperature programme 260 °C

OPTIMA® BioDiesel G

for analysis of glycerol and glycerides in accordance with DIN EN 14105

The capillary column OPTIMA® BioDiesel G allows determination of free glycerol and residues of mono-, di- and triglycerides in FAMEs intended as additives for mineral oils. The procedure can be applied for FAMEs from rapeseed oil, sunflower oil and soy bean oil. Glycerol as well as mono- and diglycerides are derivatized to more volatile substances by addition of MSTFA (see page 260) in the presence of pyridine.

similar phases: Select™ Biodiesel for Glycerides, Trace TR-BioDiesel (G), MET-Biodiesel

max. temperature for isothermal operation 380 °C, max. temperature for short isotherms in a temperature programme 400 °C

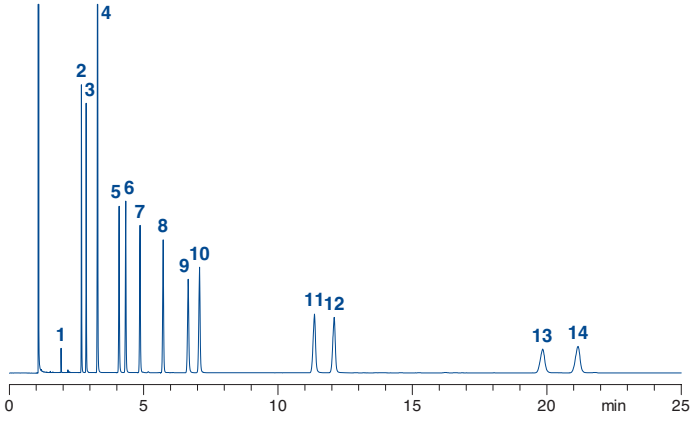
Capillary columns for analysis of biodiesel

Analysis of FAMEs from biodiesel

Column: OPTIMA® BioDiesel F, 30 m x 0.25 mm ID, max. temperature 250/260 °C, REF 726900.30
Sample: standards in *n*-heptane
Injection: 2 µl, 250 °C
Carrier gas: 1.0 bar H_2, split 50 ml/min
Temperature: 210 °C
Detector: FID 250 °C

Peaks:

1. C14
2. C16
3. C16:1
4. C17, int. st.
5. C18
6. C18:1
7. C18:2
8. C18:3
9. C20
10. C20:1
11. C22
12. C22:1
13. C24
14. C24:1



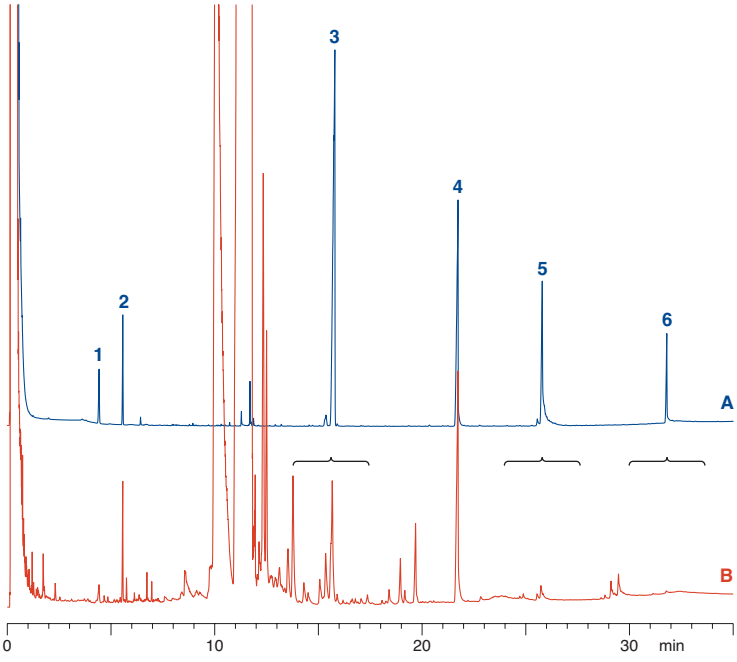
MN Appl. No. 213330

Analysis of glycerol and glycerides from biodiesel

Column: OPTIMA® BioDiesel G, 10 m x 0.25 mm ID, max. temperature 380/400 °C, REF 726903.10
Sample: A) standard in *n*-heptane
B) biodiesel
Injection: 2 µl, 350 °C, CIS (15 °C → 350 °C, 12 °C/s)
Carrier gas: 0.8 bar H_2, split 1:2.6
Temperature: 50 °C (3.5 min) → 180 °C, 15 °C/min → 280 °C, 7 °C/min → 370 °C (10 min), 10 °C/min
Detector: FID 380 °C

Peaks:

1. Glycerol (TMS)
2. Butanetriol (TMS), IS
3. Monoolein = glycerol monooleate (TMS) + monoacylglycerides
4. Tricaprin (glycerol tricaprate), IS
5. Diolein = glycerol dioleate (TMS) + diacylglycerides
6. Triolein = glycerol trioleate + triacylglycerides



MN Appl. No. 213640

Ordering information

Length →	10 m	30 m
OPTIMA® BioDiesel M		
0.32 mm ID (0.5 mm OD)		**726905.30**
OPTIMA® BioDiesel F		
0.25 mm ID (0.4 mm OD)		**726900.30**
OPTIMA® BioDiesel G		
0.25 mm ID (0.4 mm OD)	**726903.10**	

Capillary columns for special separations

OPTIMA® 1-TG · OPTIMA® 17-TG

for triglyceride analyses

- **OPTIMA® 1-TG**
  100 % dimethylpolysiloxane
  offers separation according to carbon number
  similar phases:
  SPB-1 TG, DB-1 HT, 400-1 HT, HT-5
- USP G1 / G2 / G38
- **OPTIMA® 17-TG**
  phenyl-methyl-polysiloxane (50 % phenyl) for separation according to degree of unsaturation
- USP G3

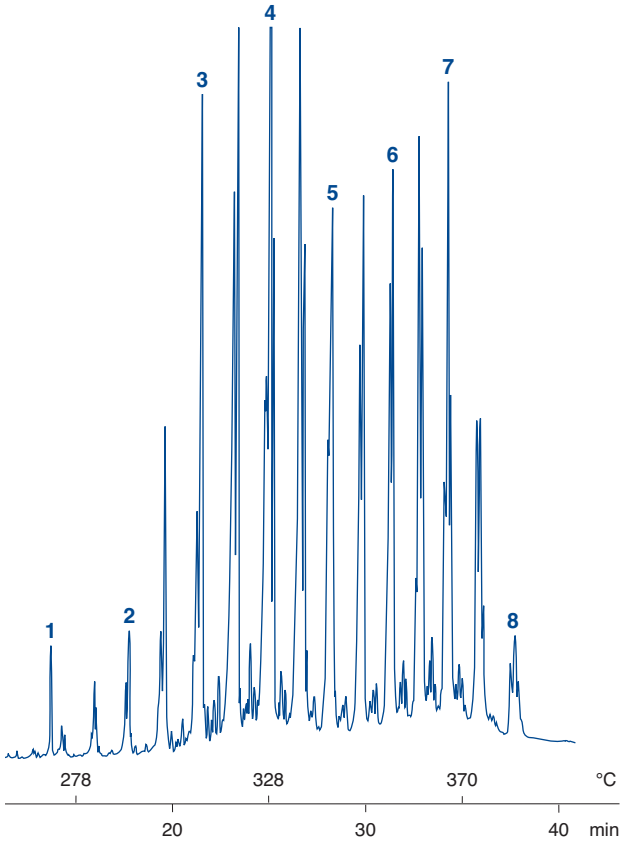
- max. temperature for both phases: 370 °C
- short capillary columns (max. 25 m and 0.32 mm ID) with low-bleeding stationary phases thermally stable with optimum deactivation

Triglycerides (from butter)

Column: OPTIMA® 1-TG, 25 m x 0.32 mm ID, max. temperature 370 °C, REF 726132.25
Injection volume: 0.5 µl
Carrier gas: 80 kPa H_2
Temperature: 80 °C (1 min) → 250 °C, 20 °C/min → 370 °C (10 min), 5 °C/min
Detector: FID 380 °C, 2^6

Peaks:
1. Cholesterol
2. T-30
3. T-34
4. T-38
5. T-42
6. T-46
7. T-50
8. T-54

MN Appl. No. 201790



Ordering information

	Length →	10 m	25 m
OPTIMA® 1-TG	0.25 mm ID (0.4 mm OD)	**726133.10**	**726133.25**
	0.32 mm ID (0.5 mm OD)	**726132.10**	**726132.25**
OPTIMA® 17-TG	0.32 mm ID (0.5 mm OD)	**726131.10**	**726131.25**

OPTIMA® 5 HT

for high temperature GC

- ultra low bleed silarylene phase with 5-type polarity
  nonpolar phase, ideal for MS detectors, can be rinsed with solvents
- similar phases: DB-5HT, VF-5HT, HT-5, XTI-5HT, ZB-5HT

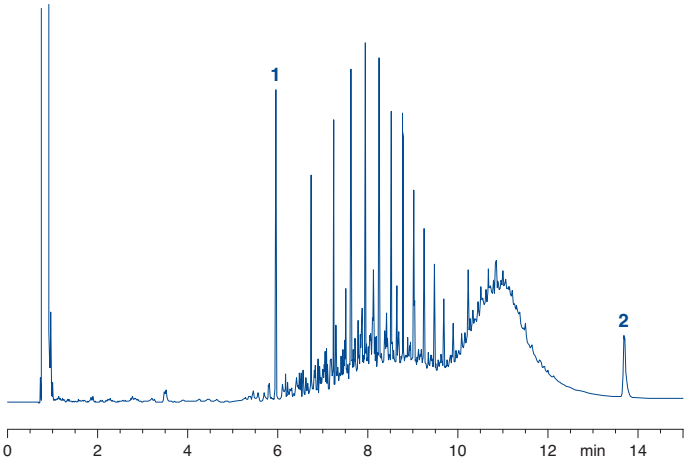
- max. temperature for isothermal operation 380 °C, max. temperature for short isotherms in a temperature programme 400 °C

- recommended application: for simulated distillation, hydrocarbon, fuel and oil analysis, high-boiling analytes
- USP G27 / G36

Separation of motor oil / mineral oil (type A + B), rapid determination in accordance with DIN H-53 / ISO DIS 9377 with a steep heating rate

Column:	OPTIMA® 5 HT, 0.25 µm film, 15 m x 0.32 mm ID, max. temperature 400 °C, REF 726108.15
Sample:	mineral oil type A + B (hydrocarbon index kit acc. to EN ISO 9377-2) in hexane
Injection volume:	1 µl, splitless, 300 °C
Carrier gas:	0.6 bar He
Temperature:	40 °C (5 min) → 390 °C, 50 °C/min
Detector:	FID 280 °C

Peaks:
1. Decane (C10)
2. Tetracontane (C40)



MN Appl. No. 213400

Ordering information

Length →	15 m	30 m
0.25 mm ID (0.4 mm OD)		
0.10 µm film	726102.15	726102.30
0.25 µm film	726106.15	726106.30
0.32 mm ID (0.5 mm OD)		
0.10 µm film	726104.15	726104.30
0.25 µm film	726108.15	726108.30

Capillary columns for special separations

OPTIMA® 5 Amine

special column for analysis of amines

- especially deactivated for the analysis of polyfunctional amines such as ethanolamines, amino-functionalised diols and similar compounds, which are important base materials in industrial chemistry, and show strong tailing on standard-deactivated columns

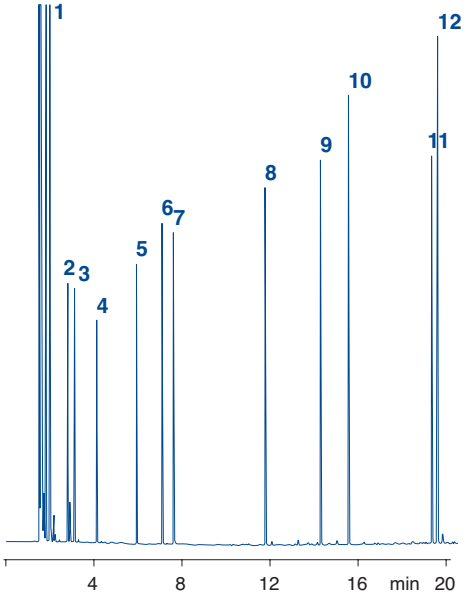
  similar phases: Rtx-5 Amine, PTA-5, CP-Sil 8 CB for Amines
- USP G27 / G36
- max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature programme 320 °C
- improved linearity for analyses of active components at trace levels: no amine absorptions even for aliphatic and aromatic amines at concentrations of 100 pg/peak

  tested with the OPTIMA® Amine test mixture (REF 722317), which among others also contains diethanolamine and propanol-pyridine (this test mixture is supplied with each column)

Separation of secondary and tertiary amines

Column: OPTIMA® 5 Amine, 0.5 µm film, 30 m x 0.25 mm ID, max. temperature 300/320 °C, REF 726354.30
Injection volume: 1 µl
Carrier gas: 0.6 bar H_2, split 1:100
Temperature: 100 °C (3 min) → 280 °C, 10 °C/min
Detector: FID 280 °C

Peaks:
1. Diethylamine
2. Di-isopropylamine
3. Triethylamine
4. Di-*n*-propylamine
5. Di-*n*-butylamine
6. Tri-*n*-propylamine
7. Di-isobutylamine
8. Tri-*n*-butylamine
9. Di-isohexylamine
10. Dicyclohexylamine
11. Dibenzylamine
12. Tri-*n*-hexylamine



MN Appl. No. 210280

Ordering information

Length →	10 m	25 m	30 m
0.1 mm ID (0.4 mm OD)			
0.40 µm film	**726361.10**		
0.2 mm ID (0.4 mm OD)			
0.35 µm film		**726355.25**	
0.25 mm ID (0.4 mm OD)			
0.50 µm film			**726354.30**
1.00 µm film			**726358.30**
0.32 mm ID (0.5 mm OD)			
0.25 µm film			**726360.30**
1.00 µm film			**726353.30**
1.50 µm film			**726356.30**
0.53 mm ID (0.8 mm OD)			
1.00 µm film			**726359.30**
3.00 µm film			**726357.30**

FS-CW 20 M-AM

polyethylene glycol 20 000, non-immobilised

- polyethylene glycol, basic for amine separations
  similar phases: Carbowax™ Amine, CP-Wax 51, CAM, Stabilwax® DB
- USP G16

max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature programme 240 °C

Ordering information

Length →	10 m	25 m	50 m
0.1 mm ID (0.4 mm OD)			
0.20 µm film	**733111.10**		
0.25 mm ID (0.4 mm OD)			
0.25 µm film		**733110.25**	**733110.50**
0.32 mm ID (0.5 mm OD)			
0.25 µm film		**733299.25**	**733299.50**
0.35 µm film			**733442.50**
0.53 mm ID (0.8 mm OD)			
1.00 µm film		**733551.25**	

PERMABOND® P-100

for analyses of petrochemical products

- extra long column with nonpolar dimethylpolysiloxane phase
  high resolution and sufficient capacity for analysis of complex mixtures of hydrocarbons
- USP G1 / G2 / G38

max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature programme 320 °C

Ordering information

Length →	100 m
0.25 mm ID (0.4 mm OD)	
0.50 µm film	**723890.100**

Capillary columns for special separations

PERMABOND® SE-54-HKW — for volatile halogenated hydrocarbons

- SE-54 optimised for volatile halogenated hydrocarbons
- USP G36
- max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature programme 320 °C

For the analysis of halogenated hydrocarbons we recommend our optimised columns PERMABOND® SE-54 HKW with 25 or 50 m length with the well-known polysiloxane phase SE-54.

As an alternative and for confirming analytical results, columns OPTIMA® 624 show advantages especially for the determination of 1,1,2-trichlorotrifluoroethane (F 113) besides dichloromethane.

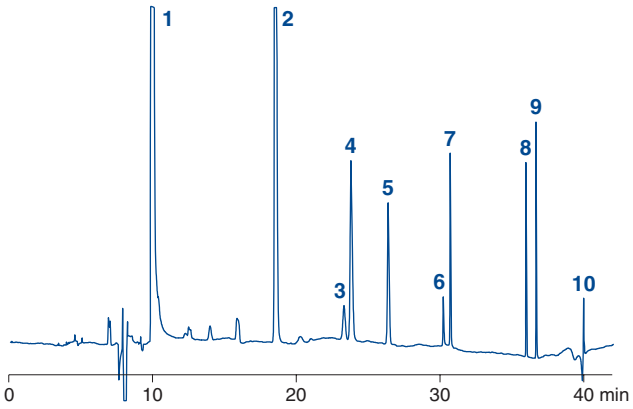
Both phases are also suited for determination of vinyl chloride and separation of *cis/trans*-1,2-dichloroethene. The high film thickness results in high capacity and outstanding resolution. For GC-MS coupling we recommend the phase OPTIMA® 624 *LB* or OPTIMA® 624 with 0.2 or 0.25 mm ID.

Volatile halogenated hydrocarbons

Column: PERMABOND® SE-54-HKW, 50 m x 0.32 mm ID, max. temperature 300 °C, REF 723945.50
Injection volume: 1 µl
Carrier gas: 0.9 bar He
Split: about 1:30
Temperature: 35 °C (25 min) → 160 °C (5 min), 10 °C/min
Detector: ECD 300 °C

Peaks:
1. Dichloromethane (795 ng/ml)
2. Chloroform (75 ng/ml)
3. 1,1,1-Trichloroethane (67 ng/ml)
4. 1,2-Dichloroethane (100 ng/ml)
5. Carbon tetrachloride (15.9 ng/ml)
6. Trichloroethylene (14.6 ng/ml
7. Bromodichloromethane (20 ng/ml)
8. Dibromochloromethane (122 ng/ml)
9. Tetrachloroethylene (81 ng/ml)
10. Bromoform (28.9 ng/ml)

MN Appl. No. 2124880

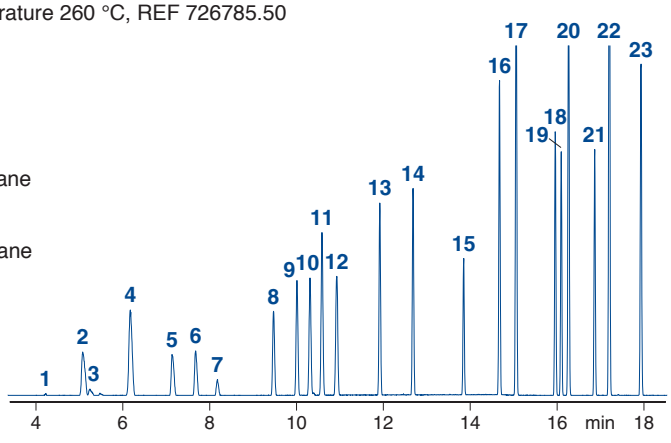


Volatile halogenated hydrocarbons and BTX

Column: OPTIMA® 624, 50 m x 0.25 mm ID, max. temperature 260 °C, REF 726785.50
Injection volume: 1 µl
Carrier gas: 0.9 ml/min He (constant flow), split 50 ml/min
Temperature: 40 °C (5 min) → 160 °C, 10 °C/min
Detector: MSD 5971

Peaks:
1. Vinyl chloride
2. Trichlorofluoromethane (F 11)
3. Pentane
4. 1,1,2-Trichlorotrifluoroethane (F 113)
5. Dichloromethane
6. *trans*-1,2-Dichloroethene
7. Hexane
8. *cis*-1,2-Dichloroethene
9. Trichloromethane
10. 1,1,1-Trichloroethane
11. Tetrachloromethane
12. 1,2-Dichloroethane + benzene
13. Trichloroethene
14. Bromodichloromethane
15. Toluene
16. Tetrachloroethene
17. Dibromochloromethane
18. Chlorobenzene
19. Ethylbenzene
20. *m*- + *p*-Xylene
21. *o*-Xylene
22. Tribromomethane
23. Bromobenzene

MN Appl. No. 200160



Ordering information

Length →	25 m	50 m
0.32 mm ID (0.5 mm OD)		
1.80 µm film	723945.25	723945.50

PERMABOND® Silane

for silane analyses

- developed especially for the analysis of monomeric silanes and chlorosilanes (not for the separation of trimethylsilyl derivatives)
  also suited for the separation of dimeric siloxanes and silazanes
- for columns with 0.32 mm ID the max. temperature for isothermal operation is 260 °C, the max. temperature for short isotherms in a temperature programme is 280 °C; for 0.53 mm ID columns the max. temperatures are 240 and 260 °C, resp.

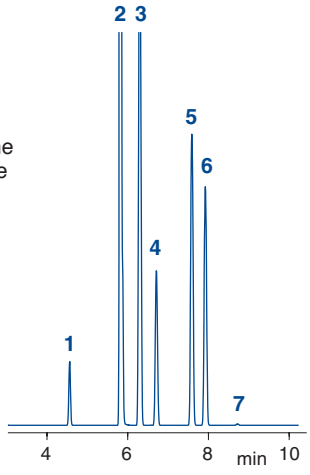
Ordering information

Length →	25 m	50 m
0.32 mm ID (0.5 mm OD)		**723409.50**
0.53 mm ID (0.8 mm OD)	**723411.25**	

Chloromethylsilanes

Column: PERMABOND® Silane, 50 m x 0.32 mm ID, max. temp. 260/280 ° C, REF 723409.50
Injection volume: 0,5 µl gas
Carrier gas: 1 ml/min He (constant flow)
Split: 80 ml/min
Temperature: 50 °C → 100 °C, 5 °C/min
Detector: MSD 5971

Peaks:
1. Tetramethylsilane
2. Dichloromethane
3. Tetrachlorosilane
4. Chlorotrimethylsilane
5. Methyltrichlorosilane
6. Dichlorodimethylsilane
7. Hexamethyldisiloxane

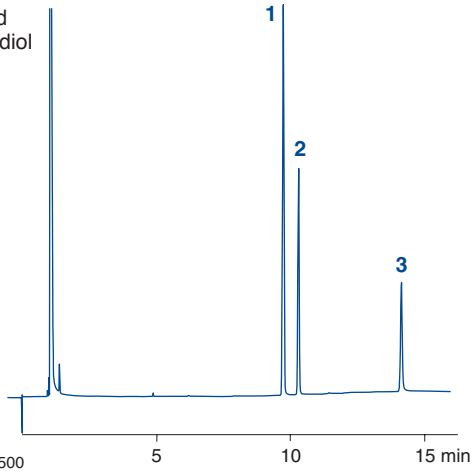


MN Appl. No. 200090

Diethylene glycol standard in wine

Column: PERMABOND® CW 20 M-DEG, 25 m x 0.25 mm ID, max. temp. 220/240 ° C, REF 723063.25
Injection volume: 0.5 µl
Carrier gas: 1.2 bar N_2
Split: ~1 : 40
Temperature: 80 °C → 200 °C, 10 °C/min
Detector: FID 260 °C, 10 x 2^2

Peaks:
DEG standard
1. 1,4-Butanediol
2. Diethylene glycol
3. Glycerol



MN Appl. No. 201500

PERMABOND® CW 20 M-DEG

for determination of diethylene glycol

- polyethylene glycol 20 000 (diethylene glycol tested)
- USP G16
- max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature programme 240 °C
- recommended application: determination of diethylene glycol, e.g. for the quality control of wine

Ordering information

Length →		25 m
0.25 mm ID (0.4 mm OD)	0.25 µm film	**723063.25**
0.32 mm ID (0.5 mm OD)	0.25 µm film	**723327.25**

Fused silica capillaries

Untreated capillaries

- recommended applications:
  for capillary electrophoresis · for preparation of capillary columns · for capillary LC applications

Ordering information

Length →	1 m (pack of 3)	10 m (pack of 1)	25 m (pack of 1)
Capillaries for electrophoresis			
0.025 mm ID (0.4 mm OD)	**723793.1**	**723793.2**	
0.05 mm ID (0.4 mm OD)	**723790.1**	**723790.2**	
0.075 mm ID (0.2 mm OD)	**723791.1**	**723791.2**	
0.10 mm ID (0.4 mm OD)	**723792.1**	**723792.2**	
Untreated capillaries			
0.20 mm ID (0.4 mm OD)		**723148.10**	**723148.25**
0.25 mm ID (0.4 mm OD)		**723101.10**	**723101.25**
0.32 mm ID (0.5 mm OD)		**723151.10**	**723151.25**
0.53 mm ID (0.8 mm OD)		**723501.10**	**723501.25**

Untreated capillaries are supplied without cage.

Deactivated capillary columns (precolumns)

- recommended applications:
  for preparation of capillary columns
  as precolumns, whenever a larger contamination capacity is required.

Ordering information

Length →	10 m	25 m
Methyl-Sil deactivated (max. temperature 320 °C)		
0.25 mm ID (0.4 mm OD)	**723106.10**	**723106.25**
0.32 mm ID (0.5 mm OD)	**723346.10**	**723346.25**
0.53 mm ID (0.8 mm OD)	**723558.10**	**723558.25**
Phenyl-Sil deactivated (max. temperature 320 °C)		
0.25 mm ID (0.4 mm OD)	**723108.10**	**723108.25**
0.32 mm ID (0.5 mm OD)	**723348.10**	**723348.25**
0.53 mm ID (0.8 mm OD)	**723560.10**	**723560.25**
CW deactivated (max. temperature 250 °C)		
0.25 mm ID (0.4 mm OD)	**723105.10**	**723105.25**
0.32 mm ID (0.5 mm OD)	**723349.10**	**723349.25**
0.53 mm ID (0.8 mm OD)	**723562.10**	**723562.25**

Deactivated capillaries are supplied without cage.

Retention gaps

- The retention gap technique in combination with on-column injection allows concentration of a large sample volume in the capillary column.
- choice of the retention gap depends on the solvent used: the flooded zone after injection should be between 20 – 30 cm/µl

Me-Sil retention gap:	only for use with *n*-hexane and diethyl ether
Phe-Sil retention gap:	for all solvents except methanol and water
CW retention gap:	for all solvents and especially for methanol and water

- calculation example: length of flooded zone ~ 20 – 30 cm/µl, retention gap 10 m x 0.32 mm ID, capillary column: 25 m x 0.32 mm ID, max. injection volume ~ 30 – 50 µl
- A retention gap must be inert without any noticeable retention
  Me-Sil retention gaps are more inert than Phe-Sil, while Phe-Sil is less susceptible to contamination

max. temperatures: for CW retention gaps 250 °C, for Me-Sil and Phe-Sil retention gaps 320 °C

Retention gaps can also be used as transfer lines or precolumns (contamination capacity about 5 – 10 µg).

Ordering information

Length →	10 m	25 m
Me-Sil retention gaps (max temperature 320 °C)		
0.25 mm ID (0.4 mm OD)	**723706.10**	**723706.25**
0.32 mm ID (0.5 mm OD)	**723707.10**	**723707.25**
0.53 mm ID (0.8 mm OD)	**723708.10**	**723708.25**
Phe-Sil retention gaps (max temperature 320 °C)		
0.25 mm ID (0.4 mm OD)	**723709.10**	**723709.25**
0.32 mm ID (0.5 mm OD)	**723710.10**	**723710.25**
0.53 mm ID (0.8 mm OD)	**723711.10**	**723711.25**
CW retention gaps (max. temperature 250 °C)		
0.25 mm ID (0.4 mm OD)	**723712.10**	**723712.25**
0.32 mm ID (0.5 mm OD)	**723713.10**	**723713.25**
0.53 mm ID (0.8 mm OD)	**723714.10**	**723714.25**

Retention gaps are supplied without cage.

For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of **integrated precolumns**. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

Reagents and procedures for derivatisation

Derivatisation reagents

- for improved volatility, better thermal stability or a lower limit of detection in gas chromatography
  prerequisite: quantitative, rapid and reproducible formation of only one derivative
  halogen atoms introduced by derivatisation (e. g. trifluoroacetates) allow specific detection (ECD) with the advantage of high sensitivity
  elution orders and fragmentation patterns in MS can be influenced by a specific derivatisation
- reagents for **silylation, acylation,** and alkylation (**methylation**) available

Derivatisation method development kits

Designation	Contents of the kit	REF
Derivatisation method development kit		
which type of derivatisation is best suited for your sample (alkylation, acylation or silylation)?	2 x 1 ml each of TMSH, MSTFA, MBTFA	**701952**
Acylation kit		
which is the proper reagent for acylation?	2 x 1 ml each of MBTFA, TFAA, MBHFBA	**701950**
Alkylation kit		
which is the proper reagent for methylation?	3 x 1 ml each of TMSH, DMF-DMA	**701951**
Silylation kit		
which is the proper reagent for silylation?	2 x 1 ml each of MSTFA, BSTFA, TSIM, MSHFBA	**701953**

Selection guide for derivatisation of important functional groups in GC

Function	method	derivative	recommended reagents
Alcohols, Phenols	silylation	R'O - TMS	BSA, MSTFA, MSHFBA, TSIM, SILYL-2110, SILYL-21, SILYL-1139
R'OH	acylation	R'O - CO - R	TFAA, HFBA, MBTFA, MBHFBA
	alkylation	R'O - R	TMSH
sterically hindered	silylation	R'O - TMS	TSIM, BSTFA, SILYL-991
Amines	silylation	R' - NR'' - TMS	BSA, MSTFA, MSHFBA, SILYL-991
primary, secondary	acylation	R' - NR'' - CO - R	TFAA, HFBA, MBTFA, MBHFBA
hydrochlorides	silylation	R' - NR'' - TMS	MSTFA
Amides	silylation	not stable	
	acylation	R' - CO - NH - CO - R	TFAA, MBTFA, HFBA, MBHFBA
Amino acids	silylation	R' - CH(NH - TMS) - CO - O - TMS	BSA, BSTFA, MSTFA, MSHFBA
	alkylation (a) + acylation (b)	R' - CH(NH - CO-R) - CO - O - R	a) MeOH/TMCS, TMSH b) TFAA, HFBA, MBTFA, MBHFBA
Carboxylic acids (fatty acids)	silylation	R' - CO - O - TMS susceptible to hydrolysis	BSA, MSTFA, MSHFBA, TMCS, TSIM, SILYL-2110, SILYL-21, Silyl 1139
	alkylation	R' - CO - O - R	DMF-DMA, MeOH/TMCS (1 M), TMSH
salts	silylation	R' - CO - O - TMS susceptible to hydrolysis	TMCS
Carbohydrates	silylation		MSTFA, TSIM, HMDS, SILYL-1139
	acylation		TFAA, MBTFA
Steroids	silylation		BSA, TSIM
	acylation		TFAA, MBTFA, HFBA, MBHFBA

Reagents and procedures for acylation

Acylation reagents

- Acyl halides

by-product of acylation with acyl halides: corresponding hydrohalic acids
excess of reagent and acid have to be removed or trapped by a suitable base (e.g. pyridine)

Pentafluorobenzoyl chloride
PFBC: $C_6F_5 - CO - Cl$ — m.w. 230.52, Bp 158 – 159 °C (760 mm Hg), density d20°/4° = 1.601

- Anhydrides

by-products of acylation with anhydrides: corresponding acids
excess reagent and the acid formed have to be removed

Trifluoroacetic acid anhydride
TFAA: $CF_3 - CO - O - CO - CF_3$ — m.w. 210.04, Bp 39.5 – 40.5 °C (760 mm Hg), density d20°/4° = 1.490

Heptafluorobutyric acid anhydride
HFBA: $C_3F_7 - CO - O - CO - C_3F_7$ — m.w. 410.06, Bp 106 – 107 °C (760 mm Hg), density d20°/4° = 1.665

- Bisacylamides

by-products: corresponding neutral acylamides, which can be easily removed due to their high volatility; because of neutral conditions and favourable chromatographic properties often removal of the bisacylamide is not necessary. Thus sample preparation is much more convenient.

N-methyl-bis(trifluoroacetamide)
MBTFA: $CF_3 - CO - N(CH_3) - CO - CF_3$ — m.w. 223.08, Bp 123 – 124 °C (760 mm Hg), density d20°/4° = 1.55

N-methyl-bis(heptafluorobutyramide)
MBHFBA: $C_3F_7 - CO - N(CH_3) - CO - C_3F_7$ — m.w. 423.1, Bp 165 – 166 °C (760 mm Hg), density d20°/4° = 1.673

Methods for acylation

Acylation with fluorinated acid anhydrides:

Acylation with TFAA or HFBA can be used for alcohols, phenols, carboxylic acids, amines, amino acids and steroids forming volatile, stable derivatives suited for FID as well as for ECD detection.

Procedure:
Dissolve 0.1 to 1 mg of the sample in 0.1 ml solvent, add 0.1 ml of the respective anhydride and heat to 60 – 70 °C for 1 – 2 hours. If the sample need not be concentrated prior to the analysis and if there is no danger of catalytically induced side reactions, pyridine is used as solvent. The reaction solution can be injected directly into the gas chromatograph. Otherwise use a volatile solvent and evaporate solvent, excess reagent and acid in a stream of nitrogen. Dissolve the residue in 50 µl hexane, chloroform etc. and inject aliquot portions.

TFAA MN Appl. No. 213041 · HFBA MN Appl. No. 213042

Acylation with fluorinated acid amides:

This method is recommended for alcohols, primary and secondary amines as well as for thiols under mild, neutral conditions. MBTFA also forms very volatile derivatives with carbohydrates [J. Sullivan and L. Schewe, J. Chromatogr. Sci. 15 (1977) 196 – 197].

Procedure:
Add 0.5 ml MBTFA or MBHFBA to about 2 mg sample. If there is no reaction at ambient temperature, heat the reaction mixture to 120 °C. Compounds which are difficult to dissolve, can be trifluoroacetylated in suitable solvent mixtures. It is recommended to use a ratio of solvent to MBTFA or MBHFBA of 4 : 1. The reaction mixture can be chromatographed directly.

MBTFA MN Appl. No. 213051 · MBHFBFA MN Appl. No. 213052

Ordering information

Code	Packing unit 10 x 1 ml	20 x 1 ml	1 x 10 ml	5 x 10 ml
HFBA		**701110.201**	**701110.110**	**701110.510**
MBTFA		**701410.201**	**701410.110**	**701410.510**
MBHFBA	**701420.101**	**701420.201**		
PFBC	**701120.101**			
TFAA			**701130.110**	**701130.510**

Due to their purpose, derivatisation reagents are very reactive substances. For this reason they should be stored cool and protected from moisture. Our derivatisation reagents are supplied in vials with crimp caps for easy access with a syringe. Vials with pierced sealing disks have limited stability and should be used soon.

Reagents and procedures for methylation

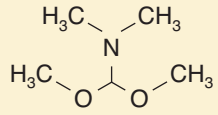
Alkylation reagents

In GC generally methylation is the main type of alkylation used.

- Methylation reagents

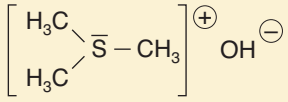
N,N-dimethylformamide dimethylacetal

DMF-DMA · m.w. 119.17 Bp 106 – 107 °C (760 mm Hg), density d20°/4° = 0.897



Trimethylsulphonium hydroxide

TMSH (0.2 M in methanol) · m.w. 94.06



Methods for methylation

Methylation with TMSH

Methylation with TMSH [W. Butte, J. Chromatogr. **261** (1983) 142] is recommended for free acids, chlorophenoxycarboxylic acids, their salts and derivatives as well as for phenols and chlorophenols. One great advantage is simplification of the sample preparation. Lipids or triglycerides can be converted to the corresponding fatty acid methyl esters (FAMEs) by a simple transesterification. Isomerisations of multiple unsaturated fatty acids have not been observed.

This reaction is very elegant and convenient, because it is just necessary to add the reagent (0.2 M in methanol) to the sample solution. Removal of excess reagent is not required, since in the injector of the gas chromatograph at 250 °C pyrolysis to volatile methanol and dimethylsulfide will occur. Due to the high reactivity, complete derivatisation is often obtained at ambient temperature. However, heating (e.g. 10 min at 100 °C) in a closed sample vial may be necessary.

Procedure:
Dissolve 100 mg sample (e.g. butter) in 5 ml of a suitable solvent (e.g. *tert.*-butyl methyl ether). Add 50 µl reagent to 100 µl of this solution. The mixture is injected directly. The temperature of the injector must be at least 250 °C.

MN Appl. No. 213060

Methylation with DMF-DMA

Methylation with DMF-DMA can be applied for fatty acids, primary amines and (partially) amino acids forming N-dimethyl-aminomethylene amino acid methyl esters [Thenot et al., Anal. Letters 5 (1972) 217 – 223, 519 – 529]. DMF-DMA is a poor solvent, for this reason it is necessary to use a mixture of DMF-DMA with pyridine, THF, acetone (barbiturates) or another solvent.

Procedure:
Add 1 ml of a mixture of DMF-DMA and pyridine (1:1) to 1–50 mg fatty acids. As soon as a clear solution has formed, the sample can be injected. However, it is recommended to heat the solution to 60 – 100 °C for 10 – 15 minutes.

MN Appl. No. 213070

Methylation with methanol/TMCS

A 1molar solution of TMCS in methanol is suited for the esterification of free carboxylic acids and transesterification of glycerides. Formation of HCl catalyses the reaction. TMCS and silyl ether remove water and thus drive the reaction to completion. The mixture should be prepared fresh.

Procedure:
Add 1 ml methanol/TMCS to about 50 mg carboxylic acid or glyceride and heat. Then evaporate in a stream of nitrogen and dissolve again for injection in e.g. *n*-heptane.

MN Appl. No. 213080

For GC separation of FAMEs from natural butter fat after derivatisation with TMSH see Appl. 201680 at *www.mn-net.com*

Ordering information

	Packing unit			
Code	10 x 1 ml	20 x 1 ml	1 x 10 ml	5 x 10 ml
DMF-DMA		**701430.201**	**701430.110**	
TMSH	**701520.101**	**701520.201**	**701520.110**	**701520.510**

Silylation reagents

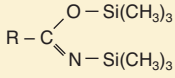
Usually the term silylation in GC stands for replacement of active hydrogen atoms by a trimethylsilyl group (TMS derivative). Sometimes, however, trialkylsilyl groups or dimethylalkylsilyl groups with longer alkyl chains are used for derivatisation. The trialkylsilyl group increases volatility and enhances thermal stability of the sample.

Silylation can be catalysed either acidic by addition of TMCS or basic by addition of pyridine or TSIM (e.g. for sterically hindered functionalities like *tert.* alcohols).

Reactivity of silylation reagents (acc. to M. Donike): TMS amides (e.g. BSA, MSTFA) > TMS amine = TSIM > Enol-O-TMS ether > S-TMS ether > O-TMS ether > TMS-O-TMS

Stability of the TMS derivatives: O-TMS ether > S-TMS ether > Enol-O-TMS ether > TMS amine > TMS amide

BSA · BSTFA · SILYL-991



N,O-bis-trimethylsilyl-acetamide

BSA: R = CH_3

m.w. 203.4, Bp 71 – 73 °C (35 mm Hg), density d20°/4° = 0.832

strong silylation reagent, which forms very stable TMS derivatives of a wide variety of compounds, e.g. alcohols, amines, carboxylic acids, phenols, steroids, biogenic amines and alkaloids

not recommended for use with carbohydrates or very low molecular weight compounds

good solvent for polar compounds, but frequently used in combination with a solvent (pyridine, DMF etc.) or with other silylation reagents. When used with DMF, BSA is the reagent of choice for derivatising phenols.

N,O-bis-trimethylsilyl-trifluoroacetamide

BSTFA: R = CF_3

m.w. 257.4, Bp 40 °C (12 mm Hg), density d20°/4° = 0.961

powerful trimethylsilyl donor with approximately the same donor strength as the nonfluorinated analog BSA

advantage of BSTFA over BSA: greater volatility of its reaction products (particularly useful for GC of some lower boiling TMS amino acids.

BSTFA is nonpolar (less polar than MSTFA), and can be mixed with acetonitrile for improved solubility. For silylating fatty acid amides, hindered hydroxyls and other compounds, which are difficult to silylate (like secondary alcohols and amines), we recommend BSTFA + 1 % trimethylchlorosilane (TMCS), available under the designation SILYL-991.

Silylation with BSA, BSTFA or SILYL-991 (BSTFA + 1 % TMCS)

Procedure:
add 0.5 ml of the silylation reagent to 1 – 10 mg sample; if necessary, add some solvent (normally pyridine or DMF [dimethylformamide] are used). Heat to 60 – 80 °C for 20 min to increase the reaction rate. 1 – 2 drops of TMCS (trimethylchlorosilane) or TSIM will also speed up the reaction.

BSA MN Appl. No. 213091 · BSTFA MN Appl. No. 213092
SILYL-991 MN Appl. No. 213093

Silylation with BSA in combination with other silylation reagents

Procedure:
BSA alone silylates all sterically unhindered hydroxyl groups of the steroid skeleton; addition of TMCS will enable reaction of moderately hindered OH groups (reaction time 3 – 6 hours at 60 °C). After addition of TSIM even strongly hindered hydroxyl groups will react (reaction time 6 – 24 hours at 60 °C).

MN Appl. No. 213100

Ordering information

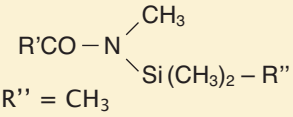
	Packing unit				
	20 x 1 ml	1 x 10 ml	5 x 10 ml	1 x 50 ml	1 x 100 ml
BSA		**701210.110**	**701210.510**	**701210.150**	
BSTFA	**701220.201**	**701220.110**	**701220.510**		
SILYL-991 (BSTFA – TMCS (99:1)	**701490.201**			**701490.150**	**701490.1100**

Due to their purpose, derivatisation reagents are very reactive substances. For this reason they should be stored cool and protected from moisture. Our derivatisation reagents are supplied in vials with crimp caps for easy access with a syringe. Vials with pierced sealing disks have limited stability and should be used soon.

Reagents and procedures for silylation

MSTFA · MSHFBA · MBDSTFA

N-methyl-N-trimethylsilyl-trifluoroacetamide



MSTFA:
R' = CF_3, R'' = CH_3

m.w. 199.1, Bp 70 °C (75 mm Hg), density d20°/4° = 1.11

the most volatile trimethylsilyl amide available

very strong TMS donor which does not cause any noticeable FID fouling even after long-time measuring series The already good solution characteristics can be improved by addition of submolar quantities of protic solvents (e.g. TFA for extremely polar compounds such as hydrochlorides) or pyridine (e.g. for carbohydrates).

recommended application: carboxylic acids, hydroxy and ketocarboxylic acids, amino acids, amines, alcohols, polyalcohols, sugars, mercaptans and similar compounds with active hydrogen atoms. Even amine hydrochlorides can be silylated directly.

advantages:
complete reaction with high reaction rates, even without a catalyst (1–2 % TMCS or TSIM)
the by-product of the reaction (N-methyltrifluoroacetamide) features high volatility and short retention time

N-methyl-N-trimethylsilyl-heptafluorobutyramide

MSHFBA: R' = C_3F_7, R'' = CH_3

m.w. 299.1, Bp 148 °C (760 mm Hg)

similar to MSTFA in reactivity and chromatography

recommended application: carboxylic acids, alcohols, phenols, primary and secondary amines and amino acids

used either alone or in combination with a catalyst (TMCS, TSIM) or another silylation reagent with or without solvent

the by-product N-methylheptafluorobutyric amide has a lower retention time than the silylating reagent

especially useful for flame ionisation detection due to the large ratio of fluorine to silicon of 7 : 1, since degradation of the excess of MSHFBA does not produce SiO_2 but volatile, non-corrosive silicon compounds

N-methyl-N-*tert*-butyldimethylsilyl-trifluoroacetamide

MBDSTFA (MTB-TFA):
R' = CF_3, R'' = C_4H_9

m.w. 241.3, Bp 168 – 170 °C (760 mm Hg), density d20°/4° = 1.121

silylation reagent which donates a *tert*-butyldimethylsilyl group (TBDMS) for derivatising active hydrogen atoms in hydroxyl, carboxyl and thiol groups as well as primary and secondary amines

fast reactions (typically 5 – 20 min) with high yields (> 96%)

by-products are neutral and volatile

TBDMS ethers are 10^4 times more stable than the corresponding TMS ethers

chromatographic retention times are longer due to the large protecting group, which may improve some separations; because of the high molecular ion concentration at M^+–57 useful for GC-MS applications

Silylation with MSTFA, MSHFBA or MBDSTFA

Procedure:
Dissolve 10 – 15 mg sample in 0.8 ml solvent, then add 0.2 ml of the silylation reagent. The reaction mixture can be heated to 60 – 70 °C for up to 1 hour and can be analysed directly. If TFA is used as a solvent, proceed as follows [M. Donike, J. Chromatogr. 85 (1973) 1 – 7]: dissolve 1 – 2 mg sample in 100 µl TFA. Dropwise add 0.9 ml of the silylating reagent. After cooling the sample can be chromatographed directly.

MSTFA MN Appl. No. 213111 · MSHFBA MN Appl. No. 213112 · MBDSTFA MN Appl. No. 213113

Ordering information

	Packing unit							
	10 x 1 ml	20 x 1 ml	1 x 10 ml	5 x 10 ml	1 x 100 ml	6 x 50 ml	6 x 100 ml	12 x 100 ml
MSHFBA		**701260.201**	**701260.110**	**701260.510**	**701260.1100**		**701260.6100**	
MSTFA		**701270.201**	**701270.110**	**701270.510**	**701270.1100**	**701270.650**	**701270.6100**	**701270.12100**
MBDSTFA	**701440.101**	**701440.201**						

DMCS · HMDS · TMCS · TSIM

Dimethyldichlorosilane

DMCS: $(CH_3)_2SiCl_2$

m.w. 129.06, Bp 70 °C (760 mm Hg), density d20°/4° = 1.07

used to form dimethylsilyl (DMS) derivatives

DMS derivatives are much more susceptible to hydrolysis than TMS derivatives, therefore strictly anhydrous conditions during reaction are very important.

Hexamethyldisilazane

HMDS: $(CH_3)_3Si - NH - Si(CH_3)_3$

m.w. 161.4, Bp 126 °C (760 mm Hg), density d20°/4° = 0.7742

weak TMS donor; used alone reaction is slow and not very effective

after addition of catalytic quantities of TMCS (e.g. 1 %) or as a mixture with TMCS (2:1, v/v; SILYL-21 and SILYL-2110) a fast and quantitative reagent for trimethylsilylation of organic compounds

Aprotic solvents like acetonitrile, pyridine, dimethylformamide, carbon disulphide and dimethylacetamide are recommended for use with HMDS.

Trimethylchlorosilane

TMCS: $(CH_3)_3SiCl$

m.w. 108.7, Bp 57 °C (760 mm Hg), density d20°/4° = 0.8580

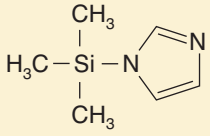
often used as a catalyst with other trimethylsilyl reagents

Without additives it can be used for preparing TMS derivatives of organic acids.

N-Trimethylsilyl-imidazole

m.w. 140.3, Bp 94 – 96 °C (760 mm Hg), density d20°/4° = 0.961

TSIM:



strongest hydroxyl silylator; reagent of choice for carbohydrates and most steroids (even highly hindered steroids)

The reagent is unique in that it reacts quickly and smooth with hydroxyl (even *tert.* OH) and carboxyl groups, but not with amines. This characteristic makes TSIM particularly useful in multi-derivatisation schemes for compounds with different functional groups, which are to be derivatised differently (e.g. -O-TMS / -N-HFB derivatives of catecholamines).

recommended application: alcohols, phenols, organic acids, steroids, hormones, glycols, nucleotides, narcotics

Silylation with TSIM or SILYL-1139 (TSIM – pyridine 11:39)

Procedure:

Dissolve 10 – 15 mg sample in 0.8 ml solvent, then add 0.2 ml of the silylation reagent. The reaction mixture can be heated to 60 – 70 °C for up to 1 hour and can be analysed directly.

recommended solvent pyridine

When using SILYL-1139, the presence of water does not interfere.

TSIM MN Appl. No. 213121 · SILYL-1139 MN Appl. No. 213122

Ordering information

	Packing unit			
	20 x 1 ml	1 x 10 ml	5 x 10 ml	6 x 50 ml
DMCS				**701230.650** *
HMDS			**701240.510**	**701240.650** *
TMCS	**701280.201** *			**701280.650** *
TSIM	**701310.201**	**701310.110**	**701310.510**	

* in vials with screw caps

Reagents and procedures for silylation

Reagent mixtures for silylation

Code		20 x 1 ml	1 x 10 ml	5 x 10 ml	1 x 50 ml	1 x 100 ml
SILYL-271	BSA – HMDS – TSIM (2:7:1)	**701450.201**	**701450.110**	**701450.510**		
SILYL-1139	TSIM – pyridine (11:39)	**701460.201**				
SILYL-21	HMDS – TMCS (2:1)	**701470.201**				
SILYL-2110	HMDS – TMCS – pyridine (2:1:10)	**701480.201**				
SILYL-991	BSTFA – TMCS (99 : 1)	**701490.201**			**701490.150**	**701490.1100**

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Silylation with SILYL-21 or SILYL-2110

Procedure:
Carefully add SILYL-21 or SILYL-2110 to 1 – 10 mg of the sample. A precipitate of ammonium chloride does not interfere. If the sample should not dissolve within 5 minutes, heat to 75 – 85 °C. If no mutarotation is to be expected, you may dissolve the sugar in warm pyridine first and then add the silylation reagent. In some cases it may be advantageous to use a different solvent instead of pyridine. For derivatisation of 3-ketosteroids we recommend to use DMF (dimethylformamide).

SILYL-21 MN Appl. No. 213131 · SILYL-2110 MN Appl. No. 213132

- suitable for sugars, glycols, sterically unhindered alcohols, carboxylic acids, acids in urine, hydroxy fatty acids, nucleotides, steroids, vitamin D, xanthone derivatives

O-Trimethylsilylation with MSTFA followed by N-trifluoroacetylation with MBTFA

Procedure:
Completely silylate 2 mg of the sample with 0.3 ml MSTFA e.g. as described on page 260. After addition of 0.3 ml MBTFA the N-trimethylsilyl group is replaced by the N-trifluoroacetyl group. The mixture can be analysed directly.

MN Appl. No. 213140

Test mixtures for GC

- Test mixtures for GC capillary columns are used for controlling the performance of fused silica capillary columns and the GC system
- Test mixtures for chiral GC columns see page 245

Ordering information

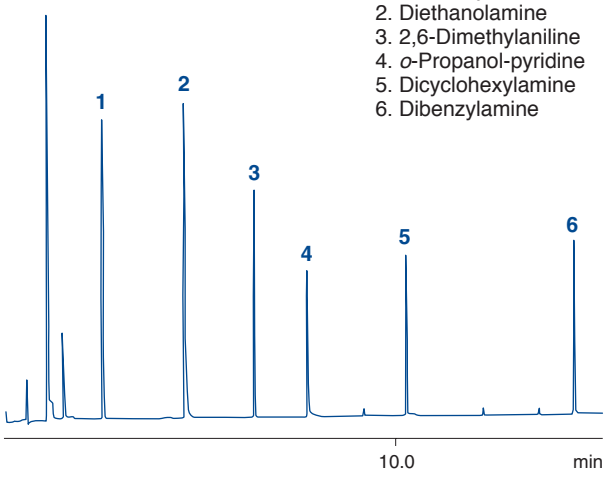
Designation	Pack of	Composition	REF
Polarity mixture POL_5 (qualitative) in *n*-pentane	1 ml	1-butanol, benzene, methyl butyrate, toluene, cyclopentanone, 1-octene, dibutyl ether	**722306**
Activity test mixture (FA-TMS test according to Donike) in MSTFA/*n*-hexane (1 + 4)	1 ml	1 mg/ml each of TMS capric acid (C_{10}), TMS myristic acid (C_{14}), TMS stearic acid (C_{18}), TMS behenic acid (C_{22}), hexadecane (C_{16}), eicosane (C_{20}), tetracosane (C_{24}), octacosane (C_{28})	**722307**
Grob test mixture (modified) in *n*-hexane	1 ml	(in mg/ml) *n*-decane (~2.8), *n*-undecane (~2.9), *n*-octanol (~3.6), 2,6-dimethylphenol (~3.2), 2,6-dimethylaniline (~3.2), methyl decanoate (~4.2), dicyclohexylamine (~3.1), methyl undecanoate (~4.2), methyl dodecanoate (~4.1)	**722310**
MN OPTIMA® test mixture in pentane	1 ml	0.1 % each of undecane, dodecane, octanol, dimethylaniline, decylamine, methyl decanoate, methyl undecanoate, henicosane, docosane, tricosane (chromatograms see page 214)	**722316**
MN OPTIMA® amine test mixture in ethanol	1 ml	0.2 % diisobutylamine, 1 % diethanolamine, 0.2 % 2,6-dimethylaniline, 0.2 % *o*-propanol-pyridine, 0.2 % dicyclohexylamine, 0.2 % dibenzylamine	**722317**
FAME test mixture in hexane	1 ml	0.1 % each of FAMEs C4, C6, C8, C10, C12, C14, C16, C18, C18:1 *cis*, C18:1 *trans*, C18:2, C18:3, C20, C22, C22:1, C24 (chromatogram see page 236)	**722320**

Test mixtures for GC capillary columns

Separation of the OPTIMA® Amine test mixture (REF 722317)

Column:	OPTIMA® 5 Amine, 1.0 µm film, 30 m x 0.32 mm ID, max. temp. 300/320 °C, REF 726353.30
Injection volume:	1 µl
Carrier gas:	0.6 bar H_2
Split:	1:40
Temperature:	100 °C → 280 °C, 10 °C/min
Detector:	FID, 280 °C, 2^6

Peaks:
1. Diisobutylamine
2. Diethanolamine
3. 2,6-Dimethylaniline
4. *o*-Propanol-pyridine
5. Dicyclohexylamine
6. Dibenzylamine



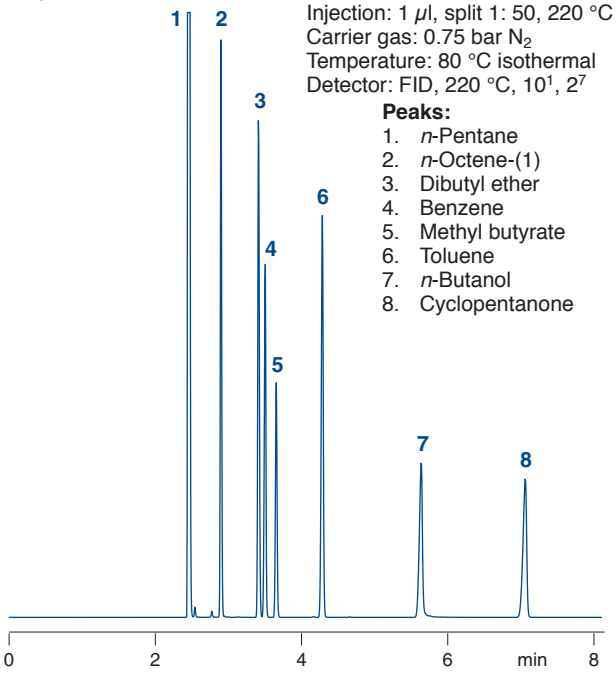
MN Appl. No. 250020

Polarity mixture POL5 (qualitative) (REF 722306)

Column: OPTIMA® Wax, 0.25 µm film, 25 m x 0.25 mm ID, max. temp. 250/260 °C, REF 726600.25

Injection: 1 µl, split 1: 50, 220 °C
Carrier gas: 0.75 bar N_2
Temperature: 80 °C isothermal
Detector: FID, 220 °C, 10^1, 2^7

Peaks:
1. *n*-Pentane
2. *n*-Octene-(1)
3. Dibutyl ether
4. Benzene
5. Methyl butyrate
6. Toluene
7. *n*-Butanol
8. Cyclopentanone

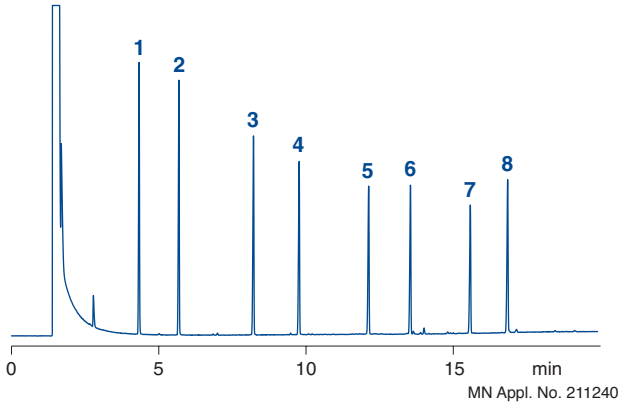


MN Appl. No. 211230

Activity test mixture (REF 722307)

Column:	OPTIMA® 5, 1.0 µm film, 25 m x 0.32 mm ID, max. temp. 340/360 °C, REF 726316.25
Injection:	1 µl, split 1: 40, 300 °C
Carrier gas:	0.6 bar H_2
Temperature:	150 °C → 300 °C (8 min), 10 °C/min
Detector:	FID, 300 °C, 10^1, 2^3

Peaks:
1. TMS capric acid (C_{10})
2. Hexadecane (C_{16})
3. TMS myristic acid (C_{14})
4. Eicosane (C_{20})
5. TMS stearic acid (C_{18})
6. Tetracosane (C_{24})
7. TMS behenic acid (C_{22})
8. Octacosane (C_{28})

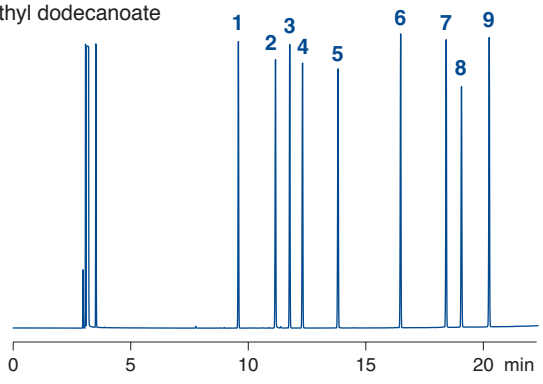


MN Appl. No. 211240

Grob test mixture (modified) (REF 722310)

Column:	OPTIMA® 5, 1.0 µm film, 50 m x 0.25 mm ID, max. temp. 340/360 °C, REF 726807.50
Injection:	1 µl, split 1: 40, 280 °C
Carrier gas:	1.5 bar H_2
Temperature:	80 °C → 280 °C (10 min), 8 °C/min
Detector:	FID, 280 °C, 10^1, 2^6

Peaks:
1. *n*-Decane
2. 1-Octanol
3. *n*-Undecane
4. 2,6-Dimethylphenol
5. 2,6-Dimethylaniline
6. Methyl decanoate
7. Methyl undecanoate
8. Dicyclohexylamine
9. Methyl dodecanoate



MN Appl. No. 211250

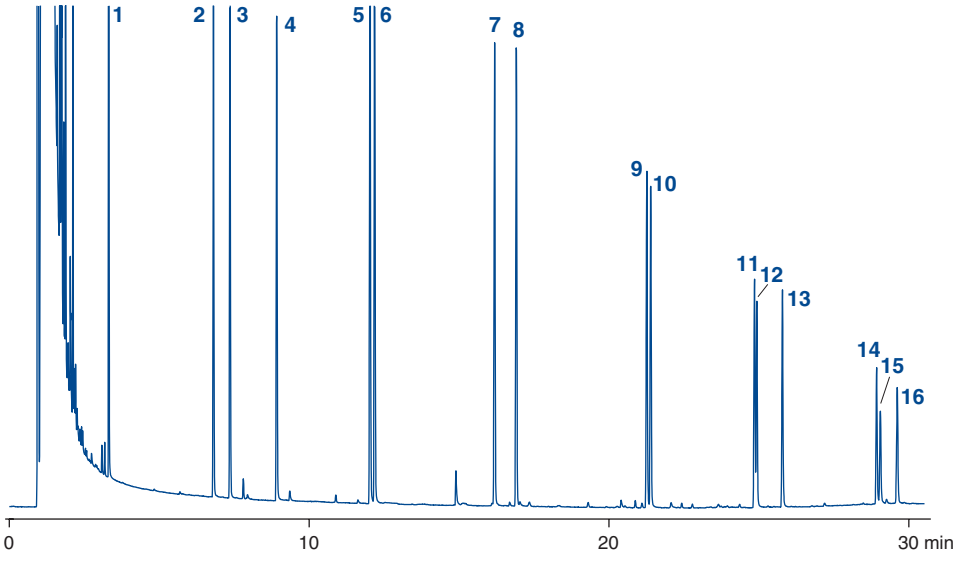
Ordering information

Designation	Pack of	Composition	REF
Haloform test mixture in *n*-pentane (qualitative)	1 ml	9 halogenated hydrocarbons acc. to German drinking water specifications (in ng/ml): dichloromethane (795), chloroform (75), 1,1,1-trichloroethane (67), carbon tetrachloride (80), trichloroethylene (73), bromodichloromethane (100), dibromochloromethane (122), tetrachloroethylene (81), bromoform (145)	**722311**
Haloform test mixture in methanol for headspace analyses (qualitative)	1 ml	9 halogenated hydrocarbons in increased concentration for calibration acc. to German Industrial Standard DIN 38407, part 5 (in µg/ml): dichloromethane (158.4), chloroform (14.9), 1,1,1-trichloroethane (13.4), carbon tetrachloride (15.9), trichloroethylene (14.6), bromodichloromethane (20), dibromochloromethane (24.5), tetrachloroethylene (16.2), bromoform (28.9)	**722371**
Haloform test kit (qualitative)	11 x 1 ml	1 ml each of 9 single undiluted halogenated hydrocarbons and 1 ml each of test mixtures REF 722311 and REF 722371	**722312**
PAH test mixture acc. to EPA in toluene	1 ml	20 µg/ml each of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene, benzo[ghi]perylene	**722314**
PAH test mixture acc. to German drinking water specifications in toluene	1 ml	20 µg/ml each of fluoranthene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, benzo[ghi]perylene	**722331**
BTX test mixture in methanol	1 ml	10 ng/µl each of benzene, ethylbenzene, toluene, *m*-, *o*-, *p*-xylene	**722372**

PAH test mixture acc. to EPA for GC (REF 722314)

Column: OPTIMA® 5, 0.25 µm film, 30 m x 0.32 mm ID, max. temperature 340/360° C, REF 726314.30
Sample: PAH test mixture according to EPA (20 µg/ml each in toluene)
Injection volume: 1.0 µl
Carrier gas: H_2, 70 KPa
Split: 1 : 15
Temperature: 100° C, 7 °C/min → 300° C
Detector: FID, 300 °C, 2^4

Peaks:
1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Phenanthrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[a]anthracene
10. Chrysene
11. Benzo[b]fluoranthene
12. Benzo[k]fluoranthene
13. Benzo[a]pyrene
14. Indeno[1,2,3-cd]pyrene
15. Dibenz[ah]anthracene
16. Benzo[ghi]perylene



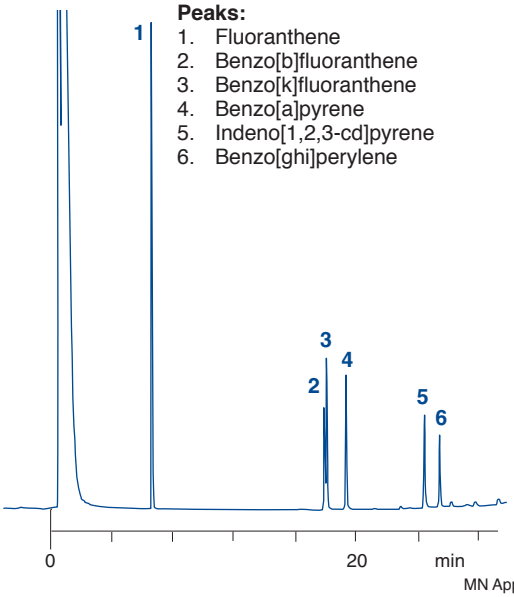
MN Appl. No. 200510

Test mixtures for environmental analyses

PAH test mixture acc. to German drinking water specifications (REF 722331)

Column: OPTIMA® 5, 0.25 µm film, 25 m x 0.32 mm ID, max. temp. 340/360 °C, REF 726314.25
Injection volume: 2 µl
Carrier gas: 0.6 bar H_2, split 1 : 10
Temperature: 80 °C ↑ 180 °C → 300 °C, 4 °C/min
Detector: FID 300 °C, 2^4

Peaks:
1. Fluoranthene
2. Benzo[b]fluoranthene
3. Benzo[k]fluoranthene
4. Benzo[a]pyrene
5. Indeno[1,2,3-cd]pyrene
6. Benzo[ghi]perylene

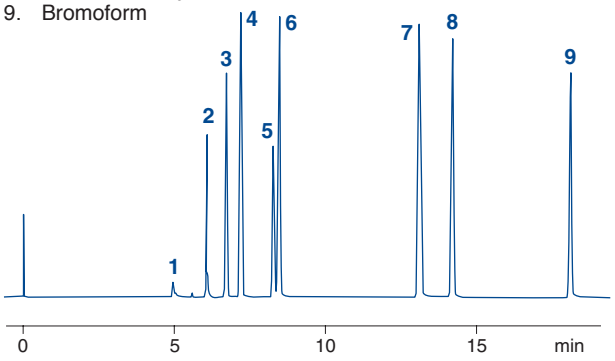


MN Appl. No. 200450

Haloform test mixture (REF 722311)

Column: FS-SE-54, 0.35 µm film, 50 m x 0.25 mm ID, max. temperature 300 °C, REF 733623.50
Injection volume: 1 µl
Carrier gas: 1 bar N_2
Split: about 1 : 30
Temperature: 45 °C (10 min) → 120 °C, 8 °C/min
Detector: ECD 260 °C, 2^8

Peaks:
1. Dichloromethane
2. Chloroform
3. 1,1,1-Trichloroethane
4. Carbon tetrachloride
5. Trichloroethylene
6. Bromodichloromethane
7. Dibromochloromethane
8. Tetrachloroethylene
9. Bromoform



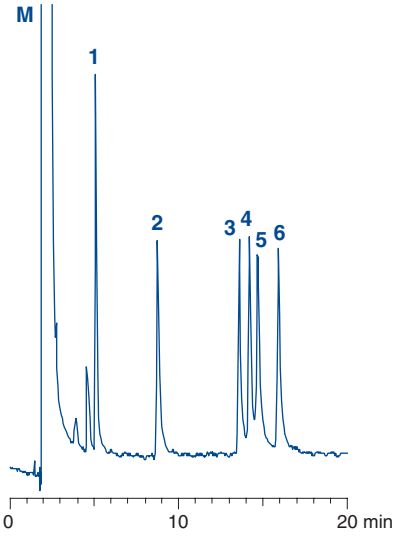
MN Appl. No. 211190

BTX test mixture (REF 722372)

Column: HYDRODEX β-PM, 50 m x 0.25 mm ID, max. temperature 250 °C, REF 723370.50

Injection volume: 2 µl (10 ng/µl each in methanol)
Carrier gas: 120 kPa H_2 (2.45 ml/min)
Split: 40 ml/min
Temperature: 60 °C → 100 °C, 2 °C/min
Detector: FID 250 °C, 2^4

Peaks:
M = Methanol
1. Benzene
2. Toluene
3. *p*-Xylene
4. *m*-Xylene
5. Ethylbenzene
6. *o*-Xylene



MN Appl. No. 211220

Ferrules for GC

- **Graphite** ferrules provide the highest temperature stability (up to 450 °C). They are reusable when handled with care. We also offer 1/16" graphite ferrules specially designed for Carlo Erba / Fisons or for Agilent gas chromatographs.
- **Vespel** ferrules come in three types: pure Vespel, Vespel with 15 % graphite and Vespel with 40 % graphite. All versions are stable up to 400 °C and reusable.
- **PTFE** ferrules can only be used up to 250 °C. They are not reusable and not recommended for temperature programming. However, they show the best chemical inertness of all ferrules.

Ordering information (packing unit 10 ferrules)

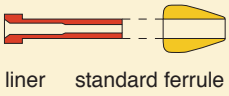
Bore (= column OD)	Graphite	Vespel			PTFE
		plain	+ 15 % graphite	+ 40 % graphite	
max. temp. →	450 °C	400 °C	400 °C	400 °C	250 °C
1/16" ferrules					
no bore	708336	706187	706167		706177
0.4 mm	708309			706246	
0.5 mm	708308			706247	
0.8 mm	708301			706248	
1 mm	708302				
1.2 mm	708303				
1/16"	706155	706180	706160	706190	706170
1/16" ferrules for Carlo Erba / Fisons instruments					
0.4 mm	708338				
0.5 mm	708339				
0.8 mm	708340				
1/16" ferrules for Hewlett-Packard / Agilent instruments					
0.4 mm	708353				
0.5 mm	708354				
0.8 mm	708355				
1/8" ferrules					
no bore	708341	706188	706168		706178
0.4 mm	708342	706266	706249	706240	
0.5 mm	708343				
0.8 mm	708333	706268			
1/16"	708158	706183			
1/8"	708156	706181		706191	706171
1/4" ferrules					
no bore	708344		706169	706199	
0.4 mm	708345				
0.5 mm	708346				
1/16"			706164		
1/8"		706185			
6.0 mm	708348	706186		706196	706176
1/4"	706157	706182		706192	706172
6 mm ferrules					
no bore		706252			
6.0 mm					706259

If you are in doubt about the correct size / REF please send us an old, used ferrule for the right selection.

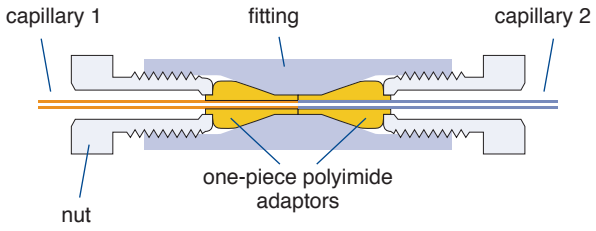
Valco fused silica adaptors and fittings for capillary GC

- **one-piece FS adaptors:** recommended for use in fittings where the polyimide ferrule need not be removed

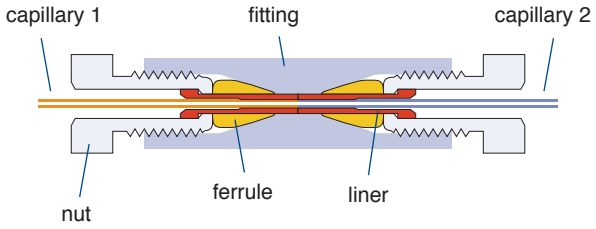
- **two-part removable FSR adaptors:** recommended for use in Valco valves; consists of a liner which slides over the fused silica tubing, and a ferrule, both made of high temperature polyimide alloys
the liner with an enlarged diameter at one end fits within the nut, thus ensuring that the liner and the tube within are removed as the nut is unscrewed from the valve (see figure below)
The 1/16" FSR adaptor comes with a special counterbored 1/16" nut (ZCN1) to receive the liner. The 1/32" adaptor works with standard Valco 1/32" nuts.



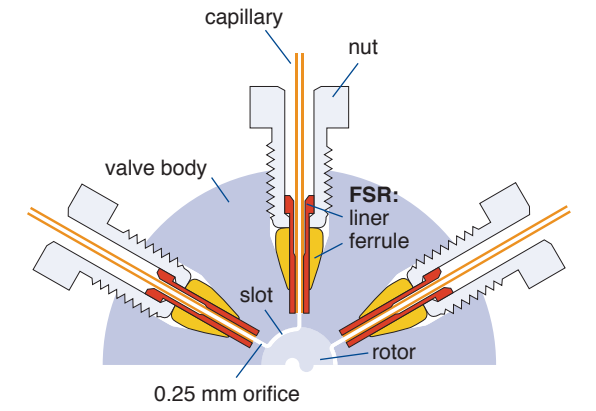
Union with FS adaptors



Union with FSR adaptors



Valve with FSR adaptors



To order Valco fittings for use with fused silica adaptors (FS or FSR recommended), add suffix "J" to the fitting code and specify the appropriate number of adaptors separately. The stainless steel ferrules normally provided with the fittings are omitted since they are replaced by the FS (or FSR) adaptors. Again, for 1/16" FSR adaptors use the counterbored nut ZCN1 supplied with the adaptor.

Examples:

1) Connection of 2 capillaries with 0.25 mm ID and 0.4 mm OD: either use a 1/32" union ZU.5TJ and 2 FS adaptors FS.4 or a 1/32" union ZU.5TJ and 2 removable FSR adaptors FSR.4
2) Connection of 2 capillaries with 0.53 mm ID and 0.8 mm OD: we recommend either a 1/16" union ZU1TJ and 2 FS adaptors FS1-.8 or a 1/16" union ZU1TJ and 2 removable FSR adaptors FS1R.8

If capillaries 1 and 2 have different outer diameters, the corresponding different FS adaptors have to be used.

For use of fused silica adaptors with Valco valves please order the number of adaptors (FSR required) when you order the valve, or when you want to use an existing valve with open tubular columns. Please note that for 1/16" FSR adaptors you have to use the special counterbored nut ZCN1 which is supplied with the adaptors FS1R.5 and FS1R.8.

Examples:

1) For connecting a capillary with 0.32 mm ID (0.5 mm OD) to a valve with 1/32" fittings we recommend the removable FSR adaptor FSR.5.
2) For connecting a capillary with 0.53 mm ID (0.8 mm OD) to a valve with 1/16" fittings we recommend the removable FSR adaptor FS1R.8.

Ordering information

Valco code	Description		Pack of	REF	
One-piece fused silica adaptors					
		for capillary OD			
FS.25-5	1/32"	< 0.25 mm	5	**724405**	
FS.4-5	1/32"	0.25 - 0.4 mm	5	**724243**	
FS.5-5	1/32"	0.4 - 0.5 mm	5	**724244**	
FS1.4-5	1/16"	< 0.4 mm	5	**724406**	
FS1.5-5	1/16"	0.4 - 0.5 mm	5	**724407**	
FS1.8-5	1/16"	0.6 - 0.8 mm	5	**724408**	
Removable fused silica adaptors (incl. nuts)					
FSR.25-5	1/32"	< 0.25 mm	5	**724409**	
FSR.4-5	1/32"	0.25 - 0.4 mm	5	**724410**	
FSR.5-5	1/32"	0.4 - 0.5 mm	5	**724411**	
FS1R.5-5	1/16"	< 0.5 mm	5	**724335**	
FS1R.8-5	1/16"	0.5 - 0.8 mm	5	**724334**	
Replacement liners					
FSL.25-5	1/32"	< 0.25 mm	5	**724412**	
FSL.4-5	1/32"	0.25 - 0.4 mm	5	**724413**	
FSL.5-5	1/32"	0.4 - 0.5 mm	5	**724414**	
FS1L.5-5	1/16"	< 0.5 mm	5	**724415**	
FS1L.8-5	1/16"	0.5 - 0.8 mm	5	**724416**	
Special nut for fused silica adaptors					
ZCN1	1/16"	counterbored	1	**724417**	
For standard Vespel ferrules as well as standard nuts please see the Valco programme, which is available on request.					
Unions, Tees and crosses for fused silica adaptors (without ferrules, but incl. standard nuts)					
ZU.5TJ	1/32"- 1/32"	for butt connection	1	**724418**	
ZU1TJ	1/16"- 1/16"	for butt connection	1	**724333**	
ZT.5J	1/32"	Tee	1	**724421**	
ZT1CJ	1/16"	Tee, capillary bore	1	**724336**	
ZX.5J	1/32"	cross	1	**724422**	
ZX1CJ	1/16"	cross, capillary bore	1	**724337**	
Tools for Valco fused silica adaptors					
OEW	open end wrench (3/16" x 1/4")		1	**724423**	for use with 1/32" fittings
PV	pin vise and drill index (0.34 to 1.0 mm)		1	**724424**	application see text below

Should a tube break in a straight-through union, remove the nuts and the tube opposite the broken one. Clear the fitting by passing a drill or wire of appropriate diameter into the unbroken side and through the centre of the fitting.

A pin vise and drill index are used for removing ferrules from Tee and cross fittings, and for enlarging the interior diameter of FS adaptors (Valco code PV).

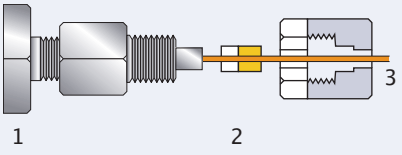
For other fittings and valves for GC please ask for our VICI / Valco programme.

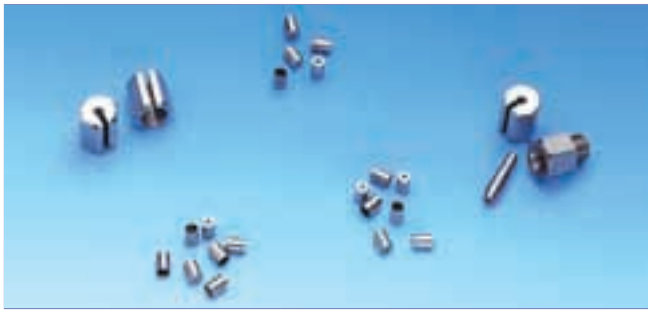
Accessories for capillary columns

Connectors for capillary GC columns

- **Graphseal ferrules** for capillaries: a stainless steel ferrule filled with graphite – the ideal sealing material for capillaries
  The capillary is mounted on a 1/16" exit (detector, injector etc.) with the appropriate ferrule, a nut (with slit) and an adaptor (see table below).
- **Glass connectors** for fused silica capillary columns from 0.2 to 0.53 mm ID
  manufactured from deactivated glass with slightly tapered inner diameter; used to join two fused silica capillaries of equal or different diameters. Advantages compared to stainless steel fittings are easy connection without tools, optical control during connection, negligible heat capacity and no dead volume.
- **PTFE shrinking tube**
  can also be used for connecting capillaries. The minimum inner diameter expanded is 1.17 mm, the maximum ID shrunk is 0.40 mm. Shrinking occurs above 310 °C. Connections with PTFE shrinking tube are applicable up to 200 °C only. They should never be used above 250 °C.

Ordering information

Description	Pack of	REF	Specification
Graphseal connecting system for capillary columns			
Graphseal ferrule, 0.4 mm bore	10 ferrules	**708337**	 1 1/16" exit, injector or detector 2 Graphseal ferrule 3 capillary
Graphseal ferrule, 0.5 mm bore	10 ferrules	**708318**	
Graphseal ferrule, 0.8 mm bore	10 ferrules	**708319**	
Universal capillary glass connectors			
linear	5 connectors	**707971**	
linear	10 connectors	**707972**	
Y splitter	1 connector	**707973**	
PTFE shrinking tube, thin-walled	1 m	**708305**	for connecting capillaries, min. ID expanded 1.17 mm, max. ID shrunk 0.40 mm



Glass injection liners for GC

- protect the sample from catalytic decomposition at active metal surfaces in the injector. The programme comprises liners with glass wool for split injection, liners for splitless injection and liners with flow reversal for different gas chromatographs.

Ordering information

Description	Length [mm]	OD [mm]	ID [mm]	Specification	Pack of [liners]	REF
for Hewlett-Packard (Agilent) instruments						
Liner with glass wool for split injection	78	6.1	4		1	**708380**
Liner for splitless injection	78	6.1	4		1	**708382**
Liner for splitless injection	78	6.1	2		1	**708381**
Liner with flow reversal b = 22 mm	78	6.1	4		1	**708383**
for Carlo Erba / Fisons (Thermo) instruments						
Liner with flow reversal	98	6.1	4	fig. see above, b = 46 mm	1	**708384**

Septa for GC

Designation	Material	Thickness	Hardness	max. Temp.
Standard septa (ST)	beige silicone rubber	4 mm	60 shore	
High temperature septa (HT)	red, specially pretreated, non-bleeding silicone rubber	3 mm	60 shore	320 °C *
Silicone septa, soft	transparent silicone rubber	3 mm	45 shore	250 °C
Silicone septa PTFE	white silicone rubber, one side coated with grey PTFE	3 mm		200 °C

* When used at considerably higher temperatures – and working without septum purge – interfering peaks can occur due to thermal decomposition of the material.

Ordering information

Septum grade (packs of 50 septa)	Outer diameter 9 mm N 9	10 mm N 10	11 mm N 11	12 mm N 12	13 mm N 13	17 mm N 17
Standard septa (ST)	**702609**	**702610**	**702611**	**702612**	**702613**	
High temperature septa (HT)	**702619**	**702620**	**702621**	**702622**	**702623**	**702632**
Silicone septa, soft	**702602**		**702604**	**702605**	**702606**	
Silicone septa PTFE		**702625**	**702626**	**702627**	**702628**	
Septum remover (tool for removing septa which have become baked into the injection port of the gas chromatograph)						**706141**

Accessories for GC in general

Systems for point-of-use gas purification

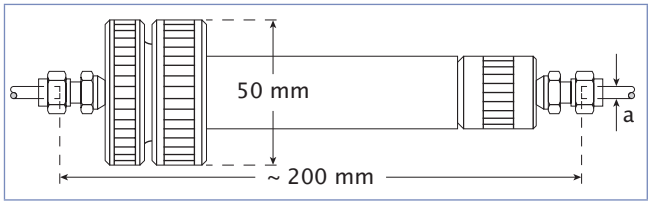
For maximum column lifetime and interference-free detector operation in GC high purity of the carrier and burner gases is prerequisite. If the gas supplies available in a laboratory do not meet quality requirements, installation of an in-line gas purification system is generally recommended. We offer purification systems which use special absorber cartridges to reduce the concentration of oxygen, water or hydrocarbons in the gas:

- **O_2-free®** (formerly Oxisorb®) for removal of oxygen by chemisorption: specially treated chromium trioxide on a large surface support; as a side effect water is removed by physisorption
  capacity per cartridge 100 ml O_2 and 500 ml H_2O (gas); final purity < 5 ppb O_2, < 30 ppb H_2O;
  packed under helium in aluminium or glass cartridges (the latter for visual control of the absorber mass)
  applicable for noble gases, nitrogen, hydrogen, carbon monoxide, carbon dioxide and saturated hydrocarbons; not applicable for purification of oxygen, pressurised air and unsaturated hydrocarbons
- **H_2O-free** (formerly Hydrosorb) for removal of water by physisorption: highly reactive molecular sieve, packed in aluminium cartridges under He; capacity per cartridge ~1 l H_2O (gas); final purity < 20 ppb H_2O
  applicable for noble gases, nitrogen, hydrogen, carbon monoxide, carbon dioxide, saturated hydrocarbons, halogenated hydrocarbons, nitrous oxide, pressurised air and oxygen
- **HC-free** (formerly Accosorb) for removal of hydrocarbons (HC), especially oil traces by physisorption: activated carbon, packed in aluminium cartridges under helium
  capacity per cartridge 1 mg C_2H_6, 180 mg higher HC, 8 g oil vapour; final purity < 10 ppb HC (except CH_4)
  applicable for noble gases, nitrogen, hydrogen, carbon monoxide, carbon dioxide, methane and pressurised air; not applicable for purification of oxygen

Holders for cartridges are available for tubing lines with 1/4", 1/8" or 6 mm OD. For 1/8" lines we also supply a multiple absorber for combination of two absorber cartridges in series (e.g. O_2-free and H_2O-free for carrier gases).

Please remember to exchange the cartridges in regular intervals (e.g. whenever you change the steel gas cylinder), because exhausted purification cartridges are useless!

Regeneration of the absorber mass is uneconomical or not possible.



Small absorber L for installation in gas tubes
a = tube diameter: 6 mm, 1/4", or 1/8"

Ordering information

Description	Pack of	REF
Gas purification cartridges		
O_2-free cartridges, glass (with visible packing)	2	**734325**
O_2-free cartridges, aluminium	2	**734329**
H_2O-free cartridges	2	**734363**
HC-free activated carbon cartridges	2	**734364**
Holders for gas purification cartridges (without cartridges)		
Small absorbers L		
for 6 mm OD tubing	1	**734326**
for 1/4" OD tubing	1	**734327**
for 1/8" OD tubing	1	**734328**
Small absorbers L, PN 10, with protective jacket for cartridges with visible packing		
for 6 mm OD tubing	1	**734322**
for 1/4'' OD tubing	1	**734323**
for 1/8" OD tubing	1	**734324**
Multiple absorber II		
Multiple absorber for 1/8" OD tubing	1	**734361**
Protective plexiglas jacket PN 10	1	**734362**

Tools and general accessories for GC

- **Soap film flowmeters:** primary standard for measuring gas flows, available in three different sizes leak check 734145 is the ideal residue-free solution to be used with these flowmeters
- **Diamond file:**
  a useful tool for cutting capillaries and smoothing ends of capillaries. Square capillary ends without protruding particles are especially important for butt connections (e.g. in Valco unions).
- **Magnifying lens:**
  a very versatile tool for any laboratory. In capillary GC it is often important to inspect column integrity or check cut ends of capillaries. When closing a column by melting the magnifying lens can be used to check whether the column is really closed or whether an open channel has been formed in the sealed end. Our lens provides 8fold magnification and is supplied with a scale as pictured in the figure below. The space between lines corresponds to 1/10 mm.
- **Glass wool, quartz wool** and **glass fibre wadding** are e.g. used for GC liners, packed GC columns etc.

Lens with scale

Diamond file

Ordering information

Description	Specification	Pack of	REF
Flowmeters and accessories			
1 ml soap film flowmeter		1	**734142**
10 ml soap film flowmeter		1	**734143**
25 ml soap film flowmeter		1	**734144**
Leak check in bottles		250 g	**734145**
Tools for capillary GC			
Diamond file	for cutting capillaries and straightening capillary ends	1	**708300**
Magnifying lens with scale	magnification 8x	1	**706296**
Glass wool			
Glass wool, long fibres, DMCS treated, for packed GC columns		50 g	**706201**
Glass fibre wadding silanised, very fine fibres		25 g	**718002**
Quartz wool, very fine fibres		25 g	**718587**
Glass wool extractor for GC columns		1	**706117**
PTFE tape for sealing, reels 10 m long, 12 mm wide, 0.1 mm thick		1 reel	**706512**

Product and subject index

A

B

C

Product and subject index

G

H

I

Product and subject index

P

Product and subject index

T

U

V

W

Index of reference numbers

Index of reference numbers

Index of reference numbers

Index of reference numbers

Index of reference numbers

Index of reference numbers

Index of reference numbers

Index of reference numbers

Index of reference numbers

Index of reference numbers

Index of reference numbers

Index of reference numbers

Index of reference numbers

Trademarks

MACHEREY-NAGEL trademarks

ALUGRAM	coated aluminium sheets for TLC
CHROMABOND	columns for solid phase extraction (SPE)
CHROMAFIL	syringe filters (membrane filters)
CHROMAFIX	cartridges for solid phase extraction (SPE)
ChromCart	cartridge system for HPLC
LIPODEX	fused silica capillaries with cyclodextrin phases for GC enantiomer separation
NUCLEODUR	spherical high purity silica for HPLC
NUCLEOGEL	HPLC polymer-based columns
NUCLEOGEN	HPLC ion-exchange columns for nucleic acid analysis
NUCLEOSIL	spherical standard silica for HPLC
OPTIMA	high performance fused silica capillary columns with immobilised phases
PERMABOND	fused silica capillaries with immobilised phases
POLYGOSIL	irregular silica for HPLC
POLYGRAM	coated polyester sheets for TLC

Trademarks of other companies

Registered trademarks (®)

Accubond	Agilent Technologies Inc. (USA)
Acquity	Waters Corp. (USA)
Alliance	Waters Corp. (USA)
Aqua	Phenomenex Inc. (USA)
AR-Glas	Schott AG (Germany)
Atlantis	Waters Corp. (USA)
AutoTrace	Caliper Life Sciences Inc. (USA)
AVICEL	FMC Corp. (USA)
Biomek	Beckman Coulter Inc. (USA)
Biotage	Biotage AB (Sweden)
Bond Elut	Varian Inc. (USA)
Celite	Manville Corp. (USA)
Cheminert	Valco Instruments Co. Inc. / VICI AG
ChiralCel	Daicel Chemical Industries Ltd. (Japan)
ChiralPak	Daicel Chemical Industries Ltd. (Japan)
Clean Screen	UCT United Chemical Technologies Inc. (USA)
CombiFlash	Teledyne Isco Inc. (USA)
Companion	Teledyne Isco Inc. (USA)
Discovery	Sigma-Aldrich Co. (USA)
Duran	Schott AG (Germany)
Eurocel	Knauer GmbH (Germany)
EXtrelut	Merck KGaA (Germany)
Fiolax	Schott AG (Germany)
Florisil	U.S. Silica Co.
Gemini	Phenomenex Inc. (USA)
Hypersil	Thermo Fisher Scientific Inc. (USA)
HyPurity	Thermo Fisher Scientific Inc. (USA)
Inertsil	GL Sciences (Japan)
Isco	Teledyne Isco Inc. (USA)
Isolute	Biotage AB (Sweden)
LiChrolut	Merck KGaA (Germany)
LiChrospher	Merck KGaA (Germany)
Luna	Phenomenex Inc. (USA)
Microlab	Hamilton Co. (USA)
MultiProbe	PerkinElmer Inc. (USA)
O_2-free	Air Liquide S.A. (France)
Oasis	Waters Corp. (USA)
Oxisorb	Messer Group GmbH (Germany)
Plexiglas	Röhm GmbH (Germany)
Purospher	Merck KGaA (Germany)
Pyrex	Corning Inc. (USA)
Quadra 3	Tomtec Inc. (USA)
RapidTrace	Caliper Life Sciences Inc. (USA)
Rtx	Restek Corp. (USA)
Sep-Pak	Waters Corp. (USA)
Sepharose	Pharmacia Biotech AB (Sweden)
Spherisorb	Waters Corp. (USA)
Stabilwax	Restek Corp. (USA)
Styre Screen	UCT United Chemical Technologies Inc. (USA)
Superspher	Merck KGaA (Germany)
Swagelok	Crawford Fitting Co. (USA)
Symmetry	Waters Corp. (USA)
Vespel	E. I. du Pont de Nemours & Co. (USA)
VICI	Valco Instruments Co. Inc. / VICI AG
Viton	DuPont Performance Elastomers (USA)
Xterra	Waters Corp. (USA)
YMC	YMC Co. Ltd. (Japan)
ZIC	Merck Sequant AB (Sweden)
Zorbax	Agilent Technologies Inc. (USA)
Zymark	Caliper Life Sciences Inc. (USA)
Zymate	Caliper Life Sciences Inc. (USA)

Trademarks

Common law trademarks (™)

AmyCoat	Eka Chemicals AB (Sweden)
ASPEC	Gilson Inc. (USA)
AT	Alltech Associates Inc. (USA)
Bakerbond	Mallinckrodt Baker Inc. (USA)
Benchmate	Zymark Corp. (USA)
BPX	SGE Analytical Sciences Pty Ltd. (Australia)
Carbowax	Union Carbide Corp. (USA)
CelluCoat	Eka Chemicals AB (Sweden)
Chem Elut	Varian Inc. (USA)
DB	J&W Scientific Inc. (USA)
Equity	Sigma-Aldrich Co. (USA)
FlashMaster	Biotage AB (Sweden)
Flash 12i	Biotage AB (Sweden)
Focus	Varian Inc. (USA)
Genesis	Tecan Group AG
Hydromatrix	Varian Inc. (USA)
Obelisc	Sielc Technologies (USA)
Nukol	Sigma-Aldrich Co. (USA)
PEEK	Victrex plc. (UK)
Porapak	Waters Corp. (USA)
SPB	Sigma-Aldrich Co. (USA)
Strata	Phenomenex Inc. (USA)
Supelcosil	Sigma-Aldrich Co. (USA)
Supelcowax	Sigma-Aldrich Co. (USA)
SymmetryShield	Waters Corp. (USA)
Synergi	Phenomenex Inc. (USA)
TPX	Mitsui Chemicals Ltd. (Japan)
WISP	Waters Corp. (USA)

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MACHEREY-NAGEL chromatography products are intended, developed, designed and sold FOR RESEARCH AND DEVELOPMENT PURPOSES AND ANALYTICAL QUALITY CONTROL / ROUTINE MEASUREMENTS ONLY, except, however, any other function of the product being EXPRESSLY set forth in original MACHEREY-NAGEL product leaflets.

MACHEREY-NAGEL products are intended for GENERAL LABORATORY USE ONLY!

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MACHEREY-NAGEL products shall in any event be used wearing adequate PROTECTIVE CLOTHING. For detailed information please refer to the respective Material Safety Data Sheet of the product !

MACHEREY-NAGEL products shall exclusively be used in an ADEQUATE TEST ENVIRONMENT.

MACHEREY-NAGEL does not assume any responsibility for damages due to improper application of our products in other fields of application.

APPLICATION ON THE HUMAN BODY IS STRICTLY FORBIDDEN. The respective user is liable for any and all damages resulting from such application.

The user has to ensure that the products used are suitable for the intended application.

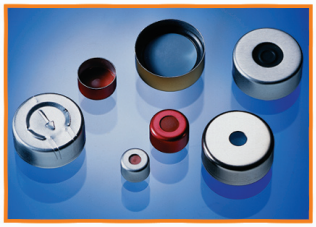
MACHEREY-NAGEL does not warrant the reproducibility of published applications.

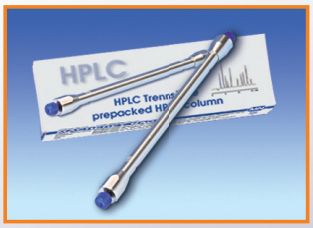
USP specification of MN HPLC phases

Code	Specification	MN phases	Page
USP L1	octadecyl silane chemically bonded to porous silica particles, 1.8 to 10 µm ∅	NUCLEODUR® C_{18} ec	120
		NUCLEODUR® C_{18} Gravity	108
		NUCLEODUR® C_{18} HTec	118
		NUCLEODUR® C_{18} Isis	112
		NUCLEODUR® C_{18} PAH	146
		NUCLEODUR® C_{18} Pyramid	114
		NUCLEODUR® Sphinx RP	116
		NUCLEOSIL® C_{18}	132
		NUCLEOSIL® C_{18} AB	134
		NUCLEOSIL® C_{18} HD	134
		NUCLEOSIL® C_{18} MPN	159
		NUCLEOSIL® C_{18} PAH	148
		NUCLEOSIL® C_{18} PPN	160
USP L3	porous silica particles, 5 to 10 µm ∅	NUCLEODUR® SiOH	123
		NUCLEOSIL® SiOH	140
USP L7	octyl silane chemically bonded to totally porous silica particles, 1.8 to 10 µm ∅	NUCLEODUR® C_8 ec	120
		NUCLEODUR® C_8 Gravity	108
		NUCLEOSIL® C_8	136
		NUCLEOSIL® C_8 HD	137
USP L8	an essentially monomolecular layer of aminopropyl silane chemically bonded to totally porous silica gel support, 3 to 10 µm ∅	NUCLEODUR® NH_2	128
		NUCLEOSIL® Carbohydrate	164
		NUCLEOSIL® NH_2	141
USP L9	irregular or spherical, totally porous silica gel having a chemically bonded, strongly acidic cation-exchange coating, 3 to 10 µm ∅	NUCLEOSIL® SA	142
USP L10	nitrile groups chemically bonded to porous silica particles, 3 to 10 µm ∅	NUCLEODUR® CN / CN-RP	126
		NUCLEOSIL® CN / CN-RP	139
USP L11	phenyl groups chemically bonded to porous silica particles, 3 to 10 µm ∅	NUCLEODUR® Sphinx RP	116
		NUCLEOSIL® C_6H_5	138
USP L14	silica gel having a chemically bonded, strongly basic quaternary ammonium anion-exchange coating, 5 to 10 µm ∅	NUCLEOSIL® SB	142
USP L16	dimethylsilane chemically bonded to porous silica particles, 5 to 10 µm ∅	NUCLEOSIL® C_2	138
USP L17	strong cation-exchange resin consisting of sulphonated cross-linked PS/DVB copolymer in the H form, 7 to 11 µm ∅	NUCLEOGEL® ION 300 OA	163
		NUCLEOGEL® SUGAR 810 H	162
USP L19	strong cation-exchange resin consisting of sulphonated cross-linked PS/DVB copolymer in the Ca form, about 9 µm ∅	NUCLEOGEL® SUGAR 810 Ca	162
		NUCLEOGEL® SUGAR Ca	163
USP L20	dihydroxypropane groups chemically bonded to porous silica, 5 to 10 µm ∅	NUCLEOSIL® OH (Diol)	140
USP L21	a rigid, spherical styrene-divinylbenzene copolymer, 5 to 10 µm ∅	NUCLEOGEL® RP	161
USP L22	cation exchange resin of porous polystyrene gel with sulphonic acid groups, about 10 µm particle size	NUCLEOGEL® SCX	158
USP L23	anion exchange resin of porous polymethacrylate or polyacrylate gel with quaternary ammonium groups, about 10 µm particle size	NUCLEOGEL® SAX	158
USP L26	butyl silane chemically bonded to totally porous silica particles, 5 to 10 µm ∅	NUCLEOSIL® C_4	137
		NUCLEOSIL® C_4 MPN	159
USP L32	a chiral ligand-exchange resin packing · L-proline copper complex covalently bonded to irregularly shaped silica particles, 5 to 10 µm ∅	NUCLEOSIL® CHIRAL-1	152
USP L34	strong cation-exchange resin consisting of sulphonated cross-linked PS/DVB copolymer in the Pb form, about 9 µm ∅	NUCLEOGEL® SUGAR Pb	163
USP L36	a 3,5-dinitrobenzoyl derivative of L-phenylglycine covalently bonded to 5 µm aminopropyl silica	NUCLEOSIL® CHIRAL-3	153
USP L40	cellulose tris-3,5-dimethylphenylcarbamate coated porous silica particles, 5 to 20 µm ∅	NUCLEOCEL DELTA	151
USP L45	beta-cyclodextrin bonded to porous silica particles, 5 to 10 µm ∅	NUCLEODEX β-OH, β-PM	149
USP L51	amylose tris-3,5-dimethylphenylcarbamate-coated, porous, spherical silica particles, 5 to 10 µm ∅	NUCLEOCEL ALPHA	150
USP L58	strong cation-exchange resin consisting of sulphonated cross-linked PS/DVB copolymer in the Na form, about 7 to 11 µm ∅	NUCLEOGEL® SUGAR Na	163
USP L60	spherical porous silica gel, 3 or 5 µm ∅, the surface of which has been covalently modified with alkyl amide groups and endcapped	NUCLEOSIL® C_{18} Nautilus	134

USP specification of MN GC phases

Code	Specification	MN phases	Page
USP G1 / G2	dimethylpolysiloxane oil	OPTIMA® 1	**205**
		OPTIMA® 1 MS	**206**
		OPTIMA® 1 MS Accent	**207**
		PERMABOND® SE-30	**221**
		PERMABOND® P-100	**226**
		OPTIMA® 1-TG	**228**
USP G3	50 % phenyl – 50 % methylpolysiloxane	OPTIMA® 17	**212**
		OPTIMA® 17-TG	**228**
USP G6	trifluoropropylmethylpolysiloxane	OPTIMA® 210	**216**
USP G7	50 % 3-cyanopropyl – 50 % phenylmethylpolysiloxane	OPTIMA® 225	**217**
USP G16	polyethylene glycol (av. mol. wt. ~ 15000); a high molecular weight compound of polyethylene glycol and a diepoxide	OPTIMA® Wax	**219**
		PERMABOND® CW 20 M	**222**
		PERMABOND® CW 20 M-DEG	**229**
		FS-CW 20 M-AM	**226**
USP G19	25 % phenyl – 25 % cyanopropyl – 50 % methylsilicone	OPTIMA® 225	**217**
USP G35	a high molecular compound of a polyethylene glycol and a diepoxide that is esterified with nitroterephthalic acid	OPTIMA® FFAP	**220**
		PERMABOND® FFAP	**222**
USP G27	5 % phenyl – 95 % methylpolysiloxane	OPTIMA® 5	**208**
		OPTIMA® 5 MS	**209**
		OPTIMA® 5 MS Accent	**210**
		OPTIMA® 5 HT	
		OPTIMA® 5 Amine	**225**
		PERMABOND® SE-52	**221**
USP G35	a high molecular compound of a polyethylene glycol and a diepoxide that is esterified with nitroterephthalic acid	OPTIMA® FFAP	**220**
		PERMABOND® FFAP	**222**
USP G36	1 % vinyl – 5 % phenylmethylpolysiloxane	OPTIMA® 5	**208**
		OPTIMA® 5 MS	**209**
		OPTIMA® 5 MS Accent	**210**
		OPTIMA® 5 HT	
		OPTIMA® 5 Amine	**225**
		PERMABOND® SE-54 HKW	**227**
USP G38	dimethylpolysiloxane oil	OPTIMA® 1	**205**
		OPTIMA® 1 MS	**206**
		OPTIMA® 1 MS Accent	**207**
		PERMABOND® SE-30	**221**
		PERMABOND® P-100	**226**
		OPTIMA® 1-TG	**228**
USP G42	35 % cyanopropylphenyl – 65 % dimethylpolysiloxane (percentages refet to molare substitution)	OPTIMA® 35 MS	**210**
USP G43	6 % cyanopropylphenyl – 94 % dimethylpolysiloxane (percentages refer to molar substitution)	OPTIMA® 1301	**214**
		OPTIMA® 624	**215**
		OPTIMA® 624 LB	**215**
USP G46	14 % cyanopropylphenyl – 86 % methylpolysiloxane	OPTIMA® 1701	**213**
USP G49	proprietary derivatized phenyl groups on a polysiloxane backbone	OPTIMA® δ-3	**203**





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