

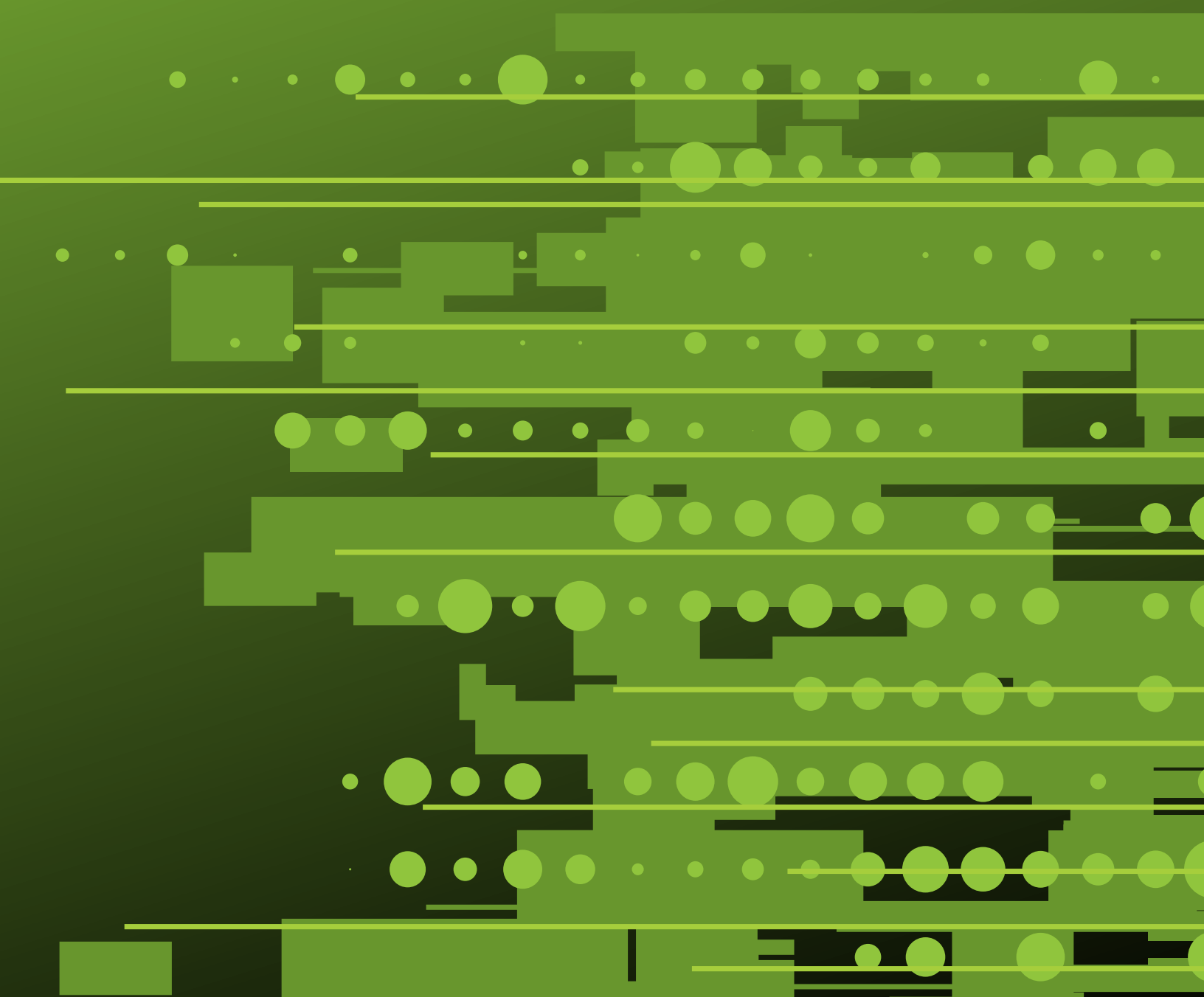
2023 TECHNICAL  
PROGRAM

EXHIBITION  
GUIDE

# SPIE. ADVANCED LITHOGRAPHY+ PATTERNING

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26 FEBRUARY-2 MARCH 2023 | THE SAN JOSE MCENERY CONVENTION CENTER  
SAN JOSE, CALIFORNIA, USA



# SPIE. ADVANCED LITHOGRAPHY+ PATTERNING

THE EVENT FOR EMERGING TECHNOLOGY IN THE SEMICONDUCTOR INDUSTRY

26 February-2 March 2023

## Conferences and Courses

The San Jose McEnery Convention Center  
San Jose, California, United States

Cutting-edge research

Exhibition

Industry

Courses



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## Enhance your SPIE conference experience

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SPIE, the international society for optics and photonics, brings engineers, scientists, students, and business professionals together to advance light-based science and technology. The Society, founded in 1955, connects and engages with our global constituency through industry-leading conferences and exhibitions; publications of conference proceedings, books, and journals in the SPIE Digital Library; and career-building opportunities. Over the past five years, SPIE has contributed more than \$22 million to the international optics community through our advocacy and support, including scholarships, educational resources, travel grants, endowed gifts, and public-policy development.

www.spie.org

## FOR A SAFER MEETING

SPIE will follow the latest published requirements and safe gathering protocols established in the location where each event occurs.

Among national, state, local, or facility-specific rules or recommendations, SPIE will abide by the most restrictive of them.

Event policies may change if local, state, or federal rules change prior to or during an event.

- » Wash hands frequently
- » Respect the personal space and comfort level of others
- » Masks are welcome but not required
- » Do not attend if you are not feeling well and/or you test positive for COVID
- » Follow health guidelines from Santa Clara County and CDC for travel



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#SPIElitho

# SAN JOSE CONVENTION CENTER



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## Experience the energy of Advanced Lithography + Patterning

Get ready to enjoy real conversations, hear the latest breakthroughs, and make important in-person connections. Join us for five days of exciting cutting-edge research. Hear leading researchers who are solving challenges in optical and EUV lithography, patterning technologies, metrology, and process integration for semiconductor manufacturing and adjacent applications. Attend technical presentations, courses, plenary presentations, and a variety of networking activities.

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Featuring six conferences. Find the conference topics that interest you most, such as optical and EUV lithography, innovations in patterning technology advancements, and materials and processes related to semiconductor manufacturing.

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Presentations by leading speakers from across the globe

#### Technical Events ..... PAGE 8

In-depth events, workshops, and networking with a technical focus workforce opportunities, and supply chain issues.

#### Social and Networking Events ..... PAGE 9

Connect with your colleagues in engaging sessions

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Add a learning opportunity to advance your career and complete your conference experience

#### Exhibition ..... PAGES 21-24

Meet with companies and suppliers that will move your projects forward

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# GENERAL INFORMATION

## Badge pick up and registration hours

San Jose McEnergy Convention Center, Upper Level Concourse

Sunday 26 February	7:15 AM-5:00 PM
Monday 27 February	7:15 AM-4:00 PM
Tuesday 28 February	7:30 AM-5:00 PM
Wednesday 1 March	7:45 AM-4:00 PM
Thursday 2 March*	7:45 AM-12:00 PM

\*Thursday is conference registration only

## SPIE Cashier

San Jose McEnergy Convention Center, Upper Level Concourse

Open during registration hours

Registration payments online only

If you are planning to register onsite, your credit card payment will be processed during registration. If you wish to pay with cash or check, register at the "Need to Register" stations; you will be directed to the Cashier once you have completed registration except for final payment.

If you have already registered and wish to add a course, workshop, or special event, you may do this online by signing into your SPIE account.

## Receipt and Certificate of Attendance

Preregistered attendees who need an SPIE-stamped receipt or attendees who need a Certificate of Attendance may obtain those at the Cashier.

## Badge Corrections

Badge corrections can be made at the Cashier. Please have your badge removed from the badge holder and marked with your changes before approaching the counter.

## Speaker check-in and preview station

Convention Center, Ballroom Concourse

Sunday 26 February	12:00 PM-5:00 PM
Monday 27 February	7:30 AM-5:00 PM
Tuesday 28 February	7:30 AM-5:00 PM
Wednesday 1 March	7:30 AM-5:00 PM
Thursday 2 March	7:30 AM-4:00 PM

All speakers must stop at Speaker Check-In to upload their slide presentation files at least two hours before their scheduled session or the day before if they present in the first session. Speakers are not able to present using their own devices. All conference rooms are equipped with a laptop, projector, screen, lapel microphone, and laser pointer.

## SPIE health and safety products

Stop by registration to pick up face masks, hand sanitizer, and other safety products all free from SPIE.

## Wi-Fi Internet access

Convention Center, Upper Level Concourse  
Lobbies, Exhibition Hall, and Registration area

Complimentary wireless Internet access provided in lobbies on the conference room level and in the exhibition hall. Instructions will be posted onsite.

WI-FI HAS BEEN SPONSORED BY:



## Phone charging stations

Convention Center Concourse  
Open during registration hours

CHARGING STATIONS HAVE BEEN SPONSORED BY:



## SPIE Conference App information

This useful tool allows you to search and browse the program, special events, participants, courses, and more. Syncs with My Schedule Tool and keeps you up to-date on changes to program. It integrates with Google Maps and provides views of area restaurants, stores, and venues. It is free and available for iPhone and Android phones.

If you don't already have it, Download the SPIE App.

APP SPONSORED BY:



## SPIE Bookstore

Convention Center, Exhibition Hall

Tuesday 28 February. . . . . 10:00 AM-5:00 PM

Wednesday 1 March. . . . . 10:00 AM-4:00 PM

Stop by the bookstore to browse the latest SPIE Press books. While there, get a t-shirt or educational toy to bring home to your family.

Credit and debit cards only will be accepted; no cash.

## SPIE Course Materials

Convention Center, Upper Level Concourse

Open during registration hours

Browse course offerings that will be available onsite or learn more about SPIE courses available in portable formats such as online and customizable, in-company courses.

**Childcare services**

**Bay Area Sitters Unlimited—lets you hand pick your childcare provider online**

408-452-0225  
Rachael Osorio  
rfosorio15@gmail.com

SPIE does not imply an endorsement nor recommendation of these services. They are provided on an “information only” basis for your further analysis and decision. Other services may be available.

Did you know SPIE offers Family Care Grants to SPIE Members? For more information on deadlines and how to apply check the details here.

**Gender inclusive restroom**

Executive Ballroom restroom across from 211A/211C  
Open during registration hours

**Mothers’ lounge**

Convention Center, Grand Ballroom Concourse  
Open during registration hours

The Mothers’ Lounge is a lockable room intended for nursing mothers. There is no storage, running water, or refrigeration available in this space.

**Quiet room**

Convention Center, Room 112  
Open during registration hours

The Quiet Room is intended for silent meditation, reflection, and prayer. No mobile devices or computer use is allowed, and no food or beverages are allowed.

**Lost and found**

SPIE Cashier  
Open during registration hours

Found items will be kept at SPIE Cashier in the Registration area during the meeting and available only during registration hours. At the end of the meeting, all found items will be turned over to the San Jose Convention Center Security, 408-277-3500.

**Food and beverage services**

Complimentary coffee will be available at the following times. Please check the conference schedule for specific break times.

Monday	Executive Ballroom Concourse, front of windows	7:30 AM-4:00 PM
Tuesday	Hall 2 Concourse	7:30 AM-9:30 AM
Tuesday	Exhibition Hall 1	10:00 AM-5:00 PM
Wednesday	Hall 2 Concourse	7:30 AM-9:30 AM
Wednesday	Exhibition Hall 1	10:00 AM-4:00 PM
Thursday	Hall 2 Concourse	7:30 AM-4:00 PM

Please check the conference schedule for specific break times.

COFFEE BREAKS HAVE BEEN SPONSORED BY:



**SPIE hosted lunches**

Convention Center, Exhibition Hall 1

Tuesday–Wednesday . . . . . 12:00 PM–1:00 PM

Check individual conference listings for exact times. Lunches are included with full conference registrations.

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**Food and Refreshments for Purchase**

**Starbucks**

San Jose Marriott Lobby

Open daily . . . . . 7:00 AM-10:00 PM

**HARASSMENT**

**consists of unwanted, unwelcomed, and uninvited behavior that demeans, threatens, or offends another.**

To report harassment you have witnessed or experienced at this meeting, contact any SPIE staff member or use the SPIE reporting hotline at 1-888-818-6898 or [spie.ethicspoint.com](http://spie.ethicspoint.com).

More information:

[spie.org/conduct](http://spie.org/conduct)

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# PLENARY SESSIONS

World-class speakers share insights on the latest challenges and opportunities from industry and academia.



## Welcome and Monday Plenary Session

Monday 27 February 2023 • 8:00 AM - 10:00 AM  
Convention Center, Ballroom 220A

Join us for the Symposium welcome, introduction of new SPIE Fellows, the presentation of the SPIE Kingslake and Zernike Awards, and plenary talks by Martin van den Brink of ASML and Laurie E. Locascio of NIST.

8:00 AM:

**Symposium Welcome and Opening Remarks**  
**Kafai Lai**, University of Hong Kong (United States);  
**Qinghuang Lin**, LAM Research Corp. (United States)

8:05 AM:

**Introduction of New SPIE Fellows**

8:15 AM:

**2023 SPIE Rudolf and Hilda Kingslake Award in Optical Design**

Presented in recognition of significant achievement in the field of optical design, including the theoretical or experimental aspects of optical engineering.



**Wilhelm Ulrich**, recently retired head of optics research and design at Zeiss Optics, is the 2023 recipient of the SPIE Rudolf and Hilda Kingslake Award in Optical Design in recognition of his pioneering work on notable optical systems for infrared optics, industrial metrology, interferometry, and high-power laser optics.

8:25 AM:

**2023 SPIE Frits Zernike Award for Microlithography**

Presented in recognition of outstanding accomplishments in microlithographic technology, especially those furthering the development of semiconductor lithographic imaging solutions.



**Anthony Yen**, Vice President and Head of Technology Development Center at ASML, is the 2023 recipient of the SPIE Frits Zernike Award for Microlithography in recognition of his pioneering work across optical physics, nanopatterning, and EUV lithography.

8:35 AM:

**Presentation of the Nick Cobb Memorial Scholarship**

The Nick Cobb Memorial Scholarship is awarded to an outstanding graduate student studying advanced lithography or a related field. The scholarship is jointly funded by Siemens EDA and SPIE.

8:40 AM to 10:00 AM

**Plenary Presentations**

SPONSORED BY:



8:40 AM - 9:20 AM



**Driving Moore's Law into the next decade**

**Martin van den Brink**  
ASML Netherlands B.V. (Netherlands)

Martin van den Brink has been the President and Chief Technology Officer of ASML Holding NV since July 1, 2013.

9:20 AM - 10:00 AM



**Update on CHIPS Act Implementation**

**Laurie Locascio**  
National Institute of Standards and Technology  
(United States)

This talk will provide details about the rapidly developing CHIPS for America program, including the Research and Development Office, along with updates and some examples to illustrate the CHIPS vision for interaction with the semiconductor community.

Laurie Locascio is the 17th director of NIST and the fourth Under Secretary of Commerce for Standards and Technology. In this role, she provides high-level oversight and direction of NIST.



## Tuesday Plenary Session

Tuesday 28 February 2023 • 8:00 AM - 9:50 AM  
Convention Center, Ballroom 220A

Join us for Tuesday morning plenaries, where we will hear from Vivek Singh of NVIDIA on Accelerated Computing for Silicon Leadership, and Google's Bernard Kress on how the lithography community can support augmented and virtual reality hardware.

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8:00 AM - 8:10 AM

### Introduction and Announcements

8:10 AM - 8:30 AM

### 50th anniversary of Micralign: A retrospective

8:30 AM - 9:10 AM



### Accelerated Computing for Silicon Leadership

**Vivek Singh**

NVIDIA Corp. (United States)

It is well known that the computations required to manufacture semiconductors have been increasing exponentially. This talk will describe these larger trends towards Accelerated Computing and give examples of how its use in silicon manufacturing will likely be required for the fastest time to market.

Vivek Singh currently works as Vice President, Advanced Technology Group at NVIDIA.

9:10 AM - 9:50 AM



### Pushing the limits of nano-imprint lithography for immersive displays

**Bernard Kress**

Google (United States)

Mass adoption of AR, VR and MR headsets as gateways to the Metaverse and smart glasses for contextual displays are conditioned by solving all three immersive displays comfort pillars: wearable, visual, and social. To do so, new micro- and nano-fabrication challenges need to be addressed, specifically efficient waveguide combiners and miniature display engines. Novel lithographic fabrication techniques are needed to reduce costs and improve performance of such optical display building blocks especially when targeting the consumer market. We will review conventional and novel nano-imprint technologies that aim at pushing the envelope beyond what is possible today.

Bernard Kress is currently the Director of XR Engineering at Google and the 2023 President of SPIE.

## Tuesday Evening Plenary

Tuesday 28 February 2023 • 5:30 PM - 6:15 PM  
Convention Center, Ballroom 220A

Join us for a special evening plenary session where Kevin O'Brien from Intel will argue whether 2D transition metal dichalcogenides (TMDs) can replace silicon transistors.

5:30 PM - 6:15 PM:



### Are 2D transition metal dichalcogenides transistors the future silicon replacement or hype?

**Kevin O'Brien**

Intel (United States)

We present the case for 2D transition metal dichalcogenides [TMD] replacing silicon transistors at ultra-scaled gate lengths. This new TMD 2D transistor technology has numerous clear advantages but experimentally there are still unsolved questions, therefore we will share both our current successes of high performance 2D transistors, as well as some of the current roadblocks. This talk includes a review of our progress in materials, contacts, gate stack and stacked gate all around 2D nanoribbons.

Kevin P. O'Brien is currently a Senior Staff Research Engineer in the Novel Memory and Device group of the Components Research division at Intel. His focus is on device integration of novel materials, specializing in 2D materials.



# TECHNICAL EVENTS

Connect with your colleagues and explore topics in depth. Events include technical networking opportunities, keynote sessions, panel discussions, and poster sessions.

## Sustainability and Lithography's Role: A Panel Discussion

Tuesday 28 February 2023 • 6:15 PM - 7:15 PM  
Convention Center, Ballroom 220A

Hear from a panel representing worldwide fabs and equipment manufacturers on their companies' commitments to new business models and supply chain strategies for conservation and carbon neutrality (net zero).

Join us for a discussion about sustainability and net zero efforts in the semiconductor industry.

MODERATOR:

**Dan Hutcheson**, TechInsights (United States)

PANELISTS:

**John Cahill**, ASML-Cymer (United States)

**Emily Gallagher**, imec (Belgium)

**Chris Jones**, Edwards Vacuum (United Kingdom)

**Mark Merrill**, Lam Research (United States)

**Ryan Russell**, Intel (United States)

**Akihisa Sekiguchi**, Tokyo Electron LTD. (Japan)

## Exploring Career Paths in Lithography and Patterning

Convention Center, Exhibition Hall, Community Stage

*Open to those with a paid registration badge.*

*No advance registration is required. However, seating is limited and will be granted on a first-come, first-served basis.*

Wednesday 1 March 2023 • 10:30 AM - 11:30 AM

This panel discussion will help you explore potential career pathways in the world of advanced lithography and patterning. Get expert advice on how you can translate your knowledge, abilities, and interests into meaningful work. Whether you end up in academia, industry, or start your own company, getting a clear picture of the options from experienced leaders will help you better manage your career trajectory.

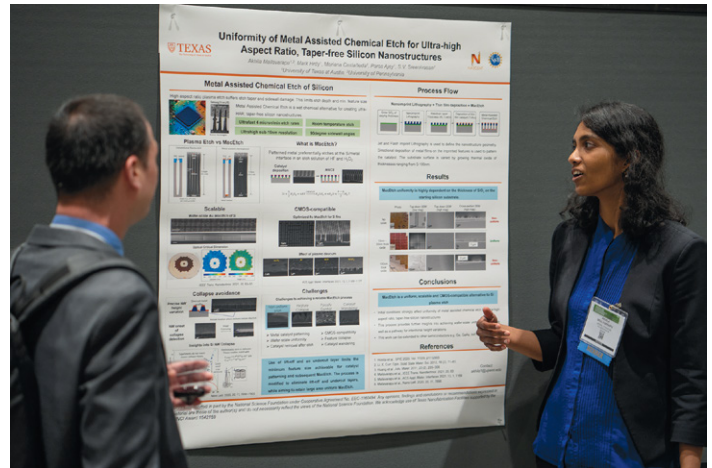
PANELISTS:

**Anuja De Silva**, Lam Research

**Emily Gallagher**, imec

**Indira P. Seshadri**, IBM

**Maryann Chenting Tung**, PsiQuantum



## Poster Session

Wednesday 1 March 2023 • 5:30 PM - 7:00 PM  
Convention Center, Hall 2

Conference attendees are invited to attend the poster session on Wednesday evening with all SPIE Advanced Lithography + Patterning conferences. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions.

**Poster Setup . . . . . Wednesday 10:00 AM - 4:30 PM**

Poster authors, view poster presentation guidelines and set-up instructions at <https://spie.org/ALPosterGuidelines>.

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**ASML**

# SOCIAL AND NETWORKING EVENTS

These interactive sessions give you the opportunity to network, learn, and discuss your work with lithography professionals from around the world.

## Mentor and Student Luncheon

Monday 27 February 2023 • 12:10 PM - 1:10 PM  
Marriott, San Jose V

Student conference attendees are invited to this engaging networking lunch with top members in the field. This event gives students an opportunity to meet mentors who will share their insights into career paths in lithography. Lunch is complimentary. Mentors will receive a personal invitation, student seating is available on a first-come, first-served basis.

## Welcome Reception

Monday 27 February 2023 • 6:00 PM - 7:00 PM  
Convention Center, Grand Ballroom Concourse

Join your colleagues at the Welcome Reception. Relax, socialize, and enjoy beverages and hors-d'oeuvres on the first night of the conference. All attendees welcome.

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## Women in Optics Networking Lunch

Tuesday 28 February 2023 • 12:30 PM - 1:30 PM  
Convention Center, Room 212B

Join other women in the field for informal discussions and networking during the scheduled lunch on Tuesday.

## LGBTQ+ Meetup

Tuesday 28 February 2023 • 3:00 PM - 4:00 PM  
Convention Center, Exhibition Hall, Community Stage

Socialize and network with other LGBTQ+ attendees and allies in the lithography and patterning community.

## Networking and Social Hour

Wednesday 1 March 2023 • 3:00 PM - 4:00 PM  
Convention Center, Exhibition Hall

Join your colleagues, make new connections, and meet with exhibitors! Open to all attendees.

## JM3 Editors Reception

Wednesday 1 March 2023 • 4:30 PM - 6:00 PM  
Marriott, Salon 1

The editorial volunteers for the *Journal of Micro/Nanopatterning, Materials, and Metrology* are invited to a private reception. Location information will be sent via invitation.

## Career Networking Social

Convention Center, Exhibition Hall, Community Stage

Wednesday 1 March 2023 • 11:30 AM - 12:30 PM

Network with the panelists, your peers and the 2023 Advanced Lithography and Patterning Student Conference Support program sponsors, including ASML, EMD Electronics, Fractilia, IBM, KLA, and Lam, who are looking to hire! Join the advanced lithography community to discuss current projects, next career steps, and more. Free snacks and beverages provided.

# SPIE. ADVANCED LITHOGRAPHY+ PATTERNING

PRESENT YOUR WORK AT THE CONFERENCE  
FOR EMERGING TECHNOLOGY IN THE  
SEMICONDUCTOR INDUSTRY

MARK YOUR CALENDAR

2024

25-29 February  
Exhibition: 27-28 February  
The San Jose McEnery  
Convention Center  
San Jose, California USA

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# EVENT SCHEDULE

	<b>CONFERENCE 12494</b> <b>Optical and EUV</b> <b>Nanolithography XXXVI</b> Chairs: Anna Lio; Martin Burkhardt 27 February-2 March 2023 <b>Grand Ballroom 220A</b>	<b>CONFERENCE 12495</b> <b>DTCO and Computational</b> <b>Patterning II</b> Chairs: Ryoung-Han Kim; Neal V. Lafferty 27 February-2 March 2023 <b>Room 210A</b>	<b>CONFERENCE 12496</b> <b>Metrology, Inspection, and Process</b> <b>Control XXXVII</b> Chairs: John C. Robinson; Matthew J. Sendelbach 27 February-2 March 2023 <b>Grand Ballroom 220B</b>
<b>TIME</b>	<b>MONDAY 27 FEBRUARY</b>		
<b>MORNING</b>	<b>Welcome and Monday Plenary Session</b> Convention Center, Grand Ballroom 220A Session Chairs: <b>Kafai Lai</b> , The Univ. of Hong Kong (United States); <b>Qinghuang Lin</b> , Lam Research Corp. (United States)  <b>Symposium Welcome and Opening Remarks</b> Kafai Lai, University of Hong Kong (United States) and Qinghuang Lin, LAM Research Corp. (United States)  <b>Introduction of New SPIE Fellows</b>  <b>2023 SPIE Rudolf and Hilda Kingslake Award in Optical Design</b>  <b>2023 SPIE Frits Zernike Award for Microlithography</b>  <b>Presentation of the Nick Cobb Memorial Scholarship</b>  <b>Driving Moore's Law into the next decade (Plenary Presentation)</b> <b>Martin van den Brink</b> , ASML Netherlands B.V. (Netherlands)  <b>Update on CHIPS act implementation (Plenary Presentation)</b> <b>Laurie E. Locascio</b> , National Institute of Standards and Technology (United States)		
8:00 AM - 10:00 AM			
10:00 AM - 10:30 AM	<b>Coffee Break</b>	<b>Coffee Break</b>	<b>Coffee Break</b>
		10:30 AM - 12:10 PM Room 210A <b>SESSION 1:</b> <b>Curvilinear in Computational Patterning</b>	10:30 AM - 12:10 PM Grand Ballroom 220B <b>SESSION 1:</b> <b>Keynote Session</b>
<b>AFTERNOON</b>			
		12:10 PM - 1:10 PM <b>Lunch Break</b>	12:10 PM - 1:10 PM <b>Lunch Break</b>
1:10 PM - 2:50 PM	Grand Ballroom 220A <b>SESSION 1:</b> <b>Opening Remarks and Keynotes</b>		Grand Ballroom 220B <b>SESSION 2:</b> <b>Stochastics</b>
2:50 PM - 3:20 PM	<b>Coffee Break</b>		<b>Coffee Break</b>
3:20 PM - 5:00 PM	Grand Ballroom 220A <b>SESSION 2:</b> <b>EUVL Stochastics</b> <i>Joint Session with 12494 and 12498</i>	3:40 PM - 5:20 PM Room 210A <b>SESSION 2:</b> <b>Computational Patterning I and High NA EUV</b>	3:20 PM - 6:00 PM Grand Ballroom 220B <b>SESSION 3:</b> <b>Optical Metrology</b>
<b>EVENING</b>	<b>Welcome Reception • Convention Center, Grand Ballroom Concourse</b>		
6:00 PM-7:00 PM			

## SYMPOSIUM CHAIRS:



**Kafai Lai**  
University of  
Hong Kong (USA)

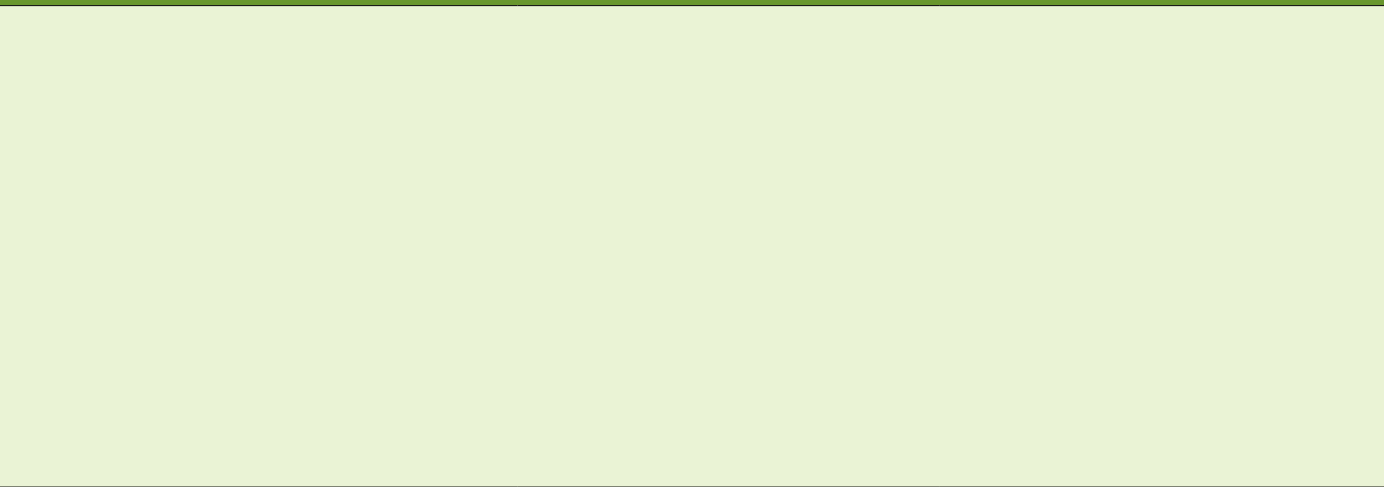


**Qinghuang Lin**  
LAM Research  
Corp. (USA)

**CONFERENCE 12497**  
**Novel Patterning Technologies 2023**  
 Chairs: J. Alexander Liddle;  
 Ricardo Ruiz  
 27 February-2 March 2023  
**Room 211B**

**CONFERENCE 12498**  
**Advances in Patterning Materials and Processes XL**  
 Chairs: Douglas Guerrero;  
 Gilles R. Amblard  
 27 February-1 March 2023  
**Grand Ballroom 220C**

**CONFERENCE 12499**  
**Advanced Etch Technology and Process Integration for Nanopatterning XII**  
 Chairs: Nihar Mohanty;  
 Efrain Altamirano-Sánchez  
 28 February-2 March 2023  
**Room 210C**



	10:00 AM - 10:30 AM <b>Coffee Break</b>
	10:30 AM - 12:10 PM Grand Ballroom 220C <b>SESSION 1:</b> <b>Materials for High NA EUV Lithography</b>
	12:10 PM - 1:20 PM <b>Lunch Break</b>
	1:20 PM - 3:00 PM Grand Ballroom 220C <b>SESSION 2:</b> <b>Process</b>
	3:00 PM - 3:20 PM <b>Coffee Break</b>
3:20 PM - 6:00 PM Room 211B <b>SESSION 1:</b> <b>Keynote Session</b>	3:20 PM - 5:00 PM Grand Ballroom 220A <b>NOTE ROOM CHANGE</b> <b>SESSION 3:</b> <b>EUVL Stochastics</b> <i>Joint Session with 12494 and 12498</i>



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 INCLUDED WITH REGISTRATION  
**50 proceedings downloads**  
 Paid registration includes 50 content downloads from the SPIE Digital Library. SPIE will email details on using proceedings download tokens.

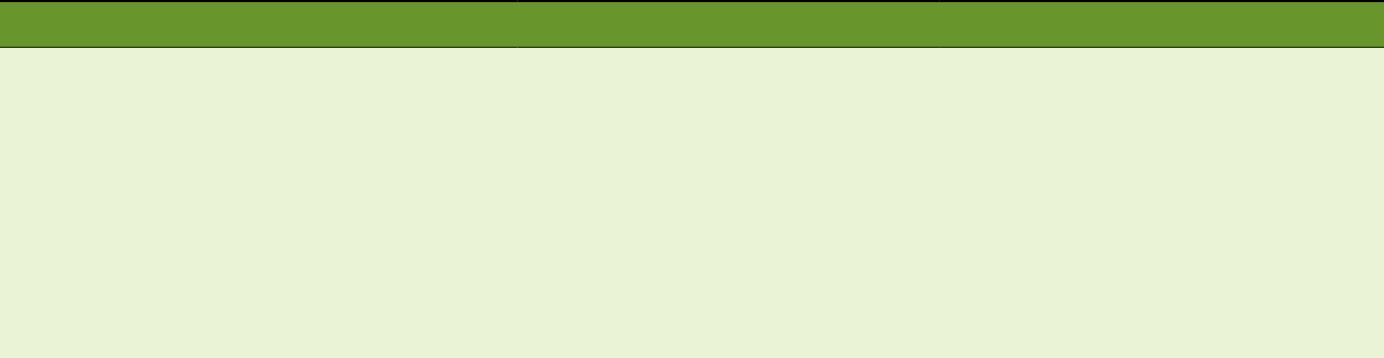


See full details and updates at [spie.org/al](https://spie.org/al) or on the **SPIE App**

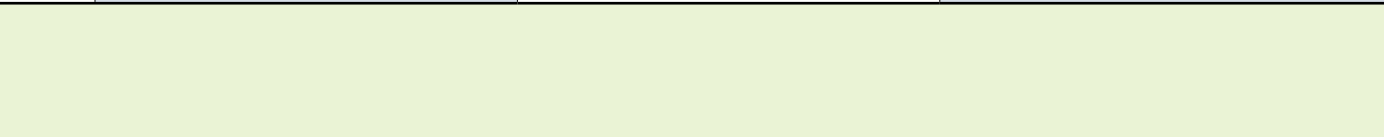
# EVENT SCHEDULE

TIME	<b>CONFERENCE 12494</b> <b>Optical and EUV Nanolithography XXXVI</b> Chairs: Anna Lio; Martin Burkhardt 27 February-2 March 2023 <b>Grand Ballroom 220A</b>	<b>CONFERENCE 12495</b> <b>DTCO and Computational Patterning II</b> Chairs: Ryoung-Han Kim; Neal V. Lafferty 27 February-2 March 2023 <b>Room 210A</b>	<b>CONFERENCE 12496</b> <b>Metrology, Inspection, and Process Control XXXVII</b> Chairs: John C. Robinson; Matthew J. Sendelbach 27 February-2 March 2023 <b>Grand Ballroom 220B</b>	
<b>MORNING</b>	<b>TUESDAY 28 FEBRUARY</b>			
8:00 AM - 10:00 AM	<b>Tuesday Morning Plenary Session</b> Grand Ballroom 220A Session Chairs: <b>Kafai Lai</b> , The Univ. of Hong Kong (United States); <b>Qinghuang Lin</b> , Lam Research Corp. (United States) <b>Introduction and Announcements</b> <b>50th anniversary of Micralign: A retrospective</b> <b>Accelerated computing for silicon leadership</b> ( <i>Plenary Presentation</i> ) <b>Vivek K. Singh</b> , NVIDIA Corp. (United States) <b>Pushing the limits of nano-imprint lithography for immersive displays</b> ( <i>Plenary Presentation</i> ) <b>Bernard C. Kress</b> , Google (United States)			
9:50 AM - 10:20 AM	<b>Coffee Break</b>	<b>Coffee Break</b>	<b>Coffee Break</b>	
10:20 AM - 12:00 PM	Grand Ballroom 220A <b>SESSION 3:</b> <b>EUV Present and Future Outlook</b>	Room 210A <b>SESSION 3:</b> <b>Invited Presentations I</b>	Grand Ballroom 220B <b>SESSION 4:</b> <b>Overlay</b>	
<b>AFTERNOON</b>	12:00 PM - 1:30 PM <b>Lunch Break</b>	12:00 PM - 1:40 PM <b>Lunch Break</b>	12:00 PM - 1:30 PM <b>Lunch Break</b>	
1:30 PM - 3:10 PM	Grand Ballroom 220A <b>SESSION 4:</b> <b>Mask</b>	Room 210A <b>SESSION 4:</b> <b>Keynote Session</b>	Grand Ballroom 220B <b>SESSION 5:</b> <b>EPE</b>	
3:10 PM - 3:40 PM	<b>Coffee Break</b>	3:10 PM - 5:40 PM Room 210A <b>Session 5:</b> <b>Invited Presentations II</b>	3:10 PM - 3:40 PM <b>Coffee Break</b>	
3:40 PM - 5:20 PM	Grand Ballroom 220A <b>SESSION 5:</b> <b>Optical and EUV Lithography</b>		3:40 PM - 5:30 PM Grand Ballroom 220B <b>SESSION 6:</b> <b>Electron Beam Metrology I</b>	
<b>EVENING</b> 5:30 PM - 6:15 PM	<b>Tuesday Evening Plenary Session</b> Grand Ballroom 220A <b>Are 2D transition metal dichalcogenides transistors the future silicon replacement or hype?</b> ( <i>Plenary Presentation</i> ) <b>Kevin P. O'Brien</b> , Intel Corp. (United States)			
6:15 PM - 7:15 PM	<b>Sustainability and Lithography's Role: A Panel Discussion</b> Room 220A MODERATOR: <b>Dan Hutcheson</b> , TechInsights (United States) PANELISTS: <b>John Cahill</b> , ASML-Cymer (United States); <b>Emily Gallagher</b> , imec (Belgium); <b>Chris Jones</b> , Edwards Vacuum (United Kingdom); <b>Mark Merrill</b> , Lam Research (United States); <b>Ryan Russell</b> , Intel (United States); <b>Akihisa Sekiguchi</b> , Tokyo Electron LTD. (Japan)			

<b>CONFERENCE 12497</b> <b>Novel Patterning Technologies 2023</b> Chairs: J. Alexander Liddle; Ricardo Ruiz 27 February-2 March 2023 <b>Room 211B</b>	<b>CONFERENCE 12498</b> <b>Advances in Patterning Materials and Processes XL</b> Chairs: Douglas Guerrero; Gilles R. Amblard 27 February-1 March 2023 <b>Grand Ballroom 220C</b>	<b>CONFERENCE 12499</b> <b>Advanced Etch Technology and Process Integration for Nanopatterning XII</b> Chairs: Nihar Mohanty; Efrain Altamirano-Sánchez 28 February-2 March 2023 <b>Room 210C</b>
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9:50 AM - 10:20 AM <b>Coffee Break</b>	9:50 AM - 10:20 AM <b>Coffee Break</b>	
10:20 AM - 12:10 PM Room 211B <b>SESSION 2: E-Beam</b>	10:20 AM - 12:00 PM Grand Ballroom 220C <b>SESSION 4: Keynote Session</b>	
12:10 PM - 1:30 PM <b>Lunch Break</b>	12:00 PM - 1:30 PM <b>Lunch Break</b>	
1:30 PM - 3:30 PM Room 211B <b>SESSION 3: Multi-Beam Mask Writing</b>	1:30 PM - 3:10 PM Grand Ballroom 220C <b>SESSION 5: Resists Fundamentals I</b>	1:50 PM - 3:10 PM Room 210C <b>SESSION 1: Advanced Patterning Integration I</b>
3:30 PM - 3:50 PM <b>Coffee Break</b>	3:10 PM - 3:40 PM <b>Coffee Break</b>	3:10 PM - 3:40 PM <b>Coffee Break</b>
3:50 PM - 5:30 PM Room 211B <b>SESSION 4: Nanoimprint I</b>	3:40 PM - 5:20 PM Grand Ballroom 220C <b>SESSION 6: Underlayers and Top Coats</b>	3:40 PM - 5:00 PM Room 210C <b>SESSION 2: Materials and Etch Integration</b>



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# EVENT SCHEDULE

TIME	<b>CONFERENCE 12494</b> <b>Optical and EUV Nanolithography XXXVI</b> Chairs: Anna Lio; Martin Burkhardt 27 February-2 March 2023 <b>Grand Ballroom 220A</b>	<b>CONFERENCE 12495</b> <b>DTCO and Computational Patterning II</b> Chairs: Ryoung-Han Kim; Neal V. Lafferty 27 February-2 March 2023 <b>Room 210A</b>	<b>CONFERENCE 12496</b> <b>Metrology, Inspection, and Process Control XXXVII</b> Chairs: John C. Robinson; Matthew J. Sendelbach 27 February-2 March 2023 <b>Grand Ballroom 220B</b>
<b>MORNING</b>	<b>WEDNESDAY 1 MARCH</b>		
	8:00 AM - 9:40 AM Grand Ballroom 220A <b>SESSION 6:</b> <b>Pellicles and Advanced Masks</b>	8:00 AM - 9:40 AM Room 210A <b>SESSION 6:</b> <b>Computational Patterning II</b>	8:00 AM - 9:50 AM Grand Ballroom 220B <b>SESSION 7:</b> <b>New Methods</b>
	9:40 AM - 10:10 AM <b>Coffee Break</b>	9:40 AM - 10:10 AM <b>Coffee Break</b>	9:50 AM - 10:20 AM <b>Coffee Break</b>
	10:10 AM - 11:50 AM Grand Ballroom 220A <b>SESSION 7:</b> <b>Computational Lithography</b> <i>Joint Session with 12495 and 12494</i>	10:10 AM - 11:50 AM Grand Ballroom 220A <b>NOTE ROOM CHANGE</b> <b>SESSION 7:</b> <b>Computational Lithography</b> <i>Joint Session with 12495 and 12494</i>	10:20 AM - 12:00 PM Grand Ballroom 220B <b>SESSION 8:</b> <b>Metrology for the EUV Era</b>
<b>AFTERNOON</b>	11:50 AM - 1:20 PM <b>Lunch Break</b>	11:50 AM - 1:20 PM <b>Lunch Break</b>	12:00 PM - 1:10 PM <b>Lunch Break</b>
	1:20 PM - 3:00 PM Grand Ballroom 220A <b>SESSION 8:</b> <b>EUV Imaging</b>	1:20 PM - 3:00 PM Room 210A <b>SESSION 8:</b> <b>Design for Manufacturing and Yield</b>	12:00 PM - 1:10 PM Grand Ballroom 220B <b>SESSION 9:</b> <b>3D and Heterogeneous Integration</b>
	3:00 PM - 3:30 PM <b>Coffee Break</b>	3:00 PM - 3:30 PM <b>Coffee Break</b>	3:00 PM - 3:30 PM <b>Coffee Break</b>
	3:30 PM - 4:30 PM Grand Ballroom 220A <b>SESSION 9:</b> <b>Overlay and Stitching</b>	3:30 PM - 5:10 PM Room 210A <b>SESSION 9:</b> <b>DTCO and STCO</b>	3:30 PM - 5:30 PM Grand Ballroom 220B <b>SESSION 10:</b> <b>Machine Learning</b>
<b>EVENING</b>	4:30 PM - 5:10 PM Grand Ballroom 220A <b>Poster Preview Speed Talks</b>		
	5:30 PM - 7:00 PM Convention Center, Hall 2 <b>POSTER SESSION</b>	5:30 PM - 7:00 PM Convention Center, Hall 2 <b>POSTER SESSION</b>	5:30 PM - 7:00 PM Convention Center, Hall 2 <b>POSTER SESSION</b>

## Congratulations to the 2023 student grant recipients

**Nathan Bartlett**, University of Illinois at Urbana-Champaign

**Seungchan Moon**, Hanyang University

**Devesh Thakare**, KU Leuven

**Jander Cruz**, California State University, Northridge

**Man Hou Vong**, North Carolina State University

**Kuan Lu**, Texas A&M University

**Astrid Jordana del Socorro Saldaña Sánchez**, CIO

**Arjun Aryal**, University of New Mexico (CHTM)

**Wyatt Sullivan**, University of Waterloo

**Rajiv Naresh Sejpal**, Rochester Institute of Technology

**Keshav Samrat Modi**, AcSIR

**Yuka Esashi**, University of Colorado Boulder

**Gokce Toprak**, San Jose State University Open University

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**Julie Van Bel**, KU Leuven

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**Thibaut Bourguignon**, Grenoble-INP EEATS

**Inhwan Lee**, KU Leuven

**Hsiao-Hsuan Liu**, Katholieke Universiteit Leuven

**Tao Shen**, Swiss Federal Institute of Technology in Zürich (ETHZ)

**Parker Mei**, Rochester Institute of Technology



	<b>CONFERENCE 12497</b> <b>Novel Patterning Technologies 2023</b> Chairs: J. Alexander Liddle; Ricardo Ruiz 27 February-2 March 2023 <b>Room 211B</b>	<b>CONFERENCE 12498</b> <b>Advances in Patterning Materials and Processes XL</b> Chairs: Douglas Guerrero; Gilles R. Amblard 27 February-1 March 2023 <b>Grand Ballroom 220C</b>	<b>CONFERENCE 12499</b> <b>Advanced Etch Technology and Process Integration for Nanopatterning XII</b> Chairs: Nihar Mohanty; Efrain Altamirano-Sánchez 28 February-2 March 2023 <b>Room 210C</b>
	8:10 AM - 10:00 AM Room 211B <b>SESSION 5:</b> <b>Nanoimprint II</b>	8:10 AM - 9:50 AM Grand Ballroom 220C <b>Session 7:</b> <b>Resists Fundamentals II</b>	8:00 AM - 9:40 AM Room 210C <b>SESSION 3:</b> <b>Advanced Patterning Integration II</b>
	10:00 AM - 10:30 AM <b>Coffee Break</b>	9:50 AM - 10:20 AM <b>Coffee Break</b>	9:40 AM - 10:10 AM <b>Coffee Break</b>
	10:30 AM - 12:10 PM Room 211B <b>SESSION 6:</b> <b>Novel Patterning I</b>	10:20 AM - 12:00 PM Grand Ballroom 220C <b>SESSION 8:</b> <b>Non Chemically Amplified Resists for EUV Lithography I</b>	10:10 AM - 11:50 AM Room 210C <b>SESSION 4:</b> <b>Computational Patterning and Process Control</b>
	12:10 PM - 1:10 PM <b>Lunch Break</b>	12:00 PM - 1:30 PM <b>Lunch Break</b>	11:50 AM - 1:20 PM <b>Lunch Break</b>
	1:10 PM - 3:30 PM Room 211B <b>SESSION 7:</b> <b>DSA I</b>	1:30 PM - 3:10 PM Grand Ballroom 220C <b>SESSION 9:</b> <b>Non Chemically Amplified Resists for EUV Lithography II</b>	1:20 PM - 3:00 PM Room 210C <b>SESSION 5:</b> <b>Emerging Applications</b>
	3:30 PM - 4:00 PM <b>Coffee Break</b>	3:10 PM - 3:40 PM <b>Coffee Break</b>	3:00 PM - 3:30 PM <b>Coffee Break</b>
	4:00 PM - 5:30 PM Room 211B <b>SESSION 8:</b> <b>DSA II</b>	3:40 PM - 5:40 PM Grand Ballroom 220C <b>SESSION 10:</b> <b>Novel Patterning Materials</b>	3:30 PM - 5:30 PM Room 210C <b>SESSION 6:</b> <b>Novel Atomic Scale Processes</b>
	5:30 PM - 7:00 PM Convention Center, Hall 2 <b>POSTER SESSION</b>	5:30 PM - 7:00 PM Convention Center, Hall 2 <b>POSTER SESSION</b>	5:30 PM - 7:00 PM Convention Center, Hall 2 <b>POSTER SESSION</b>

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# EVENT SCHEDULE

TIME	<b>CONFERENCE 12494</b> <b>Optical and EUV</b> <b>Nanolithography XXXVI</b> Chairs: Anna Lio; Martin Burkhardt 27 February-2 March 2023 <b>Grand Ballroom 220A</b>	<b>CONFERENCE 12495</b> <b>DTCO and Computational</b> <b>Patterning II</b> Chairs: Ryoung-Han Kim; Neal V. Lafferty 27 February-2 March 2023 <b>Room 210A</b>	<b>CONFERENCE 12496</b> <b>Metrology, Inspection, and Process</b> <b>Control XXXVII</b> Chairs: John C. Robinson; Matthew J. Sendelbach 27 February-2 March 2023 <b>Grand Ballroom 220B</b>	
MORNING	<b>THURSDAY 2 MARCH</b>			
	8:00 AM - 9:40 AM Grand Ballroom 220A <b>SESSION 10:</b> <b>Patterning</b>	8:00 AM - 10:30 AM Room 210A <b>SESSION 10:</b> <b>Invited Presentations III</b>	8:00 AM - 9:50 AM Grand Ballroom 220B <b>SESSION 11:</b> <b>EUV and X-ray Metrology</b>	
	9:40 AM - 9:50 AM Grand Ballroom 220A <b>ASML Best Student Paper Award</b>	10:30 AM - 11:00 AM <b>Coffee Break</b>	9:50 AM - 10:20 AM <b>Coffee Break</b>	
10:10 AM - 11:50 AM Grand Ballroom 220A <b>SESSION 11:</b> <b>EUV Integration</b> <i>Joint Session with 12494 and 12499</i>	11:00 AM - 12:40 PM Room 210A <b>SESSION 11:</b> <b>Machine Learning, Deep Learning,</b> <b>and AI I</b>	10:20 AM - 12:10 PM Grand Ballroom 220B <b>SESSION 12:</b> <b>Inspection</b>		
AFTERNOON	11:50 AM - 1:20 PM <b>Lunch Break</b>	12:40 PM - 2:10 PM <b>Lunch Break</b>	12:10 PM - 1:30 PM <b>Lunch Break</b>	
	1:20 PM - 2:40 PM Grand Ballroom 220A <b>SESSION 12:</b> <b>Light Sources</b>	2:10 PM - 3:50 PM Room 210A <b>SESSION 12:</b> <b>Machine Learning, Deep Learning,</b> <b>and AI II</b>	1:30 PM - 3:20 PM Grand Ballroom 220B <b>SESSION 13:</b> <b>Electron Beam Metrology II</b>	
	2:40 PM - 3:00 PM Grand Ballroom 220A <b>Conference Chairs Closing Remarks</b>	3:50 PM - 4:20 PM <b>Coffee Break</b>	3:20 PM - 3:40 PM <b>Coffee Break</b>	
		4:20 PM - 5:20 PM Room 210A <b>SESSION 13:</b> <b>Machine Learning, Deep Learning,</b> <b>and AI III</b>	3:40 PM - 5:20 PM Grand Ballroom 220B <b>SESSION 14:</b> <b>Late Breaking News</b>	

<p><b>CONFERENCE 12497</b>  <b>Novel Patterning Technologies 2023</b>          Chairs: J. Alexander Liddle;          Ricardo Ruiz          27 February-2 March 2023  <b>Room 211B</b></p>	<p><b>CONFERENCE 12498</b>  <b>Advances in Patterning Materials and Processes XL</b>          Chairs: Douglas Guerrero;          Gilles R. Amblard          27 February-1 March 2023  <b>Grand Ballroom 220C</b></p>	<p><b>CONFERENCE 12499</b>  <b>Advanced Etch Technology and Process Integration for Nanopatterning XII</b>          Chairs: Nihar Mohanty;          Efrain Altamirano-Sánchez          28 February-2 March 2023  <b>Room 210C</b></p>
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<p>8:50 AM - 10:10 AM          Room 211B  <b>SESSION 9:</b>  <b>DSA III</b></p>		<p>8:00 AM - 9:40 AM          Room 210C  <b>SESSION 7:</b>  <b>Sustainability in Etch and Patterning Integration</b></p>
<p>10:10 AM - 10:40 AM  <b>Coffee Break</b></p>		<p>9:40 AM - 10:10 AM  <b>Coffee Break</b></p>
<p>10:40 AM - 12:30 PM          Room 211B  <b>SESSION 10:</b>  <b>Novel Patterning III</b></p>		<p>10:10 AM - 11:50 AM          Grand Ballroom 220A  <b>NOTE ROOM CHANGE</b>  <b>SESSION 8:</b>  <b>EUV Integration</b>  <i>Joint Session with 12494 and 12499</i></p>

<p>12:30 PM - 2:00 PM  <b>Lunch Break</b></p>	
<p>2:00 PM - 3:00 PM          Room 211B  <b>SESSION 11:</b>  <b>Greyscale Lithography</b></p>	

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**Member: \$780.00 / Non-member: \$925.00**  
**Student member: \$446.00**

INSTRUCTORS

**Murrae J. Bowden**, EMP Consultants (United States)  
**Ralph R. Dammel**, EMD Electronics (United States)

### Lithography Process Control

**Course SC111 • Level: Intermediate**  
**Sunday, 26 February 2023 • 8:30 AM - 5:30 PM**  
**Member: \$825.00 / Non-member: \$960.00**  
**Student member: \$459.00**

INSTRUCTOR

**Harry J. Levinson**, HJL Lithography (United States)

### Practical Photoresist Processing

**Course SC616 • Level: Introductory**  
**Thursday, 2 March 2023 • 8:30 AM - 12:30 PM**  
**Member: \$470.00 / Non-member: \$545.00**  
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INSTRUCTOR

**Ralph R. Dammel**, EMD Electronics (United States)

### EUV Lithography

**Course SC888 • Level: Intermediate**  
**Sunday, 26 February 2023 • 8:30 AM - 5:30 PM**  
**Member: \$1,015.00 / Non-member: \$1,150.00**  
**Student member: \$535.00**

INSTRUCTOR

**Vivek Bakshi**, EUV Litho, Inc (United States)  
**Jinho Ahn**, Hanyang Univ. (South Korea)  
**Patrick P. Naulleau**, The Ctr. for X-Ray Optics (United States)

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INSTRUCTORS

**Qinghuang Lin**, Lam Research Corp. (United States)  
**Thorsten Lill**, Lam Research Corp. (United States)

## Introduction to Scanning Electron Microscope (SEM) Applications of Defect Inspection and Review in IC Manufacturing

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**Sunday, 26 February 2023 • 8:30 AM - 12:30 PM**  
**Member: \$470.00 / Non-member: \$545.00**  
**Student member: \$293.00**

INSTRUCTOR

**Hong Xiao**, ASML (United States)

## Interaction of Physical Design and Lithography

**Course SC1030 • Level: Introductory**  
**Monday, 27 February 2023 • 1:30 PM - 5:30 PM**  
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INSTRUCTOR

**Chi-Min (Chi) Yuan**, NXP Semiconductors (United States)

## Chemistry and Lithography

**Course SC1099 • Level: Advanced**  
**Sunday, 26 February 2023 • 8:30 AM - 5:30 PM**  
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INSTRUCTOR

**Uzodinma Okoroanyanwu**, Univ. of Massachusetts at Amherst (United States)

## Scatterometry in Profile, Overlay and Focus Process Control

**Course SC1100 • Level: Introductory**  
**Sunday, 26 February 2023 • 1:30 PM - 5:30 PM**  
**Member: \$470.00 / Non-member: \$545.00**  
**Student member: \$293.00**

INSTRUCTORS

**Hugo Cramer**, ASML Netherlands B.V. (Netherlands)  
**Igor Turovets**, Nova Measuring Instruments Ltd. (Israel)

## Advanced Concepts in Metrology Toolset Stability and Matching

**Course SC1133 • Level: Intermediate**  
**Sunday, 26 February 2023 • 8:30 AM - 12:30 PM**  
**Member: \$470.00 / Non-member: \$545.00**  
**Student member: \$293.00**

INSTRUCTOR

**Ofer Adan**, Applied Materials Israel, Ltd. (Israel)

## Metrology of Image Placement

**Course SC1158 • Level: Introductory**  
**Sunday, 26 February 2023 • 1:30 PM - 5:30 PM**  
**Member: \$475.00 / Non-member: \$550.00**  
**Student member: \$295.00**

INSTRUCTOR

**Alexander Starikov**, I & I Consulting (United States)

## Stochastic Lithography

**Course SC1263 • Level: Intermediate**  
**Sunday, 26 February 2023 • 8:30 AM - 5:30 PM**  
**Member: \$780.00 / Non-member: \$915.00**  
**Student member: \$441.00**

INSTRUCTORS

**Chris A. Mack**, Fractilia, LLC (United States)  
**John S. Petersen**, imec (Belgium)

## Machine Learning for Lithography

**Course SC1264 • Level: Advanced**  
**Sunday, 26 February 2023 • 8:30 AM - 5:30 PM**  
**Member: \$825.00 / Non-member: \$960.00**  
**Student member: \$459.00**

INSTRUCTOR

**James P. Shiely**, Synopsys, Inc. (United States)

## High NA Lithography Systems: What's in the Box?

**Course SC1321 • Level: Intermediate**  
**Tuesday, 28 February 2023 • 1:30 PM - 5:30 PM**  
**Member: \$470.00 / Non-member: \$545.00**  
**Student member: \$293.00**

INSTRUCTORS

**Jara Garcia-Santaclara**, ASML Netherlands B.V. (Netherlands)  
**Jan van Schoot**, ASML Netherlands B.V. (Netherlands)

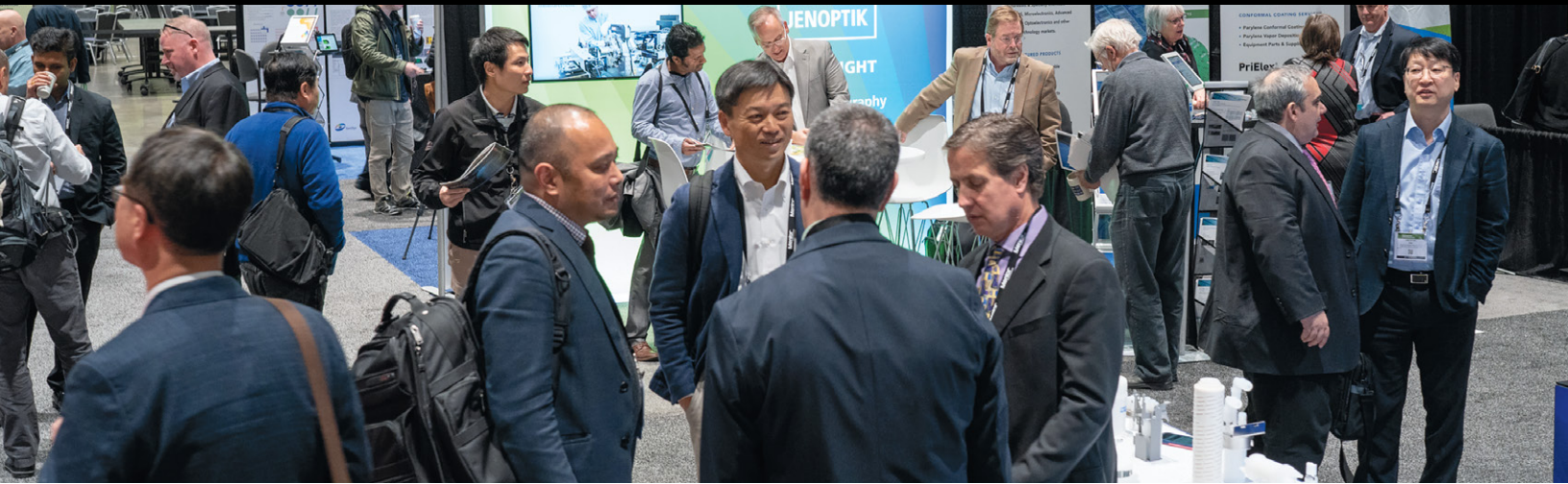
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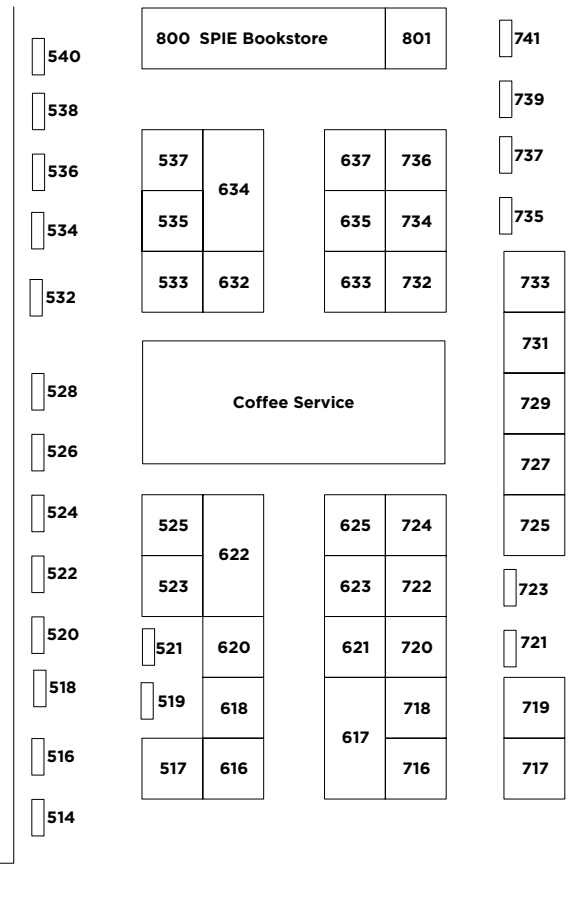
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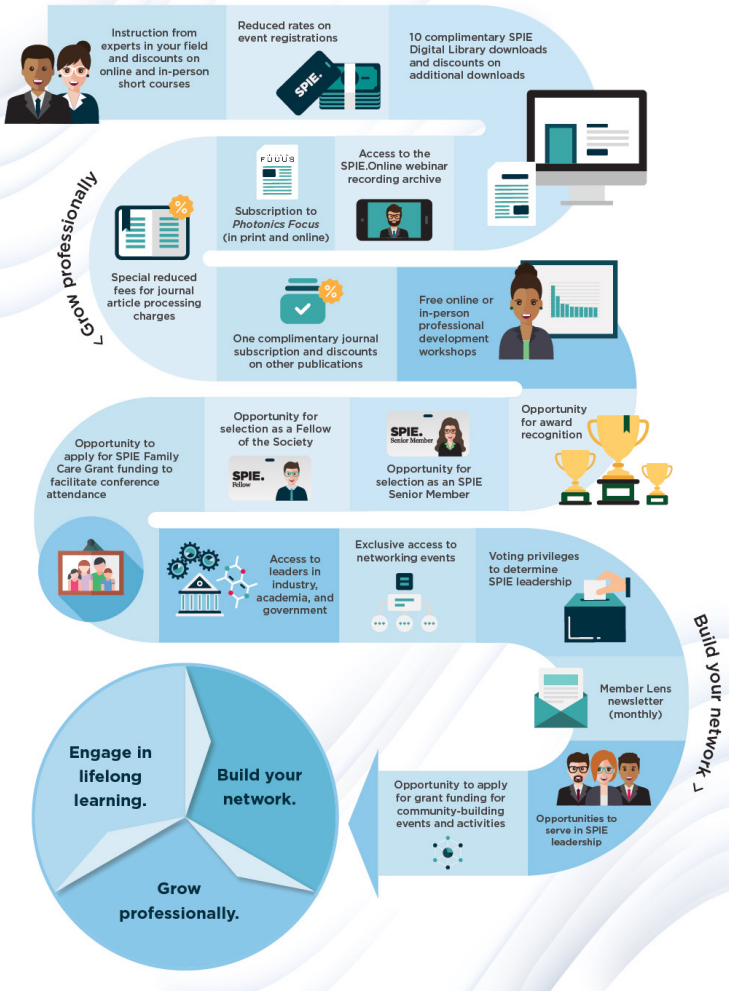
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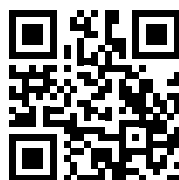
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Optics Technology							
Optiforms							
OptiGrate							

[spie.org/corporate](https://spie.org/corporate)

# CONFERENCE 12494

## Optical and EUV Nanolithography XXXVI

27 February - 2 March 2023 | Convention Center, Grand Ballroom 220A

Conference Chair: **Anna Lio**, Intel Corp. (United States)

Conference Co-Chair: **Martin Burkhardt**, IBM Thomas J. Watson Research Ctr. (United States)

Program Committee: **Steven L. Carson**, Intel Corp. (United States); **Will Conley**, Cymer, LLC (United States); **Yasin Ekinci**, Paul Scherrer Institut (Switzerland); **Andreas Erdmann**, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); **Nelson M. Felix**, IBM Thomas J. Watson Research Ctr. (United States); **Allen H. Gabor**, IBM Thomas J. Watson Research Ctr. (United States); **Kenneth A. Goldberg**, Lawrence Berkeley National Lab. (United States); **Paul Graeupner**, Carl Zeiss SMT GmbH (Germany); **Naoya Hayashi**, Dai Nippon Printing Co., Ltd. (Japan); **Soichi Inoue**, KIOXIA Corp. (Japan); **Young Seog Kang**, SAMSUNG Electronics Co., Ltd. (Republic of Korea); **Bryan S. Kasprovicz**, HOYA Corp. USA (United States); **Insung Kim**, SAMSUNG Electronics Co., Ltd. (Republic of Korea); **Toshio Konishi**, Toppan Photomasks, Inc. (Japan); **Ted Liang**, Intel Corp. (United States); **Chang-Moon Lim**, SK Hynix, Inc. (Republic of Korea); **Luciana Meli**, IBM Thomas J. Watson Research Ctr. (United States); **Lawrence S. Melvin**, Synopsys, Inc. (United States); **Hakaru Mizoguchi**, Gigaphoton Inc. (Japan); **Ken-ichiro Mori**, Canon Inc. (Japan); **Patrick P. Naulleau**, The Ctr. for X-Ray Optics (United States); **Christopher S. Ngai**, Applied Materials, Inc. (United States); **Soichi Owa**, Nikon Corp. (Japan); **Vicky Philipsen**, imec (Belgium); **Moshe E. Preil**, Carl Zeiss AG (United States); **Kurt G. Ronse**, imec (Belgium); **Katrina Rook**, Veeco Instruments Inc. (United States); **Daniel Sarlette**, Infineon Technologies Dresden GmbH (Germany); **Bruce W. Smith**, Rochester Institute of Technology (United States); **Regina Soufli**, Lawrence Livermore National Lab. (United States); **Akiyoshi Suzuki**, Gigaphoton Inc. (Japan); **Anna Tchikoulaeva**, Lasertec U.S.A., Inc. Zweigniederlassung Deutschland (Germany); **Edita Tejnil**, Siemens EDA (United States); **Geert Vandenberghe**, imec (Belgium); **Claire van Lare**, ASML Netherlands B.V. (Netherlands); **Thomas I. Wallow**, ASML (United States); **Obert R. Wood**, GlobalFoundries (United States); **Kenji Yamazoe**, TSMC North America (United States) Stanford Univ. School of Medicine (United States); **Yuxiang Xing**, Tsinghua Univ. (China); **Wei Zhao**, Stony Brook Univ. (United States)

### MONDAY 27 FEBRUARY

#### WELCOME AND MONDAY PLENARY SESSION

27 February 2023 • 8:00 AM - 10:00 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Kafai Lai, The Univ. of Hong Kong (United States), Qinghuang Lin, Lam Research Corp. (United States)

8:00 AM: **Symposium Welcome and Opening Remarks**

**Kafai Lai**, University of Hong Kong (United States) and Qinghuang Lin, LAM Research Corp. (United States)

8:05 AM: **Introduction of New SPIE Fellows**

8:15 AM: **2023 SPIE Rudolf and Hilda Kingslake Award in Optical Design**

Presented in recognition of significant achievement in the field of optical design, including the theoretical or experimental aspects of optical engineering.

8:25 AM: **2023 SPIE Frits Zernike Award for Microlithography**

Presented in recognition of outstanding accomplishments in micro-lithographic technology, especially those furthering the development of semiconductor lithographic imaging solutions.

8:35 AM: **Presentation of the Nick Cobb Memorial Scholarship**

The Nick Cobb Memorial Scholarship is awarded to an outstanding graduate student studying advanced lithography or a related field. The scholarship is jointly funded by Siemens EDA and SPIE.

12494-505 • 8:40 AM - 9:20 AM

**Driving Moore's Law into the next decade** (*Plenary Presentation*)

**Martin van den Brink**, ASML Netherlands B.V. (Netherlands)

12496-504 • 9:20 AM - 10:00 AM

**Update on CHIPS Act implementation** (*Plenary Presentation*)

**Laurie E. Locascio**, National Institute of Standards and Technology (United States)

#### SESSION 1: OPENING REMARKS AND KEYNOTES

27 February 2023 • 1:10 PM - 2:50 PM | Convention Center, Grand Ballroom 220A

Session Chairs: Anna Lio, Intel Corp. (United States), Martin Burkhardt, IBM Thomas J. Watson Research Ctr. (United States)

1:10 PM: **Opening Remarks**

12494-1 • 1:30 PM - 2:10 PM

**Memory technology: process and cell architecture** (*Keynote Presentation*)

Author(s): Jeongdong Choe, TechInsights Inc. (Canada)

12494-2 • 2:10 PM - 2:50 PM

**Augmented reality: The long-term bet** (*Keynote Presentation*)

Author(s): Alfredo Bismuto, Meta (United States)

Coffee Break 2:50 PM - 3:20 PM

#### SESSION 2: EUVL STOCHASTICS

##### Joint Session with 12494 and 12498

27 February 2023 • 3:20 PM - 5:00 PM | Convention Center, Grand Ballroom 220A

Session Chairs: Thomas I. Wallow, ASML (United States), Robert L. Brainard, SUNY Polytechnic Institute (United States)

12494-3 • 3:20 PM - 3:40 PM

**Distribution of defective sub-cluster formation probability for stochastic hotspot prediction**

Author(s): Hiroshi Fukuda, Hitachi High-Tech Corp. (Japan)

12498-11 • 3:40 PM - 4:00 PM

**A novel formulated developer for negative-tone imaging with EUV exposure to improve chemical stochastic**

Author(s): Toru Fujimori, Nishiki Fujimaki, Keiyu Ou, Kazuhiro Marumo, Nobuhiro Hiura, Satomi Takahashi, Naohiro Tango, FUJIFILM Corp. (Japan)

12494-4 • 4:00 PM - 4:20 PM **Chemical approach to make the most of EUVL: stochastic effect mitigation with developer and rinse**

Author(s): Hyungju Ryu, Dokyeong Kwon, Jiho Song, Wongi Park, Jinseong Gwak, Haram Ko, Jiyoung Lee, Jinpyoung Kim, Kyungseok Ryu, Sungjo Hwang, Taemin Jeong, Heeyoung Go, Yigwon Kim, Kyoungyong Cho, Sangjin Kim, Changmin Park, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12498-12 • 4:20 PM - 4:40 PM

**Towards molecular-scale kinetic Monte Carlo simulation of pattern formation in photoresist materials for EUV nanolithography**

Author(s): Lois Fernandez Miguez, Peter A. Bobbert, Reinder Coehoorn, Technische Univ. Eindhoven (Netherlands)

12498-13 • 4:40 PM - 5:00 PM

**Photoresists with precisely controlled molecular weight, composition and sequence**

Author(s): Christopher K. Ober, Florian Käfer, Cornell Univ. (United States); Zoey Meng, Rachel A. Segalman, Javier Read de Alaniz, Univ. of California, Santa Barbara (United States)

## TUESDAY 28 FEBRUARY

### TUESDAY PLENARY SESSION

28 February 2023 • 8:00 AM - 9:50 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Kafai Lai, The Univ. of Hong Kong (United States), Qinghuang Lin, Lam Research Corp. (United States)

8:00 AM - 8:10 AM

**Introduction and Announcements**

8:10 AM - 8:30 AM

**50th anniversary of Micralign: A retrospective**

12495-500 • 8:30 AM - 9:10 AM

**Accelerated computing for silicon leadership** (*Plenary Presentation*)

Vivek K. Singh, NVIDIA Corp. (United States)

12497-501 • 9:10 AM - 9:50 AM

**Pushing the limits of nano-imprint lithography for immersive displays** (*Plenary Presentation*)

Bernard C. Kress, Google (United States)

Coffee Break 9:50 AM - 10:20 AM

### SESSION 3: EUV PRESENT AND FUTURE OUTLOOK

28 February 2023 • 10:20 AM - 12:00 PM | Convention Center, Grand Ballroom 220A

Session Chairs: Steven L. Carson, Intel Corp. (United States), Nelson M. Felix, IBM Thomas J. Watson Research Ctr. (United States)

12494-5 • 10:20 AM - 10:40 AM

**High NA EUV: Development towards introduction at the customer** (*Invited Paper*)

Author(s): Rudy Peeters, ASML Netherlands B.V. (Netherlands)

12494-6 • 10:40 AM - 11:00 AM

**High NA EUV optics: Preparing the next major lithography step**

Author(s): Paul Graeupner, Daniel Golde, Carl Zeiss SMT GmbH (Germany); Jan van Schoot, ASML Netherlands B.V. (Netherlands); Peter Kuerz, Carl Zeiss SMT GmbH (Germany); Judon Stoeldraijer, ASML Netherlands B.V. (Netherlands)

12494-7 • 11:00 AM - 11:20 AM

**Hyper-NA EUV lithography: An imaging perspective**

Author(s): Inhwan Lee, imec (Belgium), KU Leuven (Belgium); Joern-Holger Franke, Kurt Ronse, imec (Belgium); Stefan De Gendt, imec (Belgium), KU Leuven (Belgium); Vicky Philippsen, Eric Hendrickx, imec (Belgium)

12494-8 • 11:20 AM - 11:40 AM

**Mirror-based EUV interference lithography: One step closer to the ultimate resolution**

Author(s): Iason Giannopoulos, Iacopo Mochi, Michaela Vockenhuber, Yasin Ekinici, Dimitrios Kazazis, Paul Scherrer Institut (Switzerland)

**12494-9 • 11:40 AM - 12:00 PM 0.33 NA EUV systems for high-volume manufacturing**

Author(s): Christophe Smeets, ASML Netherlands B.V. (Netherlands)

Lunch Break 12:00 PM - 1:30 PM

### SESSION 4: MASK

28 February 2023 • 1:30 PM - 3:10 PM | Convention Center, Grand Ballroom 220A

Session Chairs: Patrick P. Naulleau, The Ctr. for X-Ray Optics (United States), Lawrence S. Melvin, Synopsys, Inc. (United States)

12494-10 • 1:30 PM - 1:50 PM

**AIMS® EUV 3.0: ZEISS' next generation EUV mask review tool**

Author(s): Sven Krannich, Renzo Capelli, Matthias Stecher, Marc Schneider, Stefan Mueller, Carl Zeiss SMT GmbH (Germany)

12494-62 • 1:50 PM - 2:10 PM

**Actinic inspection of the EUV optical parameters of lithographic materials with lab-based radiometry and reflectometry**

Author(s): Kevin Dorney, imec (Belgium); Nicola N. Kissoon, KU Leuven (Belgium); Fabian Holzmeier, Esben W. Larsen, Dhirendra P. Singh, imec (Belgium); Shikhar Arvind, Sayantani Santra, imec (Belgium), KU Leuven (Belgium); Roberto Fallica, imec (Belgium); Igor Makhotkin, Univ. Twente (Netherlands); Vicky Philippsen, imec (Belgium); Stefan De Gendt, imec (Belgium), KU Leuven (Belgium); Claudia Fleischmann, imec (Belgium), Quantum Solid State Physics (Belgium); Paul A. W. van der Heide, John S. Petersen, imec (Belgium)

12494-12 • 2:10 PM - 2:30 PM

**Mask roughness contribution to wafer edge placement error**

Author(s): Andreas Frommhold, Joern-Holger Franke, Tatiana Kovalevich, imec (Belgium); Eelco van Setten, Vidya Vaenkatesan, ASML Netherlands B.V. (Netherlands)

12494-13 • 2:30 PM - 2:50 PM

**EUV refractive index measurements with improved accuracy and their impact in component modeling**

Author(s): Franck Delmotte, Institut d'Optique Graduate School (France); Catherine Burcklen, Lawrence Livermore National Lab. (United States); Irene Papagiannouli, Institut d'Optique Graduate School (France); Farhad Salmassi, Eric Gullikson, Lawrence Berkeley National Lab. (United States); Regina Soufli, Lawrence Livermore National Lab. (United States)

# CONFERENCE 12494

12494-14 • 2:50 PM - 3:10 PM

## **EUV phase monitoring applications with actinic reflectometry**

Author(s): Stuart Sherwin, EUV Technology (United States); Eric Gullikson, The Ctr. for X-Ray Optics, Lawrence Berkeley National Lab. (United States); Matt Hettermann, Dave Houser, Chami Perera, Patrick Naulleau, EUV Technology (United States)

Coffee Break 3:10 PM - 3:40 PM

### SESSION 5: OPTICAL AND EUV LITHOGRAPHY

28 February 2023 • 3:40 PM - 5:20 PM | Convention Center, Grand Ballroom 220A

Session Chairs: Andreas Erdmann, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany), Regina Soufli, Lawrence Livermore National Lab. (United States)

12494-15 • 3:40 PM - 4:00 PM

## **Photolithography equipment market and technology: State and challenges** *(Invited Paper)*

Author(s): Taguhi Yeghoyan, Yole Développement SA (France)

28 February 2023 | Convention Center, Grand Ballroom 220A

## **Show Abstract +**

12494-16 • 4:00 PM - 4:20 PM

## **Expected performance of digital scanner and the potential application for advanced semiconductor fabrication**

Author(s): Yoji Watanabe, Yuho Kanaya, Yusuke Saito, Toshiaki Sakamoto, Kazuo Masaki, Soichi Owa, Nikon Corp. (Japan); Thomas Koo, Bryant Lin, Michael Tan, David Tseng, Conrad Sorensen, Sujuan Li, Steve Renwick, Noriyuki Hirayanagi, Bausan Yuan, Nikon Research Corp. of America (United States)

12494-17 • 4:20 PM - 4:40 PM

## **25 years of EUV multilayer optics development at optiX fab and Fraunhofer IOF** *(Invited Paper)*

Author(s): Torsten Feigl, Marco Perske, Hagen Pauer, Tobias Fiedler, Philipp Naujok, Klara Stallhofer, Tina Seifert, Annika Schmitt, optiX fab GmbH (Germany)

12494-18 • 4:40 PM - 5:00 PM

## **A holistic approach to model-based stochastic-aware computational lithography**

Author(s): ChangAn Wang, Yongfa Fan, Mu Feng, Qian Xie, Jazer Wang, Christopher Kaplan, Michael Crouse, Xiaoyang Li, Stephen Hsu, Peigen Cao, Yi-Hsing Peng, Stephen Chang, Jun Ye, Youping Zhang, Bin Cheng, Ken Yang, Leiwu Zheng, Jen-Shiang Wang, Austin Peng, Li-Hao Yeh, Cuiping Zhang, Rafael Howell, Alexander Tan, Yiqiong Zhao, Jun Lang, Xiaolong Zhang, ASML (United States); Luc V. Kessel, Marleen Kooiman, Ruben Maas, ASML Netherlands B.V. (Netherlands)

12494-19 • 5:00 PM - 5:20 PM

## **Physical dose modeling and throughput optimization in EUV computational lithography**

Author(s): Austin Peng, Christopher Kaplan, Jeff Lu, Michael Crouse, Zuanyi Li, Xiaobo Xie, David Rio, Achim Woessner, Alexander Tan, Cuiping Zhang, Xiaoyang Jason Li, Dezheng Sun, Stephen . Hsu, Rafael C. Howell, ASML (United States)

### TUESDAY EVENING PLENARY

28 February 2023 • 5:30 PM - 6:15 PM | Convention Center, Grand Ballroom 220A

12498-502 • 5:30 PM - 6:00 PM

## **Are 2D transition metal dichalcogenides transistors the future silicon replacement or hype?** *(Plenary Presentation)*

Kevin P. O'Brien, Intel Corp. (United States)

6:15 PM - 7:15 PM

## **Sustainability and Lithography's Role: A Panel Discussion**

MODERATOR:

**Dan Hutcheson**, TechInsights (United States)

PANELISTS:

**John Cahill**, ASML-Cymer (United States)

**Emily Gallagher**, imec (Belgium)

**Chris Jones**, Edwards Vacuum (United Kingdom)

**Mark Merrill**, Lam Research (United States)

**Ryan Russell**, Intel (United States)

**Akihisa Sekiguchi**, Tokyo Electron LTD. (Japan)

It's become popular to make commitments to new business models and supply chain strategies for conservation and carbon neutrality in the semiconductor ecosystem, including initiatives to reduce greenhouse gases, conserve energy and water, and focus more on renewables and reusables. In addition to these, panelists will address the role lithography and patterning will play and has played in addressing these critical issues. For example: Koomey's law states that Compute-per-Watt improves exponentially over time. Lithography's critical role in making this possible in this is well established through its ability to make circuits more power efficient. This means that there is a long payback to lithography when considering Life-Cycle Sustainability Assessment (LCSA) methods to evaluate the chips they produce. This and more will be discussed.

### WEDNESDAY 1 MARCH

#### SESSION 6: PELLICLES AND ADVANCED MASKS

1 March 2023 • 8:00 AM - 9:40 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Ted Liang, Intel Corp. (United States), Bryan S. Kasprowicz, HOYA Corp. USA (United States)

12494-21 • 8:00 AM - 8:20 AM

## **EUV pellicle scanner integration for N2 nodes and beyond**

Author(s): Mark A. van de Kerkhof, Paul Vermeulen, Beatriz Seoane, Alexander Klein, ASML Netherlands B.V. (Netherlands); Emily Gallagher, Joost Bekaert, Marina Y. Timmermans, Ivan Pollentier, imec (Belgium)

12494-20 • 8:20 AM - 8:40 AM

## **CNT pellicles: Recent optimization and exposure results** *(Invited Paper)*

Author(s): Joost Bekaert, Emily Gallagher, Marina Y. Timmermans, Ivan Pollentier, Rik Jonckheere, Remko Aubert, Eric Hendrickx, imec (Belgium)

12494-22 • 8:40 AM - 9:00 AM

## **Absorber material deficiency impact on a stochastically patterned wafer analyzed with a clustered model**

Author(s): Lawrence S. Melvin, Yudhishtir Kandel, Zachary A. Levinson, Synopsys, Inc. (United States); Ulrich Welling, Synopsys GmbH (Germany)



12494-23 • 9:00 AM - 9:20 AM

## Estimation of EUV pellicle lifetime with particle defects

Author(s): Ji-Hyun Jeon, Hanyang Univ. (Republic of Korea); Ji-Won Kang, Hanyang University (Republic of Korea); Hye-Keun Oh, Hanyang University (Republic of Korea)

12494-24 • 9:20 AM - 9:40 AM

## Validation of EUV absorber models for Mo-Pt, Mo-Ni, and Mo-W AttPSM candidates

Author(s): Rajiv Naresh Sejjal, Bruce W. Smith, Rochester Institute of Technology (United States)

Coffee Break 9:40 AM - 10:10 AM

### SESSION 7: COMPUTATIONAL LITHOGRAPHY

#### Joint Session with 12495 and 12494

1 March 2023 • 10:10 AM - 11:50 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Yuri Granik, Siemens EDA (United States), Daniel Sarlette, Infineon Technologies Dresden GmbH (Germany)

12494-25 • 10:10 AM - 10:30 AM

## EUV single patterning validation of curvilinear routing

Author(s): Fergo Treska, Dongbo Xu, Yasser Sherazi, Werner Gillijns, imec (Belgium)

12494-26 • 10:30 AM - 10:50 AM

## Stochastic aware EUV OPC on random logic via

Author(s): Werner Gillijns, Jae-Uk Lee, imec (Belgium)

12494-27 • 10:50 AM - 11:10 AM

## Binary solution for optimization of pixelated EUV source using constrained mathematical programming

Author(s): Michael Yeung, Fastlitho Inc. (United States); Eytan Barouch, Boston Univ. (United States)

12495-27 • 11:10 AM - 11:30 AM

## Computational lithography solutions to support EUV High-NA patterning

Author(s): Rongkuo Zhao, Fan Zhou, Jialei Tang, Jeff Lu, Dezheng Sun, Ming-Chun Tien, Stephen Hsu, Rachit Gupta, Youping Zhang, ASML (United States)

12495-28 • 11:30 AM - 11:50 AM

## Process optimization using 0.33NA EUV single mask for next-generation DRAM manufacturing

Author(s): Jeonghoon Lee, Sandip Halder, imec (Belgium)

Lunch Break 11:50 AM - 1:20 PM

### SESSION 8: EUV IMAGING

1 March 2023 • 1:20 PM - 3:00 PM | Convention Center, Grand Ballroom 220A

Session Chairs: Edita Tejnjl, Siemens EDA (United States), Claire van Lare, ASML Netherlands B.V. (Netherlands)

12494-28 • 1:20 PM - 1:40 PM

## Improved methodology for prediction of 'merged contact hole' defect process window

Author(s): Andreas Frommhold, Dorin Cerbu, imec (Belgium); Gijsbert Rispens, Mark J. Maslow, ASML Netherlands B.V. (Netherlands); Paulina Rincon-Delgadillo, imec (Belgium)

12494-29 • 1:40 PM - 2:00 PM

## Feasibility of logic metal scaling with 0.55NA EUV single patterning

Author(s): Dongbo Xu, Ling Ee Tan, Vicky Philipsen, Werner Gillijns, imec (Belgium)

12494-30 • 2:00 PM - 2:20 PM

## Experimental local MEEF study using programmed mask variability on hexagonal pitch 40 nm contact hole arrays

Author(s): Lieve Van Look, Joern-Holger Franke, Andreas Frommhold, imec (Belgium); Alberto Colina, Gijsbert Rispens, ASML Netherlands B.V. (Netherlands)

12494-31 • 2:20 PM - 2:40 PM

## Depth of focus in high-NA EUV lithography: The role of assist features and their variability budget

Author(s): Roel Gronheid, KLA Corp. (Belgium); Alessandro Vaglio Pret, KLA Italy Srl (Italy); Anatoly Burov, KLA Texas (United States)

12494-32 • 2:40 PM - 3:00 PM

## Defining Tatian-Zernike polynomials for use in a lithography simulator

Author(s): Ethan Maguire, Rajiv Sejjal, Bruce W. Smith, Rochester Institute of Technology (United States)

Coffee Break 3:00 PM - 3:30 PM

### SESSION 9: OVERLAY AND STITCHING

1 March 2023 • 3:30 PM - 4:30 PM | Convention Center, Grand Ballroom 220A

Session Chairs: Soichi Owa, Nikon Corp. (Japan), Ken-Ichiro Mori, Canon Inc. (Japan)

12494-33 • 3:30 PM - 3:50 PM

## Overview of stitching for high NA: Imaging and overlay experimental and simulation results *(Invited Paper)*

Author(s): Natalia V. Davydova, ASML Netherlands B.V. (Netherlands); Vincent Wiaux, Lieve van Look, Joost Bekaert, imec (Belgium); Frank Timmermans, Bram Slachter, Eelco van Setten, Marcel Beckers, Simon van Gorp, Cees Lambregts, Chung-Tien Li, Arthur van de Nes, ASML Netherlands B.V. (Netherlands); Koen D'Havé, imec (Belgium); Rongkuo Zhao, Dezheng Sun, Ming-Chun Tien, ASML (United States); Diederik de Bruin, ASML Netherlands B.V. (Netherlands); Stephen Hsu, ASML (United States); Rene Carpaij, ASML Netherlands B.V. (Netherlands)

12494-34 • 3:50 PM - 4:10 PM

## Supporting future DRAM overlay and EPE roadmaps with the NXT:2100i

Author(s): Bart Smeets, Paul Aben, Friso Klinkhamer, Jean Philippe van Damme, Bart Paarhuis, Raaja Ganapathy Subramanian, Mohamed El Kodadi, Stefan Lichiardopol, Alberto Pirati, Peter Vanoppen, Wim de Boeij, ASML Netherlands B.V. (Netherlands)

12494-35 • 4:10 PM - 4:30 PM

## Impact of HighNA half-field to full-field overlay performance by MonteCarlo simulations

Author(s): Romain J. Lallement, Daniel Schmidt, Richard Johnson, Christopher Carr, Martin Burkhardt, Jaime Morillo, Allen Gabor, IBM Thomas J. Watson Research Ctr. (United States)

# CONFERENCE 12494

## POSTER SPEED TALKS

1 March 2023 • 4:30 PM - 5:10 PM PST | Convention Center, Grand Ballroom 220A

Session Chairs: Anna Lio, Intel Corp. (United States), Martin Burkhardt, IBM Thomas J. Watson Research Ctr. (United States)

### Five minute preview presentations of select posters

Poster Numbers: 12494-50, 12494-55, 12494-65, 12494-71, 12494-49, 12494-54, 12494-70, 12494-67

## POSTER SESSION

1 March 2023 • 5:30 PM - 7:00 PM | Convention Center, Hall 2

Conference attendees are invited to attend the Poster Session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the Poster Session.

### Poster Setup: Wednesday 10:00 AM - 4:30 PM

Poster authors, view poster presentation guidelines and set-up instructions at <http://spie.org/ALPosterGuidelines>.

12494-46

#### Effect of pellicle wrinkles on EUV reflectivity and local critical dimension

Author(s): Seungchan Moon, Donggi Lee, Jinhyuk Choi, Jinho Ahn, Hanyang Univ. (Republic of Korea)

12494-47

#### Investigation of EUV emission from Sn to rare-earth plasmas in terms of the accuracy of the atomic data and completeness of atomic model

Author(s): Akira Sasaki, National Institutes for Quantum and Radiological Science and Technology (Japan)

12494-49

#### Mask absorber/tone and process impact on resist line-edge-roughness

Author(s): Eisuke Ohtomi, Western Digital GK (Japan); Vicky Philipsen, imec (Belgium); Joren Severi, imec (Belgium), KU Leuven (Belgium); Ulrich Welling, Synopsys GmbH (Germany); Laurence S. Melvin, Synopsys (United States); Yosuke Takahata, Yusuke Tanaka, Western Digital GK (Japan); Danilo De Simone, imec (Belgium)

12494-51

#### Development progress of key components for LPP-EUV light sources

Author(s): Hiroaki Tomuro, Yoshifumi Ueno, Shinji Nagai, Fumio Iwamoto, Kenichi Miyao, Hideyuki Hayashi, Takuya Ishii, Tamotsu Abe, Hiroaki Nakarai, Takashi Saitou, Hakaru Mizoguchi, Gigaphoton Inc. (Japan)

12494-52

#### Robust and automated methodology for scanner matching using contour-based analysis

Author(s): Jean Gabriel Simiz, Romain Alestra, Romain Bange, Julien Ducoté, Florent Dettoni, Pierre Fanton, STMicroelectronics S.A. (France)

12494-53

#### Integrated simulation of laser target interactions and dynamical effects on optical mirrors roughness, contamination, and reflectivity in HVM operation

Author(s): Ahmed Hassanein, Purdue Univ. (United States); Tatyana Sizyuk, Argonne National Lab. (United States)

12494-55

#### Selective removal of EUV-exposed particles from pellicle

Author(s): Hyun-Gyu Kang, Dong-Hyeon Kwon, Tae-Gon Kim, Jinho Ahn, Sang-Sul Lee, Hanyang Univ. (Republic of Korea); Byung-Hoon Lee, Hwan-Seok Seo, Hee-Bom Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Jin-Goo Park, Hanyang Univ. (Republic of Korea)

12494-56

#### Frequency doubling and phase error tolerance exploration for chrome-less phase shift mask

Author(s): Liang Li, Miao Jiang, Di Liang, Binbin Yan, Beijing Superstring Academy of Memory Technology (China); Mingqi Gao, Dajun Wu, Andy Lan, ChangXin Memory Technologies, Inc. (China); Jiangliu Shi, Beijing Superstring Academy of Memory Technology (China)

12494-57

#### BEOL N2: M2 through SAxP process from MP21 to MP26: 193i SAQP vs EUV SADP

Author(s): Yannick Hermans, Chen Wu, Nunzio Buccheri, Filip Schleicher, Janko Versluijs, Daniel Montero, Bappaditya Dey, Patrick Wong, Paulina Rincon-Delgadillo, Seongho Park, Zsolt Tokei, Philippe Leray, Sandip Halder, imec (Belgium)

12494-58

#### Development of novel focus spot detection methods for high-volume manufacturing

Author(s): Syed Naime Mohammad, Chao-Jen Tsou, KLA Corp. (Germany); Afu Chiu, KLA Taiwan (Taiwan); Norman Birnstein, Erick deGouw, Clemens Utzny, Philip Groeger, Stefan Buhl, KLA Corp. (Germany); W.H. Wang, C.H. Huang, Elvis Yang, T.H. Yang, K.C. Chen, Macronix International Co., Ltd. (Taiwan)

12494-59

#### Focus spot monitoring: design of an automatable detection, classification, and impact analysis pipeline

Author(s): Syed Naime Mohammad, Sven Boese, Philip Groeger, Holger Bald, Alberto Lopez-Gomez, Clemens Utzny, Stefan Buhl, Qoniac GmbH (Germany)

12494-60

#### Contributing to sustainability delivers maximizing availability by the latest light source for the ArF immersion lithography and KrF lithography

Author(s): Takeda Yuuki, Takamitsu Komaki, Hirotaka Miyamoto, Tsukasa Hori, Katsuhiko Wakana, Takeshi Ohta, Takashi Saito, Hakaru Mizoguchi, Gigaphoton Inc. (Japan)

12494-61

#### EUV SRAFs printing modeling and verification in 2D hole array

Author(s): Ling Ee Tan, imec (Belgium); Chih-I Wei, Siemens EDA (Belgium); Shumay Shang, Germain Fenger, Le Hong, Siemens EDA (United States); Werner Gillijns, imec (Belgium)

12494-63

#### Kinetic simulations of plasma dynamics in the EUV sources

Author(s): Kirill V. Lezhnin, William Fox, Princeton Plasma Physics Lab. (United States); Samuel Totorica, Princeton Univ. (United States); John Sheil, Oscar Versolato, Advanced Research Ctr. for Nanolithography (Netherlands); Ahmed Diallo, Princeton Plasma Physics Lab. (United States)

12494-64

## **Kinetic simulations of laser-produced tin EUV sources**

Author(s): Samuel Totorica, Princeton Univ. (United States); Will Fox, Kirill V. Lezhnin, Ahmed Diallo, Princeton Plasma Physics Lab. (United States); John Sheil, Oscar Versolato, Advanced Research Ctr. for Nanolithography (Netherlands)

12494-65

## **Impact of MoSi<sub>2</sub> crystal structure on nano-membrane emissivity**

Author(s): Haneul Kim, Seong Ju Wi, Young-Woo Kang, Wonjin Kim, Jinho Ahn, Hanyang Univ. (Republic of Korea)

12494-67

## **Application of Gaussian Random Field EUV stochastic model to quantification of stochastic variability of EUV vias**

Author(s): Zexin Pan, Siemens EDA (United States), Stanford Univ. (United States); Azat M. Latypov, Siemens EDA (United States); Chih-Wei, Siemens EDA (Belgium); Peter De Bisschop, imec (Belgium); Germain Fenger, John Sturtevant, Siemens EDA (United States)

12494-69

## **Imaging performance enhancement by source-mask-laser optimization**

Author(s): Zhewei Cai, Yun Gao, Xuan Liu, Xian He, Yuntao Jiang, Qingwei Liu, Chenhao Li, Yunhang Qiu, Semiconductor Manufacturing International Corp. (China)

12494-70

## **Study on the influence of pattern transmission on ArF lithographic performance**

Author(s): He Xian, Yun Gao, Yuntao Jiang, Qingwei Liu, Zhewei Cai, Linyu Zhou, Gaoying Zhang, Semiconductor Manufacturing International Corp. (China)

12494-73

## **Surface treatment to reduce process defects**

Author(s): Yuan Hsu, Edison Yang, Photronics DNP Semiconductor Mask Corp. (Taiwan); Mochihiro Shimizu, Dai Nippon Printing Co., Ltd. (Japan)

12494-50

## **Tin fluid dynamics driven by laser-produced plasmas relevant to EUV nanolithography**

Author(s): Diko Hemminga, Lucas Poirier, Advanced Research Ctr. for Nanolithography (Netherlands), Vrije Univ. Amsterdam (Netherlands); Javier Hernandez-Rueda, Advanced Research Ctr. for Nanolithography (Netherlands); Bo Liu, Advanced Research Ctr. for Nanolithography (Netherlands), Vrije Univ. Amsterdam (Netherlands); Adam Lassise, Advanced Research Ctr. for Nanolithography (Netherlands); Ronnie Hoekstra, Advanced Research Ctr. for Nanolithography (Netherlands), Univ. of Groningen (Netherlands); John Sheil, Oscar Versolato, Advanced Research Ctr. for Nanolithography (Netherlands), Vrije Univ. Amsterdam (Netherlands)

12494-54

## **Impact of mask rule constraints on ideal sraf placement**

Author(s): Monica Kempzell Sears, Farah Kmiec, Neal Lafferty, John Sturtevant, Siemens EDA (United States)

12494-71

## **Measurement of tin diffusion coefficients through molecular hydrogen**

Author(s): Gordon J. Crouse, Gavin McCoy, Nathan Bartlett, Andrew Herschberg, Univ. of Illinois (United States)

12494-72

## **Plasma enhanced CO<sub>2</sub> recombination in EUV drive lasers**

Author(s): Andrew C. Herschberg, Nathan Bartlett, Gordon J. Crouse, David N. Ruzic, Univ. of Illinois (United States)

12494-68

## **Modelling of patterning impact from diffraction hot spots in high-NA EUV lenses**

Author(s): Ethan Maguire, Rajiv Sejal, Bruce W. Smith, Rochester Institute of Technology (United States)

12494-74

## **Measurement of tin ion-hydrogen total elastic scattering cross sections for improved ion transport modeling**

Author(s): Nathan Bartlett, Andrew Herschberg, Gordon J. Crouse, Univ. of Illinois (United States); Jack Stahl, ASML San Diego (United States); Tamar Dallal, Jake Nuttall, David N. Ruzic, Univ. of Illinois (United States)

12494-76

## **Hydrogen recycling for EUV**

Author(s): Shannon Lee, Edwards Vacuum LLC (United States)

## THURSDAY 2 MARCH 2023

### SESSION 10: PATTERNING

2 March 2023 • 8:00 AM - 9:40 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Luciana Meli, IBM Thomas J. Watson Research Ctr. (United States), Geert Vandenberghe, imec (Belgium)

12494-36 • 8:00 AM - 8:20 AM

## **Reducing single layer EPE variations in EUV Lithography**

Author(s): Jo Finders, Claire van Lare, Eelco van Setten, ASML Netherlands B.V. (Netherlands)

12494-37 • 8:20 AM - 8:40 AM

## **Speculation on the EUV photoresist behavior at different dose and pitch**

Author(s): Suk-Koo Hong, Young Joo Choi, Eunseol Kim, Sang Hyun Je, Jun Soo Kim, Jaewoo Nam, Su Min Park, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12494-38 • 8:40 AM - 9:00 AM

## **EUV sub-resolution assist feature impact: experimental and simulation evaluation**

Author(s): Zheng Chen, Martin Burkhardt, Stuart Sieg, Luciana Meli, IBM Corp. (United States)

12494-39 • 9:00 AM - 9:20 AM

## **An investigation on the process control for the solid application of EUV MOR (*Invited Paper*)**

Author(s): Sangjin Kim, Il-Hwan Kim, Hyungju Ryu, Yongbeom Seo, Yigwon Kim, Jinhee Jang, Tae-Min Choi, Sol Jeong, Yongchul Jeong, Kyoungyong Cho, Cheolin Jang, Kyeongbeom Park, Changmin Park, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12494-40 • 9:20 AM - 9:40 AM

## **Process optimization for next generation high-NA EUV patterning by computational lithography techniques**

Author(s): Zachary A. Levinson, Thuc Dam, Synopsys, Inc. (United States); Pervaiz Kareem, Synopsys Korea Inc. (Republic of Korea); C.Jay Lee, Synopsys Taiwan Co., Ltd. (Taiwan); Wolfgang Demmerle, Ulrich Klostermann, Synopsys GmbH (Germany)

# CONFERENCE 12494

## ASML BEST STUDENT PAPER AWARD

2 March 2023 • 9:40 AM - 9:50 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Anna Lio, Intel Corp. (United States), Will Conley, Cymer, LLC (United States)

Join us for the ASML Best Student Paper Award presentation

Coffee Break 9:50 AM - 10:10 AM

## SESSION 11: EUV INTEGRATION

### Joint Session with 12494 and 12499

2 March 2023 • 10:10 AM - 11:50 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Eric A. Hudson, Lam Research Corp. (United States), Moshe E. Preil, Carl Zeiss AG (United States)

12494-41 • 10:10 AM - 10:30 AM

### EUV single patterning of random logic via using bright field mask

Author(s): Ling Ee Tan, Werner Gillijns, Dongbo Xu, Jae Uk Lee, Jeroen van de Kerkhove, Vicky Philipsen, Ryoung-Han Kim, imec (Belgium)

12494-42 • 10:30 AM - 10:50 AM

### Improvement of CD uniformity using a new selective exposure focusing method

Author(s): Seonho Lee, Jaewoong Sohn, Hyosung Lee, Jaehyung Jung, Youngjun Kim, Heehong Lee, Hyoungwha Jin, Harim Oh, Yongchan Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Maarten Boogaarts, Nataliya Nishchenko, ASML Netherlands B.V. (Netherlands); Jin-Sung Kim, ASML Korea Co., Ltd. (Republic of Korea); Noh-Kyoung Park, ASML Netherlands B.V. (Netherlands); Sang-Jin Kim, ASML Korea Co., Ltd. (Republic of Korea); Javier L. Rivas, Jens Wustefeld, Martin de Nivel, Valerio Altini, ASML Netherlands B.V. (Netherlands)

12499-35 • 10:50 AM - 11:10 AM

### Plasma etch challenges and innovations to enable sub-26nm pitch L/S patterning with high-NA EUV

Author(s): Nafees A. Kabir, Intel Corp. (United States)

12499-36 • 11:10 AM - 11:30 AM

### Understanding etch properties of advanced chemically amplified EUV resist

Author(s): Jong Keun Park, Emad Aqad, Conner Hoelzel, DuPont Electronics & Industrial (United States); Philjae Kang, You Rim Shin, DuPont Electronics & Industrial (Republic of Korea); Yinjie Cen, Choong Bong Lee, Li Cui, Suzanne Coley, Benjamin Naab, Rochelle Rena, DuPont Electronics & Industrial (United States); Lei Zhang, DuPont Science & Innovation (United States)

12499-37 • 11:30 AM - 11:50 AM

### Challenges and innovations in EUV patterning: Lithography and etch outlook (Invited Paper)

Author(s): Eric Liu, Akiteru C. Ko, Sophie Thibaut, Katie Lutker-Lee, Steven Grzeskowiak, Alexandra Krawicz, Christopher Cole, Hamed Hajibabaei, Sergey Voronin, Nayoung Bae, TEL Technology Ctr., America, LLC (United States); Angelique Raley, Tokyo Electron America, Inc. (United States); Lior Huli, Kanzo Kato, David Hetzer, TEL Technology Ctr., America, LLC (United States); Kathleen Nafus, Tokyo Electron Europe Ltd. (Belgium); Seiji Fujimoto, Seiji Nagahara, Satoru Shimura, Shinichiro Kawakami, Congque Dinh, Yuhei Kuwahara, Tokyo Electron Kyushu Ltd. (Japan); Shigeru Tahara, Masanobu Honda, Tetsuya Nishizuka, Tokyo Electron Miyagi Ltd. (Japan); Peter Biolsi, TEL Technology Ctr., America, LLC (United States); Hiromasa Mochiki, Tokyo Electron Miyagi Ltd. (Japan)

Lunch Break 11:50 AM - 1:20 PM

## SESSION 12: LIGHT SOURCES

2 March 2023 • 1:20 PM - 2:40 PM | Convention Center, Grand Ballroom 220A

Session Chairs: Bruce W. Smith, Rochester Institute of Technology (United States), Hakaru Mizoguchi, Gigaphoton Inc. (Japan)

12494-43 • 1:20 PM - 1:40 PM

### EUV light source for high-NA lithography, with update on performance and availability of EUV sources in high volume manufacturing (HVM) on EUVL scanners at customer fabs

Author(s): Karl Umstadter, Michael Purvis, Alex Schafgans, Jayson Stewart, Peter Mayer, ASML (United States)

12494-44 • 1:40 PM - 2:00 PM

### To enhance EPE through PSD based quantification analysis of resist impact and lightsource induced LWR/ LER

Author(s): Toshihiro Oga, Takamitsu Komaki, Takeshi Ohta, Shinichi Matsumoto, Takashi Saitou, Gigaphoton Inc. (Japan); Tomohiko Iwaki, Micron Memory Japan, K.K. (Japan); Kanji Sugino, Micron Memory Japan (Japan)

12494-45 • 2:00 PM - 2:20 PM

### Plasma dynamics and future of LPP-EUV source for semiconductor manufacturing

Author(s): Hakaru Mizoguchi, Kyushu Univ. (Japan), Gigaphoton Inc. (Japan)

12494-75 • 2:20 PM - 2:40 PM

### Improvement of LDP EUV Source Performance for Actinic Patterned Mask Inspection

Author(s): Safak Sayan, Kishore K. Chakravorty, Intel Corp. (United States); Yusuke Teramoto, Usihio Germany GmbH (Germany); Bárbara Santos, Ushio Germany GmbH (Germany); Akihisa Nagano, Noritaka Ashizawa, Takahiro Shirai, Shunichi Morimoto, Kazuya Aoki, Hidenori Watanabe, Yoshihiko Sato, Ushio Inc. (Japan)

## CONFERENCE CHAIRS CLOSING REMARKS

2 March 2023 • 2:40 PM - 3:00 PM PST | Convention Center, Grand Ballroom 220A

Closing remarks by conference chairs Anna Lio and Martin Burkhardt.

# CONFERENCE 12495

## DTCO and Computational Patterning II

27 February - 2 March 2023 | Convention Center, Room 210A

Conference Chair: **Ryoung-Han Kim**, imec (Belgium)

Conference Co-Chair: **Neal V. Lafferty**, Siemens EDA (United States)

Program Committee: **Jason P. Cain**, Advanced Micro Devices, Inc. (United States); **Luigi Capodieci**, Motivo, Inc. (United States); **Lifu Chang**, MOSIS Integrated Circuit Fabrication Service (United States); **Dan J. Dechene**, IBM Thomas J. Watson Research Ctr. (United States); **David M. Fried**, Lam Research Corp. (United States); **Yuri Granik**, Siemens EDA (United States); **Harsha Grunes**, Intel Corp. (United States); **Srividya Jayaram**, Siemens EDA (United States); **Seongtae Jeong**, SAMSUNG Electronics Co., Ltd. (United States); **Sachiko Kobayashi**, KIOXIA Corp. (Japan); **Kafai Lai**, The Univ. of Hong Kong (United States); **Ya-Chieh Lai**, Cadence Design Systems, Inc. (United States); **Lars W. Liebmann**, TEL Technology Ctr., America, LLC (United States); **Kevin Lucas**, Synopsys, Inc. (United States); **Lawrence S. Melvin**, Synopsys, Inc. (United States); **Shigeki Nojima**, KIOXIA Corp. (Japan); **David Z. Pan**, The Univ. of Texas at Austin (United States); **Piyush Pathak**, Cadence Design Systems, Inc. (United States); **Michael L. Rieger**, Consultant (United States); **Vivek K. Singh**, NVIDIA Corp. (United States); **Chun-Ming Wang**, Western Digital Corp. (United States); **Lynn T. Wang**, GlobalFoundries (United States); **Yayi Wei**, Institute of Microelectronics, Chinese Academy of Sciences (United States); **Chi-Min Yuan**, NXP Semiconductors (United States)

### MONDAY 27 FEBRUARY

#### WELCOME AND MONDAY PLENARY SESSION

27 February 2023 • 8:00 AM - 10:00 AM | Convention Center, Grand Ballroom 220A

Session Chairs: **Kafai Lai**, The Univ. of Hong Kong (United States), **Qinghuang Lin**, Lam Research Corp. (United States)

8:00 AM: **Symposium Welcome and Opening Remarks**

**Kafai Lai**, University of Hong Kong (United States) and **Qinghuang Lin**, LAM Research Corp. (United States)

8:05 AM: **Introduction of New SPIE Fellows**

8:15 AM: **2023 SPIE Rudolf and Hilda Kingslake Award in Optical Design**

Presented in recognition of significant achievement in the field of optical design, including the theoretical or experimental aspects of optical engineering.

8:25 AM: **2023 SPIE Frits Zernike Award for Microlithography**

Presented in recognition of outstanding accomplishments in micro-lithographic technology, especially those furthering the development of semiconductor lithographic imaging solutions.

8:35 AM: **Presentation of the Nick Cobb Memorial Scholarship**

The Nick Cobb Memorial Scholarship is awarded to an outstanding graduate student studying advanced lithography or a related field. The scholarship is jointly funded by Siemens EDA and SPIE.

12494-505 • 8:40 AM - 9:20 AM

**Driving Moore's Law into the next decade** (*Plenary Presentation*)

**Martin van den Brink**, ASML Netherlands B.V. (Netherlands)

12496-504 • 9:20 AM - 10:00 AM

**Update on CHIPS Act implementation** (*Plenary Presentation*)

**Laurie E. Locascio**, National Institute of Standards and Technology (United States)

Coffee Break 10:00 AM - 10:30 AM

#### SESSION 1: CURVILINEAR IN COMPUTATIONAL PATTERNING

27 February 2023 • 10:30 AM - 12:10 PM | Convention Center, Room 210A

Session Chairs: **Lifu Chang**, The MOSIS Service (United States), **Ryan Ryoung-Han Kim**, imec (Belgium)

12495-1 • 10:30 AM - 10:50 AM

**Full chip ILT mask synthesis for advanced memory manufacturing**

Author(s): **Jennifer L. Digaum**, Micron Technology, Inc. (United States); **Lin Wang**, **Kyle Braam**, **Dave Gerold**, **Yongdong Wang**, **Thuc Dam**, Synopsys, Inc. (United States)

12495-2 • 10:50 AM - 11:10 AM

**Structured assist features in inverse lithography**

Author(s): **Yuri Granik**, **Philip Wang**, Siemens EDA (United States)

12495-3 • 11:10 AM - 11:30 AM

**Curvilinear mask handling in OPC flow**

Author(s): **Yung-Yu Chen**, **Wen-Li Cheng**, **Yu-Po Tang**, Synopsys Taiwan Co., Ltd. (Taiwan)

12495-4 • 11:30 AM - 11:50 AM

**Curvilinear data representation and its impact on file size and lithographic performance**

Author(s): **Jiuning Hu**, **Chris Spence**, **Kurt Wampler**, **Mahmoud Mohsen**, **Yen-Wen Lu**, **Rachit Gupta**, **Adam Lyons**, **Youping Zhang**, **Rafael Howell**, **Jun Ye**, ASML (United States)

12495-5 • 11:50 AM - 12:10 PM

**Curvilinear mask process correction with zero additional turnaround time**

Author(s): **Noriaki Nakayamada**, **Haruyuki Nomura**, **Ryosuke Ueba**, **Yasuo Kato**, **Kenichi Yasui**, NuFlare Technology, Inc. (Japan)

Lunch Break 12:10 PM - 1:10 PM

# CONFERENCE 12495

## SESSION 2: COMPUTATIONAL PATTERNING I AND HIGH NA EUV

27 February 2023 • 3:40 PM - 5:20 PM | Convention Center, Room 210A

Session Chairs: Seongtae Jeong, SAMSUNG Electronics Co., Ltd. (United States), Shigeki Nojima, KIOXIA Corp. (Japan)

12495-6 • 3:40 PM - 4:00 PM

### Improving OPC modeling accuracy with rigorous and compact modeling deformation effects in photoresists

Author(s): Folarin Latinwo, Synopsys, Inc. (United States); Bernd Kuechler, Synopsys GmbH (Germany); Rob DeLancey, Hyesook Hong, Delian Yang, Kevin Lucas, Synopsys, Inc. (United States)

12495-8 • 4:00 PM - 4:20 PM

### Computational evaluation of critical logical metal layers of pitch 20-24nm and the aberration sensitivity in high NA EUV single patterning

Author(s): Weimin Gao, ASML Leuven (Belgium)

12495-9 • 4:20 PM - 4:40 PM

### Resolution enhancement techniques @0.55 NA EUV applied for 6th generation of 10nm DRAM

Author(s): Ana-Maria Armeanu, Siemens EDA (France); Evgeny Malankin, Siemens EDA (Armenia); Neal Lafferty, Vlad Liubich, Germain Fenger, Siemens EDA (United States); Chih-I Wei, Siemens EDA (Belgium); Monica Sears, Siemens EDA (United States); Jae-Uk Lee, Werner Gillijns, Darko Trivkovic, Ryan Ryoung-Han Kim, Jeonghoon Lee, imec (Belgium)

12495-10 • 4:40 PM - 5:00 PM

### Evaluation of field stitching optimization for robust manufacturing with high-NA EUVL

Author(s): Zachary A. Levinson, Thuc Dam, Synopsys, Inc. (United States); C.Jay Lee, Synopsys Taiwan Co., Ltd. (Taiwan); Wolfgang Hoppe, Ulrich Klostermann, Synopsys GmbH (Germany)

12495-68 • 5:00 PM - 5:20 PM

### Probability model of bridging defects for random logic via in 3nm double patterning technology at 0.33 NA

Author(s): Xiaojing Su, Institute of Microelectronics (China); Jingjing Li, Guangdong Greater Bay Area Institute of Integrated Circuit and System (China); Taian Fan, Jiashuo Wang, Lisong Dong, Yajuan Su, Yayi Wei, Institute of Microelectronics (China)

## TUESDAY 28 FEBRUARY

### TUESDAY PLENARY SESSION

28 February 2023 • 8:00 AM - 9:50 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Kafai Lai, The Univ. of Hong Kong (United States), Qinghuang Lin, Lam Research Corp. (United States)

8:00 AM - 8:10 AM

### Introduction and Announcements

8:10 AM - 8:30 AM

### 50th anniversary of Micralign: A retrospective

12495-500 • 8:30 AM - 9:10 AM

### Accelerated computing for silicon leadership *(Plenary Presentation)*

Vivek K. Singh, NVIDIA Corp. (United States)

12497-501 • 9:10 AM - 9:50 AM

### Pushing the limits of nano-imprint lithography for immersive displays *(Plenary Presentation)*

Bernard C. Kress, Google (United States)

Coffee Break 9:50 AM - 10:20 AM

### SESSION 3: INVITED PRESENTATIONS I

28 February 2023 • 10:20 AM - 12:00 PM | Convention Center, Room 210A

Session Chairs: Ryan Ryoung-Han . Kim, imec (Belgium), Neal V. Lafferty, Siemens EDA (United States)

12495-11 • 10:20 AM - 11:00 AM

### Direct print EUV patterning of tight pitch metal layers for Intel 18A process technology node *(Invited Paper)*

Author(s): Raguraman Venkatesan, Pulkit Saksena, Intel Corp. (United States)

12495-13 • 11:00 AM - 11:30 AM

### Design and fabrication challenges for Waveguide combiners for augmented reality *(Invited Paper)*

Author(s): Richard A. Farrell, Meta (United States)

12495-19 • 11:30 AM - 12:00 PM

### A CD uniformity study comparing MRC-constrained all-angle to Manhattan OPC corrections on EUV *(Invited Paper)*

Author(s): Ryan Pearman, Raguraman Venkatesan, Arvind Sundaramurthy, Patrick Straney, Zach Rice, Rusty Conner, Harsha Grunes, Intel Corp. (United States)

Lunch Break 12:00 PM - 1:40 PM

## SESSION 4: KEYNOTE SESSION

28 February 2023 • 1:40 PM - 3:10 PM | Convention Center, Room 210A

Session Chairs: Vivek K. Singh, NVIDIA Corp. (United States), Lars W. Liebmann, TEL Technology Ctr., America, LLC (United States)

12495-14 • 1:40 PM - 2:10 PM

### Extending design technology co-optimization from technology launch to HVM *(Keynote Presentation)*

Author(s): Le Hong, Fan Jiang, Yuansheng Ma, Srividya Jayaram, Joe Kwan, Siemens EDA (United States); Doohwan Kwak, Siemens EDA (Republic of Korea); Sankaranarayanan Paninjath Ayyappan, Siemens EDA (India)

12495-15 • 2:10 PM - 2:40 PM

### 3D NAND Flash and its application *(Keynote Presentation)*

Author(s): Yan Li, Western Digital Corp. (United States)

12495-16 • 2:40 PM - 3:10 PM

### Curvilinear mask: Bridging ILT to HVM *(Invited Paper)*

Author(s): Danping Peng, TSMC North America (United States); Shang-Jung Wu, Jue-Chin Yu, Chia-Hua Chang, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); Kenneth Ho, TSMC North America (United States)

## SESSION 5: INVITED PRESENTATIONS II

28 February 2023 • 3:10 PM - 5:40 PM | Convention Center, Room 210A

Session Chairs: Harsha Grunes, Intel Corp. (United States), Daniel J. Dechene, IBM Thomas J. Watson Research Ctr. (United States)

12495-17 • 3:10 PM - 3:40 PM

### Verification methods for curvilinear and real-curve geometries *(Invited Paper)*

Author(s): Kokoro Kato, Nihon Synopsys G.K. (Japan)

12495-18 • 3:40 PM - 4:10 PM

### EUV Full-chip curvilinear mask options for logic via and metal patterning *(Invited Paper)*

Author(s): Neal Lafferty, Sagar Saxena, Siemens EDA (United States); Keisuke Mizuuchi, Siemens EDA (Japan); Yuansheng Ma, Xima Zhang, Alex Tritchkov, Pat Lacour, Le Hong, John Sturtevant, Siemens EDA (United States)

12495-20 • 4:10 PM - 4:40 PM

### Next-generation logic design architecture for vertical-transport nanosheets *(Invited Paper)*

Author(s): Biswanath Senapati, IBM Corp. (United States); Jeongho Do, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Albert Young, Daniel J. Dechene, IBM Corp. (United States); Seunghyun Song, Yonghee Park, JeongSoon Kong, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Nick A. Lanzillo, Chen Zhang, Susan S. Fan, IBM Corp. (United States); Sanghoon Baek, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Sagarika Mukesh, IBM Corp. (United States); Hemanth Jagannathan, IBM Thomas J. Watson Research Ctr. (United States); Brent Anderson, Teresa Wu, Dechao Guo, IBM Corp. (United States); Kang-ill Seo, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Huiming Bu, IBM Corp. (United States)

12495-21 • 4:40 PM - 5:10 PM

### Design-technology co-optimization overview of CFET architecture *(Invited Paper)*

Author(s): Gioele Mirabelli, Pieter Schuddinck, Hsiao-Hsuan Liu, Sheng Yang, Odysseas Zografos, Shaife Muhammad Salahuddin, Pieter Weckx, Gaspard Hiblot, Geert Hellings, Julien Ryckaert, imec (Belgium)

## TUESDAY EVENING PLENARY

28 February 2023 • 5:30 PM - 6:15 PM | Convention Center, Grand Ballroom 220A

12498-502 • 5:30 PM - 6:00 PM

### Are 2D transition metal dichalcogenides transistors the future silicon replacement or hype?

*(Plenary Presentation)*

Kevin P. O'Brien, Intel Corp. (United States)

6:15 PM - 7:15 PM

### Sustainability and Lithography's Role: A Panel Discussion

MODERATOR:

Dan Hutcheson, TechInsights (United States)

PANELISTS:

John Cahill, ASML-Cymer (United States)

Emily Gallagher, imec (Belgium)

Chris Jones, Edwards Vacuum (United Kingdom)

Mark Merrill, Lam Research (United States)

Ryan Russell, Intel (United States)

Akihisa Sekiguchi, Tokyo Electron LTD. (Japan)

It's become popular to make commitments to new business models and supply chain strategies for conservation and carbon neutrality in the semiconductor ecosystem, including initiatives to reduce greenhouse gases, conserve energy and water, and focus more on renewables and reusables. In addition to these, panelists will address the role lithography and patterning will play and has played in addressing these critical issues. For example: Koomey's law states that Compute-per-Watt improves exponentially over time. Lithography's critical role in making this possible in this is well established through its ability to make circuits more power efficient. This means that there is a long payback to lithography when considering Life-Cycle Sustainability Assessment (LCSA) methods to evaluate the chips they produce. This and more will be discussed.

## WEDNESDAY 1 MARCH

## SESSION 6: COMPUTATIONAL PATTERNING II

1 March 2023 • 8:00 AM - 9:40 AM | Convention Center, Room 210A

Session Chairs: Ya-Chieh Lai, Cadence Design Systems, Inc. (United States), Yuri Granik, Siemens EDA (United States)

12495-22 • 8:00 AM - 8:20 AM

### Refinements of a nanoimprint process simulator

Author(s): Shingo Ishida, Junichi Seki, Yuichiro Oguchi, Naoki Kiyohara, Koshiro Suzuki, Kohei Nagane, Shintaro Narioka, Yoshihiro Shiode, Sentaro Aihara, Toshiya Asano, Canon Inc. (Japan)

12495-23 • 8:20 AM - 8:40 AM

### Enabling scalable AI computational lithography with physics-inspired models

Author(s): Haoyu Yang, Haoxing Ren, NVIDIA Corp. (United States)

12495-25 • 9:00 AM - 9:20 AM

### High accuracy OPC modeling for new EUV low-K1 mask technology options

Author(s): Enas Sakr, Rob DeLancey, Robert Iwanow, Zac Levinson, Ryan Chen, Delian Yang, Kevin Lucas, Synopsys, Inc. (United States)

# CONFERENCE 12495

12495-26 • 9:20 AM - 9:40 AM

## Modeling accuracy and TAT improvements for next generation mask error correction

Author(s): Alex Zepka, Synopsys, Inc. (United States); Jack Chen, Synopsys Taiwan Co., Ltd. (Taiwan); Ryan Chen, Synopsys Taiwan Co., Ltd. (United States); Folarin Latinwo, Synopsys, Inc. (United States)

Coffee Break 9:40 AM - 10:10 AM

### SESSION 7: COMPUTATIONAL LITHOGRAPHY

#### Joint Session with 12495 and 12494

1 March 2023 • 10:10 AM - 11:50 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Yuri Granik, Siemens EDA (United States), Daniel Sarlette, Infineon Technologies Dresden GmbH (Germany)

12494-25 • 10:10 AM - 10:30 AM

## EUV single patterning validation of curvilinear routing

Author(s): Fergo Treska, Dongbo Xu, Yasser Sherazi, Werner Gillijns, imec (Belgium)

12494-26 • 10:30 AM - 10:50 AM

## Stochastic aware EUV OPC on random logic via

Author(s): Werner Gillijns, Jae-Uk Lee, imec (Belgium)

12494-27 • 10:50 AM - 11:10 AM

## Binary solution for optimization of pixelated EUV source using constrained mathematical programming

Author(s): Michael Yeung, Fastlitho Inc. (United States); Eytan Barouch, Boston Univ. (United States)

12495-27 • 11:10 AM - 11:30 AM

## Computational lithography solutions to support EUV High-NA patterning

Author(s): Rongkuo Zhao, Fan Zhou, Jialei Tang, Jeff Lu, Dezheng Sun, Ming-Chun Tien, Stephen Hsu, Rachit Gupta, Youping Zhang, ASML (United States)

12495-28 • 11:30 AM - 11:50 AM

## Process optimization using 0.33NA EUV single mask for next-generation DRAM manufacturing

Author(s): Jeonghoon Lee, Sandip Halder, imec (Belgium)

Lunch Break 11:50 AM - 1:20 PM

### SESSION 8: DESIGN FOR MANUFACTURING AND YIELD

1 March 2023 • 1:20 PM - 3:00 PM | Convention Center, Room 210A

Session Chairs: Srividya Jayaram, Siemens EDA (United States), Piyush Pathak, Cadence Design Systems, Inc. (United States)

12495-29 • 1:20 PM - 1:40 PM

## IC layouts patterns topological profiling using directional geometrical kernels

Author(s): Ahmed Hamed, Ain Shams Univ. (Egypt), Siemens EDA (Egypt); Sara Khalaf, Omar El-Sewefy, Hazem Hegazy, Siemens EDA (Egypt); Mohamed Dessouky, Ain Shams Univ. (Egypt); Ashraf Salem, Ain Shams Univ. (Egypt), Siemens EDA (Egypt)

12495-30 • 1:40 PM - 2:00 PM

## Methodology development to benchmark power delivery designs in advanced technology nodes

Author(s): Nick A. Lanzillo, Albert Chu, Reinaldo Vega, Nick Perez, Larry Clevenger, Daniel J. Dechene, IBM Corp. (United States)

12495-31 • 2:00 PM - 2:20 PM

## Design for manufacturability (DFM) in-design fixing for improving manufacturability aware scoring (MAS)

Author(s): Ariel De Jesus Reyes Ruiz, Lynn Wang, Fadi Batarseh, Uwe Paul Schroeder, GlobalFoundries Dresden Module Two, GmbH & Co. KG (Germany)

12495-32 • 2:20 PM - 2:40 PM

## Electrical analysis of a stochastically simulated 2 nm node electrical test structure

Author(s): Lawrence S. Melvin, Synopsys, Inc. (United States); Joachim Siebert, Synopsys GmbH (Germany); Phil Stopford, Synopsys, Inc. (United States); Sergey Zavadskiy, Synopsys Armenia CJSC (Armenia); Renato Hentschke, Krishna Ramkumar, Synopsys, Inc. (United States); Wolfgang Demmerle, Synopsys GmbH (Germany); Sylvain Berthiaume, Synopsys Canada (Canada); Yudhishtir Kandel, Synopsys, Inc. (United States); Wolfgang Hoppe, Ulrich Klostermann, Synopsys GmbH (Germany); Zachary A. Levinson, Synopsys, Inc. (United States); Hans-Jürgen Stock, Ulrich Welling, Synopsys GmbH (Germany)

12495-33 • 2:40 PM - 3:00 PM

## Scalable hierarchy extraction of repeating structures to enhance full chip mask synthesis

Author(s): Jun Zhu, Lin Wang, Bradley J. Falch, Synopsys, Inc. (United States); Mingchao Ji, Synopsys, Inc. (China); Petrisor Panaite, Synopsys, Inc. (United States); Ming Su, Synopsys Canada (Canada); Yongdong Wang, Synopsys, Inc. (United States)

Coffee Break 3:00 PM - 3:30 PM

### SESSION 9: DTCO AND STCO

1 March 2023 • 3:30 PM - 5:10 PM | Convention Center, Room 210A

Session Chairs: Chi-Min Yuan, NXP Semiconductors (United States), Lawrence S. Melvin, Synopsys, Inc. (United States)

12495-34 • 3:30 PM - 3:50 PM

## System-level evaluation of 3D power delivery network at 2nm node

Author(s): Giuliano Sisto, Rongmei Chen, Dragomir Milojevic, Odysseas Zografos, Pieter Weckx, Geert Van der Plas, Julien Ryckaert, imec (Belgium)

12495-35 • 3:50 PM - 4:10 PM

## DTCO of sequential and monolithic CFET SRAM

Author(s): Hsiao-Hsuan Liu, imec (Belgium), KU Leuven (Belgium); Shairfe Muhammad . Salahuddin, Boon Teik Chan, Pieter Schuddinck, Yang Xiang, Pieter Weckx, Geert Hellings, imec (Belgium); Francky Catthoor, imec (Belgium), KU Leuven (Belgium)

12495-36 • 4:10 PM - 4:30 PM

## A Synopsys TCAD-based workflow to support technology evaluation at 3nm and beyond

Author(s): Robert Robison, Janet Wilson, Reinaldo Vega, Terence Hook, IBM Corp. (United States); Frank Geelhaar, Jonathan Cobb, Tim Tsuei, Synopsys, Inc. (United States)

12495-37 • 4:30 PM - 4:50 PM

## Minimizing die fracture in three-dimensional IC advanced packaging wafer thinning process by inserting polyimide patterns

Author(s): Jaime Bravo, The MOSIS Service, Information Sciences Institute, The Univ. of Southern California (United States); Philippe Morey-Chaisemartin, XYALIS (France); Lifu Chang, The MOSIS Service (United States); Eric Beisser, Frederic Brault, XYALIS (France); Joshua Zusman, The MOSIS Service (United States)



12495-38 • 4:50 PM - 5:10 PM

**An improved transistor sizing method for standard-cell optimization**

Author(s): Pin-Yuan Su, Jia-Syun Cai, Chien-Lin Lee, Kuen-Yu Tsai, National Taiwan Univ. (Taiwan)

**POSTER SESSION**

1 March 2023 • 5:30 PM - 7:00 PM | Convention Center, Hall 2

Conference attendees are invited to attend the Poster Session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the Poster Session.

**Poster Setup: Wednesday 10:00 AM - 4:30 PM**

Poster authors, view poster presentation guidelines and set-up instructions at <http://spie.org/ALPosterGuidelines>.

12495-59

**Cost analysis of device options and scaling boosters below the A14 technology node**

Author(s): Gioele Mirabelli, Anne Vandooren, imec (Belgium); Cesar Roda Neve, Soitec (France); Victor Vega Gonzalez, Hans Mertens, Anita Farokhnejad, Pieter Schuddinck, Gayle Murdoch, Shairfe Muhammad Salahuddin, Odysseas Zografos, Lars Ragnarsson, Pieter Weckx, Zsolt Tokei, Geert Hellings, Julien Ryckaert, imec (Belgium)

12495-60

**Improving FEM wafer review efficiency by introducing different pattern grouping modes**

Author(s): Yuan Gan, Changlian Yan, Rongjia Zhang, Ming Ding, Chunying Han, Junhai Jiang, Zongchang Yu, Dongfang Jingyuan Electron Ltd. (China)

12495-62

**Lithography hotspot detection based on residual network**

Author(s): Mu Lin, Fanwenqing Zeng, Yijiang Shen, Guangdong Univ. of Technology (China); Yayi Wei, Institute of Microelectronics, Chinese Academy of Sciences (China)

12495-63

**Constructing layout hierarchy for high-efficiency OPC flow**

Author(s): Tsung-Wei Lin, Winbond Electronics Corp. (Taiwan); Hung-Yu Lin, Cadence Design Systems, Inc. (Taiwan); Mang-Shiun Chiang, Winbond Electronics Corp. (Taiwan); Yeh Shi-Cheng, Cadence Design Systems (Taiwan); Jason Sweis, Philippe Hurat, Cadence Design Systems, Inc. (United States); Tung Yu Wu, Chun-Sheng Wu, Chao-Yi Huang, Winbond Electronics Corp. (Taiwan); Ya-Chieh Lai, Cadence Design Systems, Inc. (United States)

12495-64

**CPU time prediction using machine learning for post-tapeout flow runs**

Author(s): Maram Salah, Ahmed Hamed, Siemens EDA (Egypt); Stephen Kim, Siemens EDA (United States); Pascal Gilgenkrantz, Siemens EDA (France); Wooil Han, Roberto Ramsis, Ken Jantzen, Siemens EDA (United States)

12495-65

**GPU accelerated matrix cover algorithm for multiple patterning layout decomposition**

Author(s): Guojin Chen, The Chinese Univ. of Hong Kong (Hong Kong, China); Haoyu Yang, NVIDIA Corp. (United States); Bei Yu, The Chinese Univ. of Hong Kong (Hong Kong, China)

12495-67

**Co-optimization of optical and resist models in the OPC modeling process using in-house genetic algorithm**

Author(s): Yinuo Pan, Yingfang Wang, Norman Chen, Keeho Kim, Eric Parent, HFC Semiconductor Corp. (United States)

12495-69

**Hybrid deep learning OPC framework with generative adversarial network**

Author(s): Qingchen Cao, Institute of Microelectronics (China), Beijing Superstring Academy of Memory Technology (China); Peng Xu, Juan Wei, Ruihua Liu, Fu Li, Jingjing Fan, Chunlong Yu, Beijing Superstring Academy of Memory Technology (China); Zhifeng Li, Siemens Digital Industries software (Siemens EDA) (China); Jiangliu Shi, Beijing Superstring Academy of Memory Technology (China); Yayi Wei, Institute of Microelectronics (China)

12495-71

**Fast and accurate machine learning assisted mask optimization**

Author(s): Moojoon Shin, Sooyong Lee, Joonsung Kim, Seung-Hune Yang, Heedon Hwang, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12495-72

**Design rule manual and DRC code qualification flows empowered by high coverage synthetic layouts generation**

Author(s): Aliaa Kabeel, Siemens EDA (Egypt); Sutae Kim, Young Gook Park, Donggyun Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Joe Kwan, Siemens EDA (United States); Sarah Rizk, Kareem Madkour, Marwa Shafee, Siemens EDA (Egypt); Jinhee Kim, Siemens EDA (Republic of Korea)

12495-73

**Productivity enhancement study: yield, cost, and turn-around-time modeling for EUV and high NA EUV**

Author(s): Yi-Pei Tsai, Yi-Han Chang, Jane Wang, Darko Trivkovic, Kurt Ronse, Ryan Ryoung-Han Kim, imec (Belgium)

12495-75

**Design-aware virtual metrology and process recipe recommendation**

Author(s): Nathan G. Greenelitch, J. Andres Torres, Melody Tao, Steven M. Lubin, Srividya Jayaram, Ivan Kissiov, Siemens EDA (United States); Martin Niehoff, Siemens EDA (Germany); Richard Gardner, Siemens EDA (United States); Marcus Wolf, Paul Jungmann, GlobalFoundries (Germany); Todd C. Bailey, GlobalFoundries (United States)

12495-76

**A geometric model for active contours in inverse lithography**

Author(s): Yijiang Shen, Guangdong Univ. of Technology (China); Yayi Wei, Institute of Microelectronics, Chinese Academy of Sciences (China)

12495-58

**Physical design level PPA evaluation of buried power rail at 2nm node**

Author(s): Giuliano Sisto, Odysseas Zografos, Pieter Weckx, Geert Hellings, Julien Ryckaert, imec (Belgium)

12495-57

**Lithography hotspot correction on post-OPC layout using generative adversarial networks**

Author(s): Weilun Ciou, Tony Hu, Fz Cheng, Yi-Yien Tsai, Chung-Te Hsuan, Elvis Yang, Ta-Hung Yang, Kuang-Chao Chen, Macronix International Co., Ltd. (Taiwan)

# CONFERENCE 12495

12495-70

## Fast and accurate prediction of process variation band with custom kernels extracted from convolutional networks

Author(s): Gangmin Cho, Taeyoung Kim, Yoonjae Chung, Youngsoo Shin, KAIST (Republic of Korea)

12495-7

## Layout pattern risk assessment in advanced technology node: methodology for pattern clustering and classification

Author(s): Jae-Beom Jeon, Su-Min Kim, Se-Il Oh, Dai-Hyun JUNG, Hyuck-Joon Kwon, Chang-Sik Yoo, Joo-Young Lee, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12495-91

## Exploring quantum annealing strategies for reticle optimizations

Author(s): Po-Xun Fang, Yan-Syun Chen, Jih-Sheng Wu, Peichen Yu, National Yang Ming Chiao Tung Univ. (Taiwan)

12495-93

## Lithographic Contour Simulator Enabled by Fully Convolutional Network Resist Models

Author(s): Guo Wilson, National Yang Ming Chiao Tung Univ. (Taiwan)

12495-94

## A New Class of DTCO Solutions for High Volume FinFET Manufacturing

Author(s): Devender Devender, SAMSUNG Austin Semiconductor LLC (United States)

## THURSDAY 2 MARCH

### SESSION 10: INVITED PRESENTATIONS III: DESIGN FOR TEST AND METROLOGY

2 March 2023 • 8:00 AM - 10:30 AM | Convention Center, Room 210A

Session Chairs: Jason P. Cain, Advanced Micro Devices, Inc. (United States), David M. Fried, Lam Research Corp. (United States)

12495-39 • 8:00 AM - 8:30 AM

## Novel approach to solving systematic pattern yield limiters with volume scan diagnosis *(Invited Paper)*

Author(s): Matthew Knowles, Jayant D'Souza, Manish Sharma, Siemens EDA (United States); Hans Eisenmann, PDF Solutions GmbH (Germany); Thomas Zanon, PDF Solutions, Inc. (United States)

12495-40 • 8:30 AM - 9:00 AM

## Scaling physically aware logic diagnosis to complex high volume designs *(Invited Paper)*

Author(s): Brian Archer, Cadence Design Systems, Inc. (United States)

12495-41 • 9:00 AM - 9:30 AM

## A holistic approach to zero defect products when wafer fab does not output zero defects *(Invited Paper)*

Author(s): Stephen Traynor, Jesse Yanez, NXP Semiconductors (United States)

12495-42 • 9:30 AM - 10:00 AM

## Voltage contrast evaluation of dual-damascene 28nm-pitch EUV patterning and via overlap *(Invited Paper)*

Author(s): Etienne De Poortere, ASML (Belgium); Victor M. Blanco Carballo, Imec (Belgium); Philippe Leray, Dorin Cerbu, imec (Belgium); Jeroen van de Kerkhove, Imec (Belgium); Nicola Kissoon, ASML (Belgium)

12495-43 • 10:00 AM - 10:30 AM

## Design for inspection methodology for fast in-line eBeam defect detection *(Invited Paper)*

Author(s): Andrzej J. Strojwas, PDF Solutions Inc. (United States)

Coffee Break 10:30 AM - 11:00 AM

### SESSION 11: MACHINE LEARNING, DEEP LEARNING, AND AI I

2 March 2023 • 11:00 AM - 12:40 PM | Convention Center, Room 210A

Session Chairs: Yayi Wei, Institute of Microelectronics, Chinese Academy of Sciences (China), Neal V. Lafferty, Siemens EDA (United States)

12495-44 • 11:00 AM - 11:20 AM

## Unsupervised ML classification driven process model coverage check

Author(s): SeungWon Song, Seokyeon Jeong, Sangwoo Park, Jungkee Choi, WoonHyuk Choi, No-Young Chung, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Seongtae Jeong, SAMSUNG Electronics Co. (Republic of Korea); Fan Jiang, Liang Cao, Le Hong, Siemens EDA (United States); Junhyoung Park, Doohwan Kwak, Jongwon Lee, Harin Kim, Jiyoung Lee, Siemens EDA (Republic of Korea)

12495-45 • 11:20 AM - 11:40 AM

## Machine learning assisted acceleration in chip manufacturability analysis and scoring

Author(s): Uwe Paul Schroeder, GlobalFoundries (United States); Yi Lee, Boston Univ. (United States)

12495-46 • 11:40 AM - 12:00 PM

## Machine learning applications on 3nm node technology and designs for improving block-level PPA

Author(s): Yongchan Ban, Hosoon Shin, Jaebok Kil, Synopsys, Inc. (United States); Heecheol Hwang, Kyoungin Cho, Sangmin Sim, Synopsys Korea Inc. (Republic of Korea); Bonghyun Lee, Insub Shin, Heeyeon Kim, Chaeyoung Jang, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12495-47 • 12:00 PM - 12:20 PM

## Automatic generation of representative and diversified pattern samples from a full chip layout

Author(s): Jun Zhu, Bradley J. Falch, Petrisor Panaite, Ming Su, Synopsys, Inc. (United States)

12495-48 • 12:20 PM - 12:40 PM

## Quantifying limits for high-NA EUV double patterning and DRAM with machine learning based edge placement error (EPE) modelling

Author(s): Apoorva Oak, Ryan Ryoung-Han Kim, Soobin Hwang, imec (Belgium)

Lunch Break 12:40 PM - 2:10 PM

## SESSION 12: MACHINE LEARNING, DEEP LEARNING, AND AI II

2 March 2023 • 2:10 PM - 3:50 PM | Convention Center, Room 210A

Session Chairs: Luigi Capodici, Motivo, Inc. (United States), Chun-Ming Albert Wang, Western Digital Corp. (United States)

12495-49 • 2:10 PM - 2:30 PM

### Frequency-informed deep-learning denoising method supporting sub-nm metrology for high NA EUV lithography

Author(s): Minjung Kim, NVIDIA Corp. (United States); Dorin Cerbu, imec (Belgium); Selim Dogru, Kumara Sastry, NVIDIA Corp. (United States); Gian Lorusso, Mohamed Zidan, Mohamed Saib, Joren Severi, Danilo De Simone, imec (Belgium); Vivek K. Singh, NVIDIA Corp. (United States)

12495-50 • 2:30 PM - 2:50 PM

### Machine learning based inverse lithography technology for an advanced DRAM contact layer

Author(s): Moongyu Jeong, Hyunchul Kim, Synopsys Korea Inc. (Republic of Korea); Kyle Braam, Synopsys, Inc. (United States); Munhoe Do, Synopsys Korea Inc. (Republic of Korea); Kangjin Kim, Jongcheon Park, Chunsoo Kang, Chanha Park, SK Hynix, Inc. (Republic of Korea); Thomas Cecil, Synopsys, Inc. (United States)

12495-56 • 2:50 PM - 3:10 PM

### Optical proximity correction with the conditional Wasserstein GAN

Author(s): Pengpeng Yuan, Univ. of Chinese Academy of Sciences (China); Peng Xu, Yai Wei, Institute of Microelectronics (China)

12495-52 • 3:10 PM - 3:30 PM

### Design for manufacturability (DFM) physical verification using machine learning

Author(s): Lynn T. N. Wang, Klaus-Peter Johnsen, Ivan Tanev, Fadi Batarseh, Pouya Rezaeifakhr, Uwe Paul Schroeder, GlobalFoundries (United States)

12495-53 • 3:30 PM - 3:50 PM

### Etch model calibration and usage in OPC flow for curvilinear layouts

Author(s): Elodie Sungauer, STMicroelectronics S.A. (France); Laurent Depre, Raphael La Greca, ASML France S.a.r.l. (France)

Coffee Break 3:50 PM - 4:20 PM

## SESSION 13: MACHINE LEARNING, DEEP LEARNING, AND AI III

2 March 2023 • 4:20 PM - 5:20 PM | Convention Center, Room 210A

Session Chairs: Chun-Ming Albert Wang, Western Digital Corp. (United States), Luigi Capodici, Motivo, Inc. (United States)

12495-54 • 4:20 PM - 4:40 PM

### Pushing the capabilities of deep learning for lithography through training data optimization

Author(s): Abdalaziz Awad, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Zelalem Belete, Philipp Brendel, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); Sayantan Das, Sandip Halder, imec (Belgium)

12495-55 • 4:40 PM - 5:00 PM

### Evaluation of CNN for fast EUV lithography simulation using iN3 logic mask patterns

Author(s): Hiroyoshi Tanabe, Akira Jinguji, Atsushi Takahashi, Tokyo Institute of Technology (Japan)

# CONFERENCE 12496

## Metrology, Inspection, and Process Control XXXVII

27 February - 2 March 2023 | Convention Center, Grand Ballroom 220B

Conference Chair: **John C. Robinson**, KLA Corp. (United States)

Conference Co-Chair: **Matthew J. Sendelbach**, TEL Technology Ctr., America, LLC (United States)

Program Committee: **Ofer Adan**, Applied Materials Israel, Ltd. (Israel); **John A. Allgair**, BRIDG (United States); **Masafumi Asano**, Tokyo Electron Ltd. (Japan); **Bryan M. Barnes**, National Institute of Standards and Technology (United States); **Cornel Bozdog**, Nearfield Instruments B.V. (United States); **Benjamin D. Bunday**, AMAG Consulting, LLC (United States); **Xiaomeng Chen**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Hugo Cramer**, ASML Netherlands B.V. (Netherlands); **Timothy F. Crimmins**, Intel Corp. (United States); **Shunsuke Koshihara**, Hitachi High-Tech Corp. (Japan); **Yi-Sha Ku**, Industrial Technology Research Institute (Taiwan); **Byoung-Ho Lee**, Hitachi High-Technologies Corp. (Japan); **Myungjun Lee**, SAMSUNG Electronics Co., Ltd. (Republic of Korea); **Philippe Leray**, imec (Belgium); **Narender Rana**, KLA Corp. (United States); **Christopher J. Raymond**, Onto Innovation Inc. (United States); **Daniel Schmidt**, IBM Thomas J. Watson Research Ctr. (United States); **Nivea G. Schuch**, ASELT Nanographics (France); **Alexander Starikov**, I&I Consulting (United States); **Alok Vaid**, GlobalFoundries (United States)



### MONDAY 27 FEBRUARY

#### WELCOME AND MONDAY PLENARY SESSION

27 February 2023 • 8:00 AM - 10:00 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Kafai Lai, The Univ. of Hong Kong (United States), Qinghuang Lin, Lam Research Corp. (United States)

8:00 AM: **Symposium Welcome and Opening Remarks**

**Kafai Lai**, University of Hong Kong (United States) and Qinghuang Lin, LAM Research Corp. (United States)

8:05 AM: **Introduction of New SPIE Fellows**

8:15 AM: **2023 SPIE Rudolf and Hilda Kingslake Award in Optical Design**

Presented in recognition of significant achievement in the field of optical design, including the theoretical or experimental aspects of optical engineering.

8:25 AM: **2023 SPIE Frits Zernike Award for Microlithography**

Presented in recognition of outstanding accomplishments in micro-lithographic technology, especially those furthering the development of semiconductor lithographic imaging solutions.

8:35 AM: **Presentation of the Nick Cobb Memorial Scholarship**

The Nick Cobb Memorial Scholarship is awarded to an outstanding graduate student studying advanced lithography or a related field. The scholarship is jointly funded by Siemens EDA and SPIE.

12494-505 • 8:40 AM - 9:20 AM

**Driving Moore's Law into the next decade** (Plenary Presentation)

**Martin van den Brink**, ASML Netherlands B.V. (Netherlands)

12496-504 • 9:20 AM - 10:00 AM

**Update on CHIPS Act implementation** (Plenary Presentation)

**Laurie E. Locascio**, National Institute of Standards and Technology (United States)

**Coffee Break 10:00 AM - 10:30 AM**

#### SESSION 1: KEYNOTE SESSION

27 February 2023 • 10:30 AM - 12:10 PM | Convention Center, Grand Ballroom 220B

Session Chairs: John C. Robinson, KLA Corp. (United States), Matthew J. Sendelbach, TEL Technology Ctr., America, LLC (United States)

10:30 AM - 10:50 AM:

**Opening Remarks and Awards Presentation: The Diana Nyssonen Memorial Best Paper Award Vladimir Ukraintsev Award for Collaboration in Metrology**

12496-1 • 10:50 AM - 11:30 AM

**Challenges for overlay control in the era of high-NA EUV** (Keynote Presentation)

Author(s): Martin Weiss, Intel Corp. (United States)

12496-2 • 11:30 AM - 12:10 PM

**From micro to nano, and beyond: Measuring innovations** (Keynote Presentation)

Author(s): Zhigang Wang, Byoung-Ho Lee, Hitachi High-Tech Corp. (Japan)

**Lunch Break 12:10 PM - 1:10 PM**

#### SESSION 2: STOCHASTICS

27 February 2023 • 1:10 PM - 2:50 PM | Convention Center, Grand Ballroom 220B

Session Chair: Philippe Leray, imec (Belgium)

12496-3 • 1:10 PM - 1:30 PM

**Photoresist shrinkage observation by a metrological tilting-AFM**

Author(s): Ryosuke Kizu, Ichiko Misumi, Akiko Hirai, Satoshi Gonda, National Institute of Advanced Industrial Science and Technology (Japan)

12496-199 • 1:30 PM - 1:50 PM

**A total shift show: Submilliradian tilt goniometry in scanning electron microscopy**

Author(s): Andrew C. Madison, John S. Villarrubia, Daron Westly, Ronald G. Dixon, Craig Copeland, J. Alexander Little, Samuel Stavis, National Institute of Standards and Technology (United States); John Gerling, Alan D. Brodie, Lawrence P. Muray, KLA Corp. (United States)

12496-5 • 1:50 PM - 2:10 PM

## Unbiased roughness measurements for high-NA EUV characterization

Author(s): Shahar Arad, Tal Frank, Rafi Bistrizter, Rotem M. Yosef, Bobin Mathew, Applied Materials Israel, Ltd. (Israel); Hyo Seon Suh, Sandip Halder, imec (Belgium)

12496-6 • 2:10 PM - 2:30 PM

## SEMI-PointRend: Improved semiconductor wafer defect classification and segmentation as rendering

Author(s): MinJin Hwang, Univ. of Ulsan (Republic of Korea); Bappaditya Dey, imec (Belgium); Enrique Dehaerne, KU Leuven (Belgium); Sandip Halder, imec (Belgium); Young-Han Shin, Univ. of Ulsan (Republic of Korea)

12496-7 • 2:30 PM - 2:50 PM

## Overlay and edge placement error metrology in the era of stochastics

Author(s): Chris A. Mack, Fractilia, LLC (United States)

Coffee Break 2:50 PM - 3:20 PM

### SESSION 3: OPTICAL METROLOGY

27 February 2023 • 3:20 PM - 6:00 PM | Convention Center, Grand Ballroom 220B

Session Chairs: Daniel Schmidt, IBM Thomas J. Watson Research Ctr. (United States), Bryan M. Barnes, National Institute of Standards and Technology (United States)

12496-197 • 3:20 PM - 3:40 PM

## High-fidelity actinic ptychographic imaging of EUV photomasks enabled by illumination engineering

Author(s): Bin Wang, Nathan J. Brooks, Iona Binnie, Michael Tanksalvala, Yuka Esashi, Nicholas W. Jenkins, Margaret M. Murnane, Henry C. Kapteyn, Univ. of Colorado Boulder (United States)

12496-9 • 3:40 PM - 4:00 PM

## Full wafer OCD metrology: Increasing the sampling rate without the cost of ownership penalty

Author(s): Daniel R. Douth, Ping-ju Chen, Bhargava Ravoori, Tuyen K. Tran, Intel Corp. (United States); Eitan Rothstein, Nir Kampel, Lilach Tamam, Effi Aboody, Avron Ger, Nova Ltd. (Israel); Hari Vedala, Nova Measuring Instruments Inc. (United States)

12496-10 • 4:00 PM - 4:20 PM

## Sensitivity analysis of optical scatterometry technique for high aspect ratio trench measurement

Author(s): Jean-Hervé Tortai, Lab. des Technologies de la Microélectronique, CNRS (France); Justine Grasland, Univ. Grenoble Alpes, CNRS (France); MINATEC, CEA-LETI (France), STMicroelectronics S.A. (France); Delphine Le Cunff, STMicroelectronics S.A. (France)

12496-11 • 4:20 PM - 4:40 PM

## TSV strain evolution mapping using in-line Raman spectroscopy

Author(s): Stefan Schoeche, Daniel Schmidt, IBM Thomas J. Watson Research Ctr. (United States); Marjorie Cheng, Aron Cepler, Nova Measuring Instruments Inc. (United States); Abraham Arceo de la Pena, Jennifer S. Oakley, IBM Thomas J. Watson Research Ctr. (United States)

12496-12 • 4:40 PM - 5:00 PM

## Artificial-neural-network-assisted DUV scatterometry for OCD on HAR sub-micron structures

Author(s): Zih-Ying Fu, Wei-Hsin Chein, Fu-Sheng Yang, Liang-Chia Chen, National Taiwan Univ. (Taiwan)

12496-13 • 5:00 PM - 5:20 PM

## Characterization of asymmetries in 3D NAND memory devices

Author(s): Jie Li, Onto Innovation Inc. (United States); Shashank Srivastava, Joyce Li, Onto Innovation Inc. (Singapore); Zhuo Chen, Onto Innovation Inc. (United States); Petar Žuvella, Boyang Chor, Jinyu Deng, Haodong Qiu, YaChing Chang, Onto Innovation Inc. (Singapore); Sadao Takabayashi, Micron Technology, Inc. (United States); Xadric Yiew, Bo Hui Ng, Micron Technology, Inc. (Singapore); Rohit Kothari, Dan Engelhard, Micron Technology, Inc. (United States); Han Yang Tan, Micron Technology, Inc. (Singapore)

12496-182 • 5:20 PM - 5:40 PM

## Wafer edge metrology and inspection by curved-edge interferometry

Author(s): Kuan Lu, Heebum Chun, Zhikun Wang, Chabum Lee, Texas A&M Univ. (United States)

12496-120 • 5:40 PM - 6:00 PM

## Using active asymmetry control and blind source separation to improve the accuracy of the after develop overlay measurement

Author(s): Doogyu Lee, Jungmin Lee, Eunji Lee, Inbeom Yim, Jeongjin Lee, Seung Yoon Lee, Chan Hwang, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Marc Noot, Arno J. van Leest, Yao Gao, Seung-Bin Yang, Mi-Yeon Baek, Jong-Hyuk Yim, Thomas Kim, Ho-Hyuk Lee, Kemal Dahha, Stefan N. Smith-Meerman, Koen van Witteveen, Elliott McNamara, Matthew McLaren, Simon G. J. Mathijssen, ASML Netherlands B.V. (Netherlands)

## TUESDAY 28 FEBRUARY

### TUESDAY PLENARY SESSION

28 February 2023 • 8:00 AM - 9:50 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Kafai Lai, The Univ. of Hong Kong (United States), Qinghuang Lin, Lam Research Corp. (United States)

8:00 AM - 8:10 AM

### Introduction and Announcements

8:10 AM - 8:30 AM

### 50th anniversary of Micralign: A retrospective

12495-500 • 8:30 AM - 9:10 AM

### Accelerated computing for silicon leadership (*Plenary Presentation*)

Vivek K. Singh, NVIDIA Corp. (United States)

12497-501 • 9:10 AM - 9:50 AM

### Pushing the limits of nano-imprint lithography for immersive displays (*Plenary Presentation*)

Bernard C. Kress, Google (United States)

Coffee Break 9:50 AM - 10:20 AM

# CONFERENCE 12496

## SESSION 4: OVERLAY

28 February 2023 • 10:20 AM - 12:00 PM | Convention Center, Grand Ballroom 220B

Session Chairs: Alexander Starikov, I&I Consulting (United States), Christopher J. Raymond, Onto Innovation Inc. (United States)

12496-15 • 10:20 AM - 10:40 AM

### Alignment and overlay through opaque metal layers

Author(s): Victor M. Blanco Carballo, imec (Belgium); Cyrus Tabery, Boris Menchtchikov, Gautam Gunjala, ASML US, Inc. (United States); Gabriel Zacca, Sergey P. Tarabrin, Maurits van der Schaar, Huaichen Zhang, Remko Dirks, Sanjay Lalbahadoersing, Robin D. Buijs, Theodorus T. M. van Schaijk, Arie den Boef, ASML Netherlands B.V. (Netherlands); Amir-Hossein Tamaddon, Christiane Jehoul, Alain Moussa, imec (Belgium); Ron Synowicki, J.A. Woollam Co., Inc. (United States)

12496-16 • 10:40 AM - 11:00 AM

### High spatial frequency on-device overlay characterization using CD-SEM contours.

Author(s): Thibaut Bourguignon, Bertrand Le Gratiet, STMicroelectronics S.A. (France); Jonathan Pradelles, Sébastien Bérard-Bergery, CEA-LETI (France); Charles Valade, Nivea G. Schuch, ASELTANanographics (France); Nicolas Possémé, CEA-LETI (France)

12496-17 • 11:00 AM - 11:20 AM

### On device SEM overlay ADI: Advantages and outcome

Author(s): Yaniv Abramovitz, Jeong Ho Yeo, Applied Materials Israel, Ltd. (Israel)

12496-18 • 11:20 AM - 11:40 AM

### Massive overlay metrology solution by realizing imaging Mueller matrix spectroscopic ellipsometry

Author(s): Jaehyeon Son, JunTaek Oh, Eunsoo Hwang, Jinwoo Ahn, Jaewon Lee, Byungkwan Oh, Donggun Lee, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Sangil Im, Jibin Jeong, Taehyun Yun, Changhyeong Yoon, SAMSUNG Electronics Co. (Republic of Korea); Gangbu Kim, Hankyul Moon, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Jong-hyun Hwang, SAMSUNG Electronics Co. (Republic of Korea); Youngkyu Park, Taejoong Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Suyoung Lee, Yusin Yang, SAMSUNG Electronics Co. (Republic of Korea); Myungjun Lee, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12496-19 • 11:40 AM - 12:00 PM

### Machine learning robustness in overlay metrology

Author(s): Udi Shusterman, Sveta Grechin, Boaz Ophir, KLA Israel (Israel)

Lunch Break 12:00 PM - 1:30 PM

## SESSION 5: EPE

28 February 2023 • 1:30 PM - 3:10 PM | Convention Center, Grand Ballroom 220B

Session Chairs: Masafumi Asano, Tokyo Electron Ltd. (Japan), Alexander Starikov, I&I Consulting (United States)

12496-20 • 1:30 PM - 1:50 PM

### EPE-aware process optimization for scanner dose and overlay in DRAM use case

Author(s): Inho Kwak, Nanhung Kim, Inbeom Yim, Jeongjin Lee, Seungyoon Lee, Chan Hwang, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Pieter Brandt, Kateryna Lyakhova, Marco Mueller, Ferhad Kamalizadeh, Antonio Corradi, ASML Netherlands B.V. (Netherlands); Yun-A Sung, Thomas Kim, ASML Korea Co., Ltd. (Republic of Korea); Stefan N. Smith-Meerman, Stefan Van der Sanden, ASML Netherlands B.V. (Netherlands); Sung-Min Park, Bob Boo, Hyok-Man Kwon, ASML Korea Co. (Republic of Korea)

12496-21 • 1:50 PM - 2:10 PM

### The edge placement error characterization and optimization for advanced logic and DRAM nodes

Author(s): Harm Dillen, Wim Tel, Jaap Karssenberg, Jan Mulkens, Roy Anunciado, ASML Netherlands B.V. (Netherlands)

12496-22 • 2:10 PM - 2:30 PM

### Multi-metrology: Towards parametric yield predictions beyond EPE

Author(s): Franz X. Zach, KLA Corp. (United States); Srividya Cancheepuram, KLA Corp. (India); Kaushik Sah, Roel Gronheid, KLA Corp. (Belgium); Fatima Anis, KLA Corp. (United States)

12496-114 • 2:30 PM - 2:50 PM

### Direct yield prediction from SEM images

Author(s): Shay Yogev, Lilach Choona, Shaul Pres, Boris Levant, Noam Tal, Applied Materials Israel, Ltd. (Israel); Gaetano Santoro, Applied Materials, Inc. (Belgium); Sylvain Baudot, Jerome Mitard, Ann Opdebeek, imec (Belgium); Jasmine Linshiz, Applied Materials Israel, Ltd. (Israel); Senthil Vadakupudhu Palayam, Jason Reifsnider, imec (Belgium)

12496-24 • 2:50 PM - 3:10 PM

### OPO improvements by moiré effect-based imaging

Author(s): Yonglei Li, KLA Corp. (United States); Justin Lim, Micron Technology, Inc. (United States); Nahee Park, KLA Corp. (Republic of Korea); Yuqian Zhang, KLA Corp. (United States); Xiaolei Liu, KLA Corp. (China); Yasutaka Okada, Gloria Chen, Ben McClain, Erin Hollinger, Amy Weatherly, Micron Technology, Inc. (United States); Yoav Grauer, KLA Corp. (Israel); Zephyr Liu, KLA Corp. (China); Raviv Yohanan, KLA Corp. (Israel); Greg Gray, Mark Stakely, KLA Corp. (United States); Shlomit Katz, KLA Corp. (Israel); Mahendra Dubey, Neeraj Khanna, KLA Corp. (United States)

Coffee Break 3:10 PM - 3:40 PM

## SESSION 6: ELECTRON BEAM METROLOGY I

28 February 2023 • 3:40 PM - 5:30 PM | Convention Center, Grand Ballroom 220B

Session Chairs: Byoung-Ho Lee, Hitachi High-Technologies Corp. (Japan), Ofer Adan, Applied Materials Israel, Ltd. (Israel)

12496-25 • 3:40 PM - 4:10 PM

### The rise of contour metrology from niche solution to versatile enabler *(Invited Paper)*

Author(s): Nivea G. Schuch, Frederic Robert, Thiago Figueiro, ASELTANanographics (France)

12496-26 • 4:10 PM - 4:30 PM

### Model validation for scanning electron microscopy

Author(s): John S. Villarrubia, Olga Yu Ridzel, National Institute of Standards and Technology (United States); Wataru Yamane, National Institute of Standards and Technology (United States), Hitachi High-Tech Science Corp. (Japan); Ishiaka Mansaray, National Institute of Standards and Technology (United States)

12496-27 • 4:30 PM - 4:50 PM

### Can remote SEM contours be used to match various SEM tools in fabs?

Author(s): Jonathan Pradelles, Loïc Perraud, Elie Sezestre, Aulrélien Fay, CEA-LETI (France); Nivea G. Schuch, Thiago Figueiro, Frederic Robert, ASELTANanographics (France)

12496-28 • 4:50 PM - 5:10 PM

## Measurement and analysis of variations in via measurements using critical dimension scanning electron microscopes and e-beam massive metrology techniques

Author(s): Genevieve A. Kane, Jennifer Church, Connor Franzese, IBM Thomas J. Watson Research Ctr. (United States); Chris A. Mack, Fractilia, LLC (United States); Cody Murray, Luciana Meli, IBM Thomas J. Watson Research Ctr. (United States)

12496-29 • 5:10 PM - 5:30 PM

## Simulating HV-SEM imaging of HAR and buried features

Author(s): Benjamin D. Bunday, AMAG Consulting, LLC (United States)

### TUESDAY EVENING PLENARY

28 February 2023 • 5:30 PM - 6:15 PM | Convention Center, Grand Ballroom 220A

12498-502 • 5:30 PM - 6:00 PM

## Are 2D transition metal dichalcogenides transistors the future silicon replacement or hype?

(Plenary Presentation)

Kevin P. O'Brien, Intel Corp. (United States)

6:15 PM - 7:15 PM

## Sustainability and Lithography's Role: A Panel Discussion

MODERATOR:

Dan Hutcheson, TechInsights (United States)

PANELISTS:

John Cahill, ASML-Cymer (United States)

Emily Gallagher, imec (Belgium)

Chris Jones, Edwards Vacuum (United Kingdom)

Mark Merrill, Lam Research (United States)

Ryan Russell, Intel (United States)

Akihisa Sekiguchi, Tokyo Electron LTD. (Japan)

It's become popular to make commitments to new business models and supply chain strategies for conservation and carbon neutrality in the semiconductor ecosystem, including initiatives to reduce greenhouse gases, conserve energy and water, and focus more on renewables and reusables. In addition to these, panelists will address the role lithography and patterning will play and has played in addressing these critical issues. For example: Koomey's law states that Compute-per-Watt improves exponentially over time. Lithography's critical role in making this possible in this is well established through its ability to make circuits more power efficient. This means that there is a long payback to lithography when considering Life-Cycle Sustainability Assessment (LCSA) methods to evaluate the chips they produce. This and more will be discussed.

### WEDNESDAY 1 MARCH

#### SESSION 7: NEW METHODS

1 March 2023 • 8:00 AM - 9:50 AM | Convention Center, Grand Ballroom 220B

Session Chairs: Cornel Bozdog, Onto Innovation Inc. (United States), Masafumi Asano, Tokyo Electron Ltd. (Japan)

12496-30 • 8:00 AM - 8:30 AM

## Reflection-mode Fourier ptychographic microscopy for surface metrology (Invited Paper)

Author(s): Lei Tian, Hao Wang, Jiabei Zhu, Boston Univ. (United States)

12496-31 • 8:30 AM - 8:50 AM

## A study on defect signal improvement using multi-scan optic patch Images and new detection algorithm

Author(s): Sungyoon Ryu, Seunghyeok Son, Chan-Gi Jeon, Sujin Lee, Yusin Yang, Younghoon Sohn, Minho Rim, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12496-32

## EUV grazing-incidence lensless imaging wafer metrology

Author(s): Tao Shen, Yasin Ekinici, Iacopo Mochi, Paul Scherrer Institut (Switzerland)

12496-33 • 9:10 AM - 9:30 AM

## Mueller matrix metrology with multi-angle information using multiple shearing interference

Author(s): Garam Choi, Jinyong Kim, Daehoon Han, Young-Uk Jin, Jinseob Kim, Wookrae Kim, Changhoon Choi, Myungjun Lee, Jinwoo Ahn, Jaehwang Jung, Taejoong Kim, Seungwoo Lee, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12496-34 • 9:30 AM - 9:50 AM

## High density CD measurement technology with high throughput and high precision on the entire surface of a process wafer, capable of capturing randomly occurring CD defects

Author(s): Kazuhiko Fukazawa, Yoshihiko Fujimori, Shigeru Hirukawa, Yosuke Miyazaki, Nikon Corp. (Japan); Tomohiro Iwaki, Tomonori Okada, Micron Memory Japan, Inc. (Japan)

Coffee Break 9:50 AM - 10:20 AM

#### SESSION 8: METROLOGY FOR THE EUV ERA

1 March 2023 • 10:20 AM - 12:00 PM | Convention Center, Grand Ballroom 220B

Session Chairs: Myungjun Lee, SAMSUNG Electronics Co., Ltd. (Republic of Korea), Shunsuke Koshihara, Hitachi High-Tech Corp. (Japan)

12496-35 • 10:20 AM - 10:40 AM

## Dry resist metrology readiness for high-NA EUVL

Author(s): Gian Francesco Lorusso, Dieter Van Den Heuvel, Mohamed Zidan, Alain Moussa, Christophe Beral, Anne-Laure Charley, Danilo De Simone, imec (Belgium); Anuja De Silva, Elisseos Verveniotis, Ali Haider, Lam Research Belgium BV (Belgium); Tsuyoshi Kondo, Hitachi High-Tech Corp. (Belgium)

12496-68 • 10:40 AM - 11:00 AM

## OPO robustness and measurability improvement via extended wavelengths

Author(s): Shlomit Katz, Yoav Grauer, KLA Israel (Israel); Mark Stakely, Greg Gray, Peter Kimani, KLA Idaho (United States); Nahee Park, KLA Corp. (Republic of Korea); Yuqian Zhang, KLA Corp. (United States); Yonglei Li, KLA Idaho (United States); Nikhil Aditya Kumar Roy, Nils C. Monserud, Steve McCandless, Jason Reece, Nathan Gillespie, Micron Technology, Inc. (United States)

12496-37 • 11:00 AM - 11:20 AM

## Multi-modal tabletop EUV reflectometry for characterization of nanostructures

Author(s): Yuka Esashi, Nicholas W. Jenkins, Yunzhe Shao, Michael Tanksalvala, Brendan McBennett, Joshua L. Knobloch, STROBE NSF Science and Technology Ctr. (United States), JILA, Univ. of Colorado Boulder (United States); Henry C. Kapteyn, STROBE NSF Science and Technology Ctr. (United States), JILA, Univ. of Colorado Boulder (United States), KMLabs, Inc. (United States); Margaret M. Murnane, STROBE NSF Science and Technology Ctr. (United States), JILA, Univ. of Colorado Boulder (United States)

# CONFERENCE 12496

12496-38 • 11:20 AM - 11:40 AM

## High repeatability and low shrinkage solution using CD-SEM for EUV resist

Author(s): Masaki Sugie, Hitachi High-Tech Corp. (Japan)

12496-39 • 11:40 AM - 12:00 PM

## Effect of stack and high-NA EUV resist material on shrinkage

Author(s): Ran Alkoken, Applied Materials Israel, Ltd. (Israel); Sandip Halder, Hyo Seon Suh, imec (Belgium); Mor Baram, Gadi Oron, Applied Materials Israel, Ltd. (Israel); Kasturi Saha, Applied Materials India Pvt. Ltd. (India); Kevin Houchens, Yarden Melamed, Applied Materials Israel, Ltd. (Israel)

Lunch Break 12:00 PM - 1:10 PM

### SESSION 9: 3D AND HETEROGENEOUS INTEGRATION

1 March 2023 • 1:10 PM - 3:00 PM | Convention Center, Grand Ballroom 220B

Session Chairs: Cornel Bozdog, Onto Innovation Inc. (United States), Benjamin D. Bunday

12496-187 • 1:10 PM - 1:40 PM

## Semiconductor metrology for the 3D era (*Invited Paper*)

Author(s): Janusz Bogdanowicz, Anne-Laure Charley, Philippe Leray, imec (Belgium)

12496-40 • 1:40 PM - 2:00 PM

## Overlay performance in permanent bonded wafer integration schemes

Author(s): Nathan Ip, Tokyo Electron America, Inc. (United States); Michael P. Belyansky, IBM Thomas J. Watson Research Ctr. (United States); Christopher Netzband, TEL Technology Ctr., America, LLC (United States); Norifumi Kohama, Tokyo Electron Kyushu Ltd. (Japan); Richard Johnson, Shobha Hosadurga, Jack Wong, John C. Arnold, Kisik Choi, Wai Kin Li, Indira Seshadri, Luciana Meli, IBM Thomas J. Watson Research Ctr. (United States); Ilseok Son, TEL Technology Ctr., America, LLC (United States)

12496-84 • 2:00 PM - 2:20 PM

## Characteristic Mueller matrix responses and correlation analysis for vertical GAA nanowire structure manufacturing using RCWA simulated spectra

Author(s): Colin Wadsworth, Univ. of Minnesota (United States); Ezra Mel B. Pasikatan, SUNY Polytechnic Institute (United States); Nick Keller, Onto Innovation Inc. (United States); Alain C. Diebold, SUNY Polytechnic Institute (United States); Andrew A. Antonelli, Onto Innovation Inc. (United States)

12496-42 • 2:20 PM - 2:40 PM

## AI-guided OCD metrology for single HAR sub-micron via measurement

Author(s): Fu-Sheng Yang, Liang-Chia Chen, National Taiwan Univ. (Taiwan)

12496-43 • 2:40 PM - 3:00 PM

## Detection of bonding voids for 3D integration

Author(s): Cong Chen, Dieter Van Den Heuvel, Benu Tunca Altintas, Alain Moussa, Anne Vandooren, Matteo Beggiato, Bart Baudempez, Janusz Bogdanowicz, Christophe Beral, Eugenio Dentoni Litta, Anne-Laure Charley, imec (Belgium)

Coffee Break 3:00 PM - 3:30 PM

### SESSION 10: MACHINE LEARNING

1 March 2023 • 3:30 PM - 5:30 PM | Convention Center, Grand Ballroom 220B

Session Chairs: Nivea G. Schuch, ASELT Nanographics (France), Benjamin D. Bunday

12496-44 • 3:30 PM - 3:50 PM

## Addressing misclassification costs in machine learning through asymmetric loss functions

Author(s): Bryan M. Barnes, National Institute of Standards and Technology (United States)

12496-45 • 3:50 PM - 4:10 PM

## Self-supervised deep learning neural network for CD-SEM image denoising using reduced dataset

Author(s): Alexandre Moly, Nivea G. Schuch, Thiago Figueiro, Frederic Robert, ASELT Nanographics (France); Jessy Bustos, Loïc Perraud, Jonathan Pradelles, Elie Sezestre, Univ. Grenoble Alpes (France), CEA-LETI (France)

12496-103 • 4:10 PM - 4:30 PM

## Depth estimation from SEM images using deep learning and angular data diversity

Author(s): Tim Houben, Technische Univ. Eindhoven (Netherlands); Maxim Pisarenko, Thomas Huisman, Hans Onvlee, ASML Netherlands B.V. (Netherlands); Fons van der Sommen, Peter H. N. de With, Technische Univ. Eindhoven (Netherlands)

12496-47 • 4:30 PM - 4:50 PM

## Semiconductor device metrology for detecting defective chip due to high-aspect ratio based structures using hyperspectral imaging and deep learning

Author(s): Sunhong Jun, Sungyoon Ryu, Wonjun Choi, Yong-Ju Jeon, Dongmin Kyeon, Hayan Park, Souk Kim, Moonshik Kang, Chaemin Lee, Kwangchul Kim, Jeongsu Han, Younghoon Sohn, Yongdeok Jeong, DongHoon Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12496-48 • 4:50 PM - 5:10 PM

## AI-guided optical-model-based superresolution for semiconductor CD metrology

Author(s): Wei-Yun Lee, Liang-Chia Chen, National Taiwan Univ. (Taiwan)

12496-49 • 5:10 PM - 5:30 PM

## Deep learning based automatic defect classification for semiconductor manufacturing

Author(s): Eunpa Kim, Dongchul Ihm, Myung-Chul Shin, Hee-Jun Ahn, Soyoon Park, Haesung Park, Minjung Shin, ChungSam Jun, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

### POSTER SESSION

1 March 2023 • 5:30 PM - 7:00 PM | Convention Center, Hall 2  
Session Chairs: Daniel Schmidt, IBM Thomas J. Watson Research Ctr. (United States), Myungjun Lee, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

Conference attendees are invited to attend the Poster Session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the Poster Session.

## Poster Setup: Wednesday 10:00 AM - 4:30 PM

Poster authors, view poster presentation guidelines and set-up instructions at <http://spie.org/ALPosterGuidelines>.



12496-67

**Scatterometry overlay (SCOL) measurement of small cell target using pupil optimization**

Author(s): Itay Gdor, Einat Nagar, KLA Israel (Israel); Yunhua Wu, KLA China (China); Tal Yaziv, Eitan Hajaj, Yuval Lubashevsky, Daria Negri, KLA Israel (Israel)

12496-69

**Machine-learning-based error detection modeling and feature scoring for error cause analysis of CD-SEMs**

Author(s): Yasuhiro Yoshida, Hitachi, Ltd. (Japan); Masayoshi Ishikawa, Hitachi (Japan); Fumihiko Sasajima, Shigeo Ohkoshi, Masami Takano, Hitachi High-Tech Corp. (Japan)

12496-70

**Residuals reduction in imaging-based overlay using color per layer**

Author(s): Shlomit Katz, Dor Yehuda, KLA Israel (Israel); Junho Kim, Hongcheon Yang, DoHwa Lee, Nanglyeom Oh, DongSub Choi, Wayne Zhou, KLA Corp. (Republic of Korea); Hedvi Spielberg, Ohad Bachar, KLA Israel (Israel); Suk Won Park, Joonsang You, Hyunjun Kim, Hong Goo Lee, Jungchan Kim, Dongyoung Lee, Hongbok Yeon, Joon-Seuk Lee, Sang-Ho Lee, Jae Wook Seo, SK Hynix, Inc. (Republic of Korea)

12496-71

**Optimizations of APC multivariate algorithm for linear mix and match overlay control**

Author(s): Benjamin Duclaux, Maxime Gatefait, Alice Pelletier, Pierre Leveque, Laurent Lecarpentier, Cedric Monget, STMicroelectronics S.A. (France)

12496-72

**Investigation of on-device overlay variation and control in 3D-NAND process**

Author(s): Yu-Lin Liu, Kai-Bang Hsu, Mars Yang, Elvis Yang, T. H. Yang, K. C. Chen, Li-Ting Chang, Macronix International Co., Ltd. (Taiwan)

12496-73

**Novel Electron Beam Technology using InGaN Photocathode for High-Throughput Scanning Electron Microscope Imaging**

Author(s): Daiki Sato, Atsushi Koizumi, Haruka Shikano, Shotaro Noda, Yohei Otsuka, Daisuke Yasufuku, Kazumasa Mori, Hokuto Iijima, Tomohiro Nishitani, Photo electron Soul Inc. (Japan); Yoshio Honda, Hiroshi Amano, Nagoya Univ. (Japan)

12496-74

**Precise 3D profile measurement of high aspect ratio device patterns by small-angle X-ray scattering**

Author(s): Rieko Suenaga, Yoshiyasu Ito, Takumi Goto, Kazuhiko Omote, Rigaku Corp. (Japan)

12496-75

**A study of high-accuracy stand-alone wafer metrology tool for high productivity exposure systems**

Author(s): Wataru Yamaguchi, Shinichiro Hirai, Ryota Makino, Kazuya Kijima, Seiya Miura, Canon Inc. (Japan); Isao Tanaka, Kazuhiro Segawa, Charlie Chen, Winbond Electronics Corp. (Taiwan)

12496-76

**Enabling layer transfer and back-side power delivery network applications by wafer bonding and scanner correction optimizations**

Author(s): Richard J. F. van Haren, Suwen Li, Blandine Minghetti, Leon van Dijk, Klaas Brantjes, ASML Netherlands B.V. (Netherlands); Frank Fournel, Gaëlle Mauguen, Ivanie Mendes, Marie-Line Pourteau, Michael May, Laurent Pain, CEA-LETI (France); Thomas Plach, Markus Wimplinger, EV Group (Austria)

12496-77

**Optimizing YOLOv7 for semiconductor defect detection**

Author(s): Enrique Dehaerne, KU Leuven (Belgium); Bappaditya Dey, Sandip Halder, Stefan De Gendt, imec (Belgium)

12496-78

**ADI to in-cell overlay stability improvement for DRAM using novel scatterometry and comprehensive process control**

Author(s): Hyunsok Kim, Jaewuk Ju, Ikhyun Jeong, Baikkyu Hong, Sunouk Nam, Changkyu Lee, Kangmin Lee, Sumin Jang, Jaeyoun Lee, SK Hynix Inc. (Republic of Korea); Hongcheon Yang, Minh Jeong, Mingyu Kim, KLA Corp. (Republic of Korea); Hongpeng Su, Wayne Zhou, KLA Corp. (China); Nanglyeom Oh, DongSub Choi, KLA Corp. (Republic of Korea); Tal Yaziv, Hedvi Spielberg, Ohad Bachar, Renan Milo, KLA Corp. (Israel)

12496-81

**Absolute alignment measurement of underlayer and overlayer of diffraction-based overlay mark by image-based alignment metrology system**

Author(s): Jaeil Lee, Iksun Park, Youngjin Park, Jonghyun Hwang, Hyeonjun Ha, Jaewoong Sohn, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Jaehee Lee, Jinseok Moon, Nikon Precision Korea Ltd. (Republic of Korea); Yuki Kondo, Satoshi Ando, Nikon Corp. (Japan)

12496-82

**Hyper-local, high-resolution imaging of patterned EUV photoresist**

Author(s): John W. Cossins, Andrew D. L. Humphris, Lei Feng, Ravish Rajkumar, Hamish Rogers, Infinitesima Ltd. (United Kingdom)

12496-86

**Preventing film damage induced defects when introducing new e-beam inspection step in an existing process flow**

Author(s): Kwame Owusu-Boahen, Chang Han, SAMSUNG Austin Semiconductor LLC (United States)

12496-88

**Fourier analysis of spectrum for precision improvement in thickness determined by machine learning**

Author(s): Tae Dong Kang, Moon Il Shin, Shinyoung Ryu, Inhee Joh, Sayyeon Joung, Minhyeok Lee, Jiwon Lee, Kyusik Kim, AUROS Technology, Inc. (Republic of Korea)

12496-90

**Numerical study of electromagnetic properties of the 3D through silicon via with high aspect ratio**

Author(s): Song-En Chen, Chih-Chung Wang, Hung-Wei Hsu, Yen-Ting Wu, Jia-Han Li, National Taiwan Univ. (Taiwan)

12496-91

**Frame generation methodology in tape-out flow and automation application**

Author(s): Binbin Yan, ASML Netherlands B.V. (China), Beijing Superstring Academy of Memory Technology (China); Miao Jiang, Futian Wang, Di Liang, Liang Li, Beijing Superstring Academy of Memory Technology (China); Wei Feng, Joer Huang, Dajun Wu, Andy Lan, ChangXin Memory Technologies, Inc. (China); Jiangliu Shi, Beijing Superstring Academy of Memory Technology (China)

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12496-92

## Local depth monitoring using scanning electron microscopy and its verification using atomic force microscopy

Author(s): Inseok Park, JaeHyung Ahn, Donghyun Lee, Souk Kim, Younghoon Sohn, Minho Rim, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12496-93

## Small imaging overlay metrology targets for advance nodes

Author(s): Yoel Feler, Diana Shaphirov, Mark Ghinovker, Katya Gordon, Ido Ashuah, KLA Israel (Israel); Yunhua Wu, KLA China (China); Penny Lin, KLA Taiwan (Taiwan)

12496-94

## Photoelectron beam technology for SEM imaging with pixel-specific control of irradiation beam current

Author(s): Tomohiro Nishitani, Yuta Arakawa, Shotaro Noda, Atsushi Koizumi, Daiki Sato, Haruka Shikano, Hokuto Iijima, Photo electron Soul Inc. (Japan); Yoshio Honda, Hiroshi Amano, Nagoya Univ. (Japan)

12496-95

## Advanced hybrid positioning system of SEM and AFM for material surface metrology

Author(s): ChaeHo Shin, Korea Research Institute of Standards and Science (Republic of Korea)

12496-96

## Edge detection using deep learning pipelines for TEM and SEM metrology by proposing generic and specific approaches

Author(s): Edgar Loza, Institut Pascal, Univ. Clermont Auvergne (France), POLLEN Metrology (France); Julien Baderot, Marion Grould, POLLEN Metrology (France); Emilie Péry, Frédéric Chausse, Institut Pascal, Univ. Clermont Auvergne (France); Sergio Martinez, Johann Foucher, POLLEN Metrology (France)

12496-97

## An optical critical dimension (OCD) model analysis on 3 nm complementary FET (CFET) gate stacks

Author(s): Qi Wang, Fudan Univ. (China); Yayi Wei, University of Chinese Academy of Science (China); Qiang Wu, Yanli Li, Xianhe Liu, Fudan Univ. (China)

12496-98

## Scatterometry and machine learning for in-die overlay solution

Author(s): FangJyun Yeh, KLA Taiwan (Taiwan); Houssam Chouaib, KLA Corp. (United States)

12496-99

## On-line real-time detection system for wafer surface defects based on deep learning and generative adversarial network

Author(s): Chao-Ching Ho, Shou-Lin Chu, National Taipei Univ. of Technology (Taiwan)

12496-100

## A generic deep-learning based defect segmentation model for electron micrographs for automatic defect inspection

Author(s): Martin Jacob, Ali Hallal, Univ. Clermont Auvergne (France), POLLEN Metrology (France); Julien Baderot, POLLEN Metrology (France); Vincent Barra, Arnaud Guillin, Univ. Clermont Auvergne (France); Sergio Martinez, Johann Foucher, POLLEN Metrology (France)

12496-101

## The development of a machine learning-based excimer laser performance simulator for engineering maintenance decisions

Author(s): Jacob P. Strock, Levi Jordan, Gigaphoton USA Inc. (United States); Yuji Minegishi, Satoshi Tanaka, Katsunori Isomoto, Takeshi Asayama, Takehiko Tomonaga, Yousuke Kawagoe, Yuuki Sakou, Gigaphoton Inc. (Japan)

12496-102

## Mueller matrix spectroscopy and physics-based machine learning for gate-all-around sheet-specific metrology

Author(s): Houssam Chouaib, Anderson Chou, Valeria Dimastrodonato, Kai-Hsiang Lin, KLA Corp. (United States); Ben Hsieh, Hao-miao Chang, James Chuang, Brooks Hsiao, KLA Corp. (Taiwan); Stilian Pandev, Zhengquan Tan, Derrick Shaughnessy, KLA Corp. (United States)

12496-104

## Determination of deep hole structure for advanced semiconductor devices analyzed by transmission X-ray scattering

Author(s): Takumi Goto, Yoshiyasu Ito, Rieko Suenaga, Kazuhiko Omote, Rigaku Corp. (Japan)

12496-105

## Wide-field massive CD metrology based on the imaging Mueller-matrix ellipsometry for semiconductor devices

Author(s): JunTaek Oh, Jaehyeon Son, Eunsoo Hwang, Jinwoo Ahn, Hankyool Moon, Jaewon Lee, Taehyun Yun, Jibin Jeong, Taejoong Kim, Myungjun Lee, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12496-106

## A study of diffraction based overlay (DBO) on a 3 nm CFET metal layer

Author(s): Yanli Li, Fudan Univ. (China); Yayi Wei, Institute of Microelectronics, Chinese Academy of Sciences (China); Qiang Wu, Xianhe Liu, Qi Wang, Fudan Univ. (China)

12496-108

## A study of 3 nm CFET middle-of-the-line contact layer OCD measurement sensitivity

Author(s): Xianhe Liu, Fudan Univ. (China); Yayi Wei, Institute of Micro electronics, Chinese Academy of Science (China); Qiang Wu, Qi Wang, Yanli Li, Fudan Univ. (China)

12496-109

## Laser assisted SEM for visualizing electrical property using voltage contrast dynamics

Author(s): Minami Shoji, Hitachi, Ltd. (Japan); Yohei Nakamura, Hitachi High-Tech Korea Co., Ltd. (Republic of Korea), Hitachi, Ltd. (Japan); Yasuhiro Shirasaki, Hitachi, Ltd. (Japan); Heita Kimizuka, Hitachi High-Tech Korea Co., Ltd. (Republic of Korea), Hitachi High-Tech Corp. (Japan); Satoshi Takada, Yuko Iwabuchi, Hitachi High-Tech Corp. (Japan); Shota Mitsugi, Natsuki Tsuno, Hitachi (Japan)

12496-112

## The role of neutral drag force in pulsed plasma enabled particle contamination control

Author(s): Job Beckers, Judith van Huijstee, Federico Medini, Technische Univ. Eindhoven (Netherlands); Paul Blom, Ton Peijnenburg, VDL Enabling Technologies Group (Netherlands)

12496-113

## Wafer in process impact simulation caused by lens calibration

Author(s): Jae-Doug Yoo, Young-Hoon Song, Junhyung Lee, Ha-neul Yang, ASML Korea Co., Ltd. (Republic of Korea)

12496-115

**Die-level nano-topography metrology to characterize the stress-induced in-plane distortion contribution to overlay**

Author(s): Viorel Balan, Florent Michel, Ivanie Mendes, Celine Lapeyre, Lionel Vignoud, CEA-LETI (France); Ronald Otten, Orion Mouraille, Leon van Dijk, Blandine Minghetti, Jerome Depre, Richard J. F. van Haren, ASML Netherlands B.V. (Netherlands)

12496-116

**Ultra-Thin Uncooled Integrable-on-Chip Detector to Measure Wide Infrared Radiation Residue in Lithography Exposure and Metrology Inspection Tools**

Author(s): Mojtaba Jahangiri, Technische Univ. Delft (Netherlands); Jaroslaw Pawluczuk, Karol Dabrowski, VIGO Photonics S.A. (Poland); Stoyan Nihtianov, Technische Univ. Delft (Netherlands)

12496-121

**Automatic defect classification (ADC) solution using data-centric artificial intelligence (AI) for outgoing quality inspections in the semiconductor industry**

Author(s): Onder Anilturk, Edwin Lumanauw, James Bird, NXP Semiconductors (United States); Juan Olloniego, Dillon Laird, Juan Camilo Fernandez, Quinn Killough, Landing AI (United States)

12496-122

**Investigation of multiple feedforward modes of on product overlay control**

Author(s): Chi Zhang, Guoping Liu, Hongwen Zhao, Shanghai Huali Integrated Circuit Corp. (China)

12496-123

**Deep learning analysis of x-ray scattering data from high-aspect ratio structures**

Author(s): Andrei Baranovskiy, Inbar Grinberg, Michael G. Greene, Yehonatan Amasay, Bruker Technologies Ltd. (Israel); Matthew Wormington, Bruker Nano, Inc. (United States)

12496-124

**MEMS-based AFM-on-a-chip for high-throughput metrology**

Author(s): Zhenle Cao, Wyatt Sullivan, David Morris, ICSPi Corp. (Canada)

12496-128

**Automated (S)TEM metrology characterization of gate-all-around and 3D NAND devices**

Author(s): Michael Strauss, Thermo Fisher Scientific Inc. (United States); Chen Li, Thermo Fisher Scientific Inc. (Netherlands); Chris Hakala, Xiaoting Gu, Thermo Fisher Scientific Inc. (United States); Antonio Mani, Thermo Fisher Scientific Inc. (Netherlands); Zhenxin Zhong, Thermo Fisher Scientific Inc (United States)

12496-131

**Parallax method for diffraction-based single-cell overlay and film thickness measurement**

Author(s): Mordechy Kot, Yuval Lamhot, Alon Yagil, Tal Yaziv, Nadav Gutman, Renan Milo, KLA Israel (Israel)

12496-132

**Precise optical constant determination in the soft X-ray, EUV, and VUV spectral range**

Author(s): Najmeh Abbasirad, Qais Saadeh, Richard Ciesielski, Alexander Gottwald, Physikalisch-Technische Bundesanstalt (Germany); Vicky Philipsen, imec (Belgium); Igor Makhotkin, Univ. Twente (Netherlands); Andrey Sokolov, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany); Michael Kolbe, Victor Soltwisch, Frank Scholze, Physikalisch-Technische Bundesanstalt (Germany)

12496-133

**Large field of view metrology: detecting critical edge placement error signatures not seen with small field of view in an HVM environment**

Author(s): Mohamed Ridane, ASML Netherlands B.V. (Netherlands); Ivy Chen, ASML Taiwan Ltd. (Taiwan); Sung-Min Song, ASML Korea Co., Ltd. (Republic of Korea); Peter Nikolsky, Kuan-Ming Chen, ASML Netherlands B.V. (Netherlands); Shinyeong Lee, Sean Park, ASML Korea Co., Ltd. (Republic of Korea); Kolos Lin, ASML (United States); Yu-Chi Su, Kyoyeon Cho, ASML Taiwan Ltd. (Taiwan); Ethan Yu, ASML (United States); James Park, ASML Korea Co., Ltd. (Republic of Korea); Abdalmohsen Elmalk, Chih-Hung Hsieh, ASML (United States); Alexander Serebryakov, Lei Zhang, ASML Netherlands B.V. (Netherlands); Taekwon Jee, Joonsang You, Hong Goo Lee, Jongmin Park, Jungchan Kim, Sang-Woo Kim, Jaewook Seo, SK Hynix, Inc. (Republic of Korea)

12496-134

**Advanced overlay metrology for 3D NAND bonding applications**

Author(s): Yoav Grauer, Shlomo Eisenbach, Motti Penia, Arkady Simkin, Dror Elka, Avner Safrani, Efi Megged, KLA Israel (Israel)

12496-135

**Tracing optimized condition for electron beam metrology of EUV photoresist pattern using low landing energy**

Author(s): Ran Alkoken, Applied Materials Israel, Ltd. (Israel); Jong-Hoi Cho, SungHun Lim, TaeSeop Lee, DaeYoung Choi, Jong-Hyun Seo, SeungHyun Lee, JunKyoung Lee, SK Hynix, Inc. (Republic of Korea); You Jin Kim, Jeong Ho Yeo, Kyeongju Han, Sujin Lim, KyungJae Choi, Woosung Jung, Chanhee Kwak, Hyeon Sang Shin, Applied Materials Korea, Ltd. (Republic of Korea); Alex Brikker, Roi Meir, Applied Materials Israel, Ltd. (Israel)

12496-136

**Orientation measurement on DRAM contact hole as an aberration correlated metric**

Author(s): Ran Alkoken, Applied Materials Israel, Ltd. (Israel); Jong-Hoi Cho, SungHun Lim, TaeSeop Lee, DaeYoung Choi, Jong-Hyun Seo, SeungHyun Lee, JunKyoung Lee, SK Hynix, Inc. (Republic of Korea); You Jin Kim, Jeong Ho Yeo, Kyeongju Han, Sujin Lim, KyungJae Choi, Woosung Jung, Chanhee Kwak, Hyeon Sang Shin, Applied Materials Korea, Ltd. (Republic of Korea); Roi Meir, Applied Materials Israel, Ltd. (Israel)

12496-137

**Comparison between Supervised and Self-supervised Deep Learning for SEM Image Denoising**

Author(s): Tomoyuki Okuda, Hitachi High-Tech Science Corp. (Japan); Jun Chen, Takahiro Motoyoshi, Ryou Yumiba, Hitachi High-Tech Corp. (Japan); Masayoshi Ishikawa, Hitachi, Ltd. (Japan); Yasutaka Toyoda, Hitachi High-Tech Corp. (Japan)

12496-138

**New metrology technique for measuring the free shape of a patterned 300mm wafer held vertically**

Author(s): Juan M. Trujillo-Sevilla, Wootpix, S.L. (Spain); Jan O. Gaudestad, Wootpix, S.L. (United States); Óscar Casanova-González, Alex Roqué-Velasco, Miguel Jesús Sicilia, Jose Manuel Ramos-Rodríguez, Wootpix, S.L. (Spain)

# CONFERENCE 12496

12496-139

## The comprehensive enhancement for the precision trade-off of Morie pattern based overlay

Author(s): Yi Yang, Song Bai, Qiu Li, Qingwei Liu, Yi Zhou Ye, Zhi Feng Gan, Xiao Chi Xu, Wei Chen, Cheng Zhang, Semiconductor Manufacturing International Corp. (China)

12496-140

## The study of Monte Carlo method to replace the normal assumption at edge placement error estimation

Author(s): Zhewei Cai, Huilin Cai, Qingwei Liu, Yuntao Jiang, Jian Yang, Song Bai, Xiaoyu Huang, Xian He, Yun Gao, Semiconductor Manufacturing International Corp. (China)

12496-141

## Comprehensive comparison for all industrialized four optical overlay metrology principle and potential

Author(s): Song Bai, Qingwei Liu, Yuntao Jiang, Gaoying Zhang, Zhaoyang Chen, Xian He, Antai Li, Yi Yang, Jingen Wu, Yunhang Qiu, Semiconductor Manufacturing International Corp. (China)

12496-142

## AI-guided reliability diagnosis for 5,7nm automotive process

Author(s): Dongin Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Srividya Jayaram, Siemens EDA (United States); Seungwon Paek, Minhoo Kwon, Ho Lee, Yeongdo Kim, Hyobe Jung, SAMSUNG Electronics Co., Ltd. (Republic of Korea); S.P. Hong, Sanghyun Choi, Siemens EDA (Republic of Korea); Andres Torres, Ivan Kissiov, Melody Tao, Nathan Greeneltch, Siemens EDA (United States); Doohwan Kwak, Siemens EDA (Republic of Korea)

12496-143

## The novel apply of process induced non-linear optical response for real device overlay detection

Author(s): Song Bai, Zhaoyang Chen, Qingwei Liu, Yuntao Jiang, Gaoying Zhang, Jian Yang, Xian He, Antai Li, Zhewei Cai, Semiconductor Manufacturing International Corp. (China)

12496-144

## Wafer yield prediction using AI: Potentials and pitfalls

Author(s): Rebecca Busch, Michael Wahl, Bhaskar Choubey, Univ. Siegen (Germany)

12496-186

## Reflective deep-ultraviolet Fourier ptychographic microscopy for nanoscale imaging

Author(s): Kwan Seob Park, Yoon Sung Bae, National Institute of Standards and Technology (United States); Sang-Soo Choi, Photonics, Inc. (Republic of Korea); Martin Y. Sohn, National Institute of Standards and Technology (United States)

12496-60

## 3D measurement using SEM technology

Author(s): Younghoon Sohn, JaeHyung Ahn, Inseok Park, Souk Kim, DongHoon Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12496-190

## Simulation assisted design for SEM overlay targets

Author(s): Kevin Houchens, Yaniv Abramovitz, Shay Attal, Ofer Adan, Nahum Bomshtein, Itai Buks, Applied Materials Israel, Ltd. (Israel); Ryan Hsieh, Applied Materials Taiwan, Ltd. (Taiwan); Tal Itzkovich, Jenny Perry, Applied Materials Israel, Ltd. (Israel)

12496-192

## Exploiting spatial characteristic of wafer for effective OCW : Area Partitioning OCW

Author(s): Gil-Woo Song, Dooho Kang, Sungchai Kim, Sungwon Park, Taeyong Jo, Euseok Kum, Jonghyun Lee, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Jaehyung Kim, SAMSUNG Electronics Co. (Republic of Korea); Dooho Park, Dongmin Kim, Sungwoon Uh, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12496-195

## Effective Tool Induced Shift (eTIS) for determining the Total Measurement Uncertainty (TMU) in Overlay Metrology

Author(s): Ohad Bachar, KLA Israel (Israel); Hyunsok Kim, Ikhyun Jeong, Baikkyu Hong, Sejung Ham, Dongsu Kim, Dongsuk Lim, Kangmin Lee, SK Hynix, Inc. (Republic of Korea); Jeongpyo Lee, Minhoo Jung, Nanglyeom Oh, Dongsu Choi, KLA Corp. (Republic of Korea); Hedvi Spielberg, KLA Israel (Israel)

12496-196

## General effective medium model for phonon heat flow in highly-confined semiconductor nanosystems

Author(s): Brendan McBennett, Albert Beardo, Emma E. Nelson, Margaret M. Murnane, Joshua L. Knobloch, JILA, Univ. of Colorado Boulder (United States), STROBE NSF Science and Technology Ctr. (United States); Baowen Li, Univ. of Colorado Boulder (United States); Henry C. Kapteyn, JILA, Univ. of Colorado Boulder (United States), STROBE NSF Science and Technology Ctr. (United States)

## THURSDAY 2 MARCH

### SESSION 11: EUV AND X-RAY METROLOGY

2 March 2023 • 8:00 AM - 9:50 AM | Convention Center, Grand Ballroom 220B

Session Chairs: Bryan M. Barnes, National Institute of Standards and Technology (United States), Xiaomeng Chen, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

12496-50 • 8:00 AM - 8:30 AM

## Soft X-Ray: Novel metrology for 3D profilometry and device pitch overlay (*Invited Paper*)

Author(s): Christina L. Porter, Teis Coenen, ASML Netherlands B.V. (Netherlands); William T. Blanton, Sury Ganesan, Intel Corp. (United States); Niels Geypen, Han-Kwang Nienhuys, Sandy Scholz, Loes van Rijswijk, Johan Reinink, Jeroen Ploegmakers, Omar El Gawhary, Hugo Cramer, Rik van Laarhoven, Andrea Invernizzi, Ricarda Wohrweg, Hugo Jonquiere, Juliane Reinhardt, Simon G. J. Mathijssen, Peter D. Engblom, Heidi Chin, ASML Netherlands B.V. (Netherlands); Mark Phillips, Intel Corp. (United States)

12496-51 • 8:30 AM - 8:50 AM

## Small target compatible dimensional and analytical metrology for semiconductor nanostructures using X-ray fluorescence techniques

Author(s): Philipp Hönicke, Yves Kayser, Victor Soltwisch, Nils Wauschkuhn, Physikalisch-Technische Bundesanstalt (Germany); Jeroen E. Scheerder, imec (Belgium); Claudia Fleischmann, imec (Belgium), KU Leuven (Belgium); Thomas Siefke, Friedrich-Schiller- Univ. Jena (Germany); Anna Andrlé, Physikalisch-Technische Bundesanstalt (Germany); Grzegorz Gwalt, Frank Siewert, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany); Richard Ciesielski, Burkhard Beckhoff, Physikalisch-Technische Bundesanstalt (Germany)

12496-52 • 8:50 AM - 9:10 AM

## Critical dimension measurement: from synchrotron Small Angle X-ray Scattering to industrial Optical Scatterometry techniques

Author(s): Timothée Choisset, Univ. Grenoble Alpes (France), CEA-LETI (France); Abdelali Hammouti, Vincent Gagneur, STMicroelectronics S.A. (France); Jerome Reche, Guido Rademaker, Guillaume Freychet, Univ. Grenoble Alpes (France), CEA-LETI (France); Guillaume Jullien, Julien Ducote, STMicroelectronics S.A. (France); Patrice Gergaud, Univ. Grenoble Alpes (France), CEA-LETI (France); Delphine Le Cunff, STMicroelectronics S.A. (France)

12496-53 • 9:10 AM - 9:30 AM

## Reconstruction of the in-depth profile of line gratings with Critical Dimension Grazing Incidence Small Angle X-ray Scattering on a laboratory equipment.

Author(s): Guillaume Freychet, Univ. Grenoble Alpes (France), CEA-LETI (France); Yoann Blancquaert, Guido J. Rademaker, Patrice Gergaud, CEA-LETI (France)

12496-54 • 9:30 AM - 9:50 AM

## Pushing the boundaries of EUV scatterometry: Reconstruction of complex nanostructures for next-generation transistor technology

Author(s): Richard Ciesielski, Leonhard M. Lohr, Physikalisch-Technische Bundesanstalt (Germany); Hans Mertens, Anne-Laure Charley, Rudi de Ruyter, imec (Belgium); Philipp Hönicke, Najmeh Abbasirad, Victor Soltwisch, Physikalisch-Technische Bundesanstalt (Germany)

Coffee Break 9:50 AM - 10:20 AM

### SESSION 12: INSPECTION

2 March 2023 • 10:20 AM - 12:10 PM | Convention Center, Grand Ballroom 220B

Session Chairs: Byoung-Ho Lee, Hitachi High-Technologies Corp. (Japan), Narendra Rana, KLA Corp. (United States)

10:20am - 10:30am:

## 2023 Karel Urbánek Best Student Paper Award Presentation

12496-55 • 10:30 AM - 10:50 AM

## A novel method for improving yield prediction by matching layout pattern and defect inspection

Author(s): Min-Chul Han, Chang-Hun Ko, Cheol-Hwan Kim, Masayuki Terai, Hye-Sun Kim, Oh-Hun Kwon, Ji-Hyun Cheon, Jin-Woo Choi, Jung-Hoon Park, Kyu-Sul Park, Jae-Ho Pak, Do-Youn Park, Seung-Yeol Oh, Min-Su Kim, Hyun-Woo Ryoo, Myung-Chul Shin, Bo-Tak Lim, Il-Mok Park, Hyuck-Joon Kwon, Yoon-Jong Song, Jung-Yun Choi, Gwan-Hyeob Koh, Hyung-Jong Ko, Yu-Gyun Shin, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12496-56 • 10:50 AM - 11:10 AM

## In-situ electrical property quantification of memory devices by modulated electron microscopy

Author(s): Muneyuki Fukuda, Kazuhisa Hasumi, Takashi Nobuhara, Hirohiko Kitsuki, Zhigang Wang, Hitachi High-Tech Corp. (Japan); Kazuhiro Nojima, Akira Hamaguchi, KIOXIA Corporation (Japan)

12496-57 • 11:10 AM - 11:30 AM

## Quantifying CD SEM contact hole roughness and shape combined with machine learning-based pattern fidelity scores for process optimization and monitoring

Author(s): Hyosung Lee, Seonho Lee, Hyungju Rah, Iksun Park, Jaeil Lee, Jaewoong Sohn, Yongchan Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Christoph Ehrlich, Philip Groeger, Sven Boese, Enrico Bellmann, Stefan Buhl, Qoniac GmbH (Germany); Seop Kim, Kang-san Lee, Qoniac Korea Ltd. (Republic of Korea)

12496-58 • 11:30 AM - 11:50 AM

## Unsupervised deep learning approach for voltage contrast (VC) image denoising towards device pillars yield analysis

Author(s): Bappaditya Dey, Victor M. Blanco Carballo, Sandip Halder, imec (Belgium)

12496-59 • 11:50 AM - 12:10 PM

## Novel depth quantification technique of buried defect for development of non-destructive optical inspection

Author(s): Min Ho Rim, Jongsok Yi, Jungtaek Lim, Souk Kim, Younghoon Sohn, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

Lunch Break 12:10 PM - 1:30 PM

### SESSION 13: ELECTRON BEAM METROLOGY II

2 March 2023 • 1:30 PM - 3:20 PM | Convention Center, Grand Ballroom 220B

Session Chairs: Nivea G. Schuch, ASELTA Nanographics (France), Hugo Cramer, ASML Netherlands B.V. (Netherlands)

12496-198 • 1:30 PM - 2:00 PM

## Bringing next-generation e-beam technology out of the lab and into the fab (*Invited Paper*)

Author(s): Ofer Adan, Ziv Parizat, Applied Materials Israel, Ltd. (Israel)

12496-61 • 2:00 PM - 2:20 PM

## Laser assisted SEM for high spatial resolution material metrology and inspection

Author(s): Yasuhiro Shirasaki, Minami Shoji, Hitachi, Ltd. (Japan); Yohei Nakamura, Hitachi High-Tech Korea Co., Ltd. (Republic of Korea), Hitachi, Ltd. (Japan); Shota Mitsugi, Hitachi, Ltd. (Japan); Heita Kimizuka, Hitachi High-Tech Korea Co., Ltd. (Republic of Korea), Hitachi High-Tech Corp. (Japan); Satoshi Takada, Yuko Iwabuchi, Hitachi High-Tech Corp. (Japan); Natsuki Tsuno, Hitachi, Ltd. (Japan)

12496-62 • 2:20 PM - 2:40 PM

## A holistic approach to sub-angstrom CD-SEM fleet matching

Author(s): Bobin Mathew, Gadi Oron, Shmuel Mizrachi, David Uliel, Eyal Angel, Ilan Ben Harush, Mor Baram, Liraz Gershtein, Ran Alkoken, Atai Baldinger, Albert Burshtein, Amos Laist, Applied Materials Israel, Ltd. (Israel)

12496-63 • 2:40 PM - 3:00 PM

## In-line metrology for vertical edge placement control of monolithic CFET using CD-SEM

Author(s): Wei Sun, Hitachi, Ltd. (Japan); Ayumi Doi, Miki Isawa, Hitachi High-Tech Corp. (Japan); Zsolt Tokai, Victor Vega-Gonzales, Gian Lorusso, imec (Belgium)

# CONFERENCE 12496

12496-166 • 3:00 PM - 3:20 PM

## **Advanced high voltage e-beam system combined with an enhanced D2DB for on-device overlay measurement**

Author(s): Seul-Ki Kang, Kotaro Maruyama, Yuichiro Yamazaki, TASMIT, Inc. (Japan); Gian Francesco Lorusso, Anabela Veloso, Matteo Beggiato, imec (Belgium)

**Coffee Break 3:20 PM - 3:40 PM**

### SESSION 14: LATE BREAKING NEWS

2 March 2023 • 3:40 PM - 5:20 PM | Convention Center, Grand Ballroom 220B

Session Chairs: John C. Robinson, KLA Corp. (United States), Matthew J. Sendelbach, TEL Technology Ctr., America, LLC (United States)

12496-65 • 3:40 PM - 4:00 PM

## **300mm in-line metrologies for the characterization of ultra-thin layer of 2D materials**

Author(s): Alain Moussa, Janusz Bogdanowicz, Benjamin Groven, Pierre Morin, Mohamed Saib, Gian Francesco Lorusso, imec (Belgium); Gaetano Santoro, Applied Materials, Inc. (Belgium); Yaniv Abramovitz, Kevin Houtchens, Shmuel Ben Nissim, Applied Materials Israel, Ltd. (Israel); Noga Meir, Joey Hung, Adam M. Urbanowicz, Roy Koret, Igor Turovets, Nova Ltd. (Israel); Anne-Laure Charley, imec (Belgium)

12496-66 • 4:00 PM - 4:20 PM

## **Detection of defective areas and hidden weak patterns in the wafer using massive measurement data**

Author(s): DongHoon Kim, Sungyoon Ryu, Sunhong Jun, Heeyoon Han, Wonjun Choi, Yong-Ju Jeon, Hyun Lee, Souk Kim, Younghoon Sohn, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12496-85 • 4:20 PM - 4:40 PM

## **Measurement of W-recess profile in an advanced node 3D NAND device with IRCD technology utilizing a specialized design-rule compliant target**

Author(s): Nick Keller, Zhuo Chen, Peter Wang, Youcheng Wang, Onto Innovation Inc. (United States); Joshua Frederick, Sadao Takabayashi, Dan Engelhard, Micron Technology, Inc. (United States); Troy Ribaud, Rostislav Grynko, George A. Antonelli, Onto Innovation Inc. (United States); John Hauck, Micron Technology (United States)

12496-83 • 4:40 PM - 5:00 PM

## **Enhancement of overlay metrology accuracy by multi-wavelength scatterometry with rotated quadrupole illumination**

Author(s): Hyun-Sok Kim, Ikhyun Jeong, Baikkyu Hong, Sunouk Nam, Sumin Jang, Kangmin Lee, SK Hynix, Inc. (Republic of Korea); Hongpeng Su, KLA China (China); Minh Jeong, Mingyu Kim, Hongcheon Yang, KLA Corp. (Republic of Korea); Wayne Zhou, KLA China (China); Nanglyeom Oh, DongSub Choi, KLA Corp. (Republic of Korea); Tal Yaziv, Hedvi Spielberg, Ohad Bachar, KLA Israel (Israel)

12496-129 • 5:00 PM - 5:20 PM

## **Expanding optical AEI metrology horizons by introducing multi-wavelength in-device metrology for greater robustness and accuracy**

Author(s): Jinsun Kim, Joeeon Oh, Nanhyung Kim, Inbeom Yim, Jeongjin Lee, Seungyoon Lee, Chan Hwang, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Won-Jae Jang, Se-Ra (Ella) Kim, Thomas Kim, Jin-Moo Byun, Jun Mun, Thuy Vu, Jelmer M. Boter, Mohammad Ali Najafi, Gonzalo Sanguinetti, Stefan N. Smith-Meerman, Mir Shahrjerdy, Filippo Belletti, Vladimir Derenskyi, ASML Netherlands B.V. (Netherlands)



### MONDAY 27 FEBRUARY

#### WELCOME AND MONDAY PLENARY SESSION

27 February 2023 • 8:00 AM - 10:00 AM | Convention Center, Grand Ballroom 220A

Session Chairs: **Kafai Lai**, The Univ. of Hong Kong (United States), Qinghuang Lin, Lam Research Corp. (United States)

8:00 AM: **Symposium Welcome and Opening Remarks**

**Kafai Lai**, University of Hong Kong (United States) and Qinghuang Lin, LAM Research Corp. (United States)

8:05 AM: **Introduction of New SPIE Fellows**

8:15 AM: **2023 SPIE Rudolf and Hilda Kingslake Award in Optical Design**

Presented in recognition of significant achievement in the field of optical design, including the theoretical or experimental aspects of optical engineering.

8:25 AM: **2023 SPIE Frits Zernike Award for Microlithography**

Presented in recognition of outstanding accomplishments in micro-lithographic technology, especially those furthering the development of semiconductor lithographic imaging solutions.

8:35 AM: **Presentation of the Nick Cobb Memorial Scholarship**

The Nick Cobb Memorial Scholarship is awarded to an outstanding graduate student studying advanced lithography or a related field. The scholarship is jointly funded by Siemens EDA and SPIE.

12494-505 • 8:40 AM - 9:20 AM

**Driving Moore's Law into the next decade** (*Plenary Presentation*)

**Martin van den Brink**, ASML Netherlands B.V. (Netherlands)

12496-504 • 9:20 AM - 10:00 AM

**Update on CHIPS Act implementation** (*Plenary Presentation*)

**Laurie E. Locascio**, National Institute of Standards and Technology (United States)

#### SESSION 1: KEYNOTE SESSION

27 February 2023 • 3:20 PM - 6:00 PM | Convention Center, Room 211B

Session Chairs: **J. Alexander Liddle**, National Institute of Standards and Technology (United States), **Ricardo Ruiz**, Lawrence Berkeley National Lab. (United States)

12497-1 • 3:20 PM - 4:00 PM

**Inkjet printing for additive manufacturing, semiconductors and other applications** (*Keynote Presentation*)

Author(s): **Michael Doran**, Kai Keller, Antonio Schmidt, Notion Systems GmbH (Germany)

12497-2 • 4:00 PM - 4:40 PM

**The evolution of heterogeneous integration and packaging for the age of chiplets** (*Keynote Presentation*)

Author(s): **Spyridon Skordas**, IBM Research Artificial Intelligence Hardware Ctr. (United States)

12497-3 • 4:40 PM - 5:20 PM

**Nanoimprint process to mass manufacture highly-angled high-RI gratings for augmented reality combiners** (*Keynote Presentation*)

Author(s): **Giuseppe Calafiore**, Tingling Rao, Ankit Vora, Matt Colburn, Nihar Mohanty, Zachary Perlmutter, Emily Makoutz, Alexander Koshelev, Richard A. Farrell, Meta (United States)

12497-158 • 5:20 PM - 6:00 PM

**Material and patterning innovation: The foundation for Moore's law extension** (*Keynote Presentation*)

Author(s): **Florian Gstrein**, Intel Corp. (United States)

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TUESDAY 28 FEBRUARY

## TUESDAY PLENARY SESSION

28 February 2023 • 8:00 AM - 9:50 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Kafai Lai, The Univ. of Hong Kong (United States), Qinghuang Lin, Lam Research Corp. (United States)

8:00 AM - 8:10 AM

### Introduction and Announcements

8:10 AM - 8:30 AM

### 50th anniversary of Micralign: A retrospective

12495-500 • 8:30 AM - 9:10 AM

**Accelerated computing for silicon leadership** (*Plenary Presentation*)

Vivek K. Singh, NVIDIA Corp. (United States)

12497-501 • 9:10 AM - 9:50 AM

**Pushing the limits of nano-imprint lithography for immersive displays** (*Plenary Presentation*)

Bernard C. Kress, Google (United States)

Coffee Break 9:50 AM - 10:20 AM

## SESSION 2: E-BEAM

28 February 2023 • 10:20 AM - 12:10 PM | Convention Center, Room 211B

Session Chairs: Ines A. Stolberg, Vistec Electron Beam GmbH (Germany), Hans Loeschner, IMS Nanofabrication GmbH (Austria)

12497-4 • 10:20 AM - 10:50 AM

**The potential of e-beam lithography for micro- and nano-optics on large areas** (*Invited Paper*)

Author(s): Uwe D. Zeitner, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany); Michael Banasch, Vistec Electron Beam GmbH (Germany); Marcus Trost, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany)

12497-5 • 10:50 AM - 11:10 AM

**Efficient Exposure of Non-Manhattan Layouts using Vistec's Shaped Beam Systems**

Author(s): Eike Linn, Stefan Fasold, Vistec Electron Beam GmbH (Germany); Reinhard Galler, Sebastian Kuefner, EQUIcon Software GmbH Jena (Germany); Ines Stolberg, Vistec Electron Beam GmbH (Germany); Martin Suelzle, EQUIcon Software GmbH Jena (Germany); Ulf Weidenmueller, Vistec Electron Beam GmbH (Germany)

12497-6 • 11:10 AM - 11:30 AM

**Industrial maskless aligner: New levels of flexibility in lithography**

Author(s): Philip Paul, Heidelberg Instruments Mikrotechnik GmbH (Germany)

12497-7 • 11:30 AM - 11:50 AM

**High-productivity direct-write e-beam lithography: An enabling patterning technology to augment your lithography toolbox**

Author(s): Kenneth P. MacWilliams, Andrew C. Ceballos, Ted A. Prescop, David K. Lam, Multibeam Corp. (United States)

12497-51 • 11:50 AM - 12:10 PM

**E-beam direct write lithography the versatile ally of optical lithography**

Author(s): Fabien Laulagnet, Univ. Grenoble Alpes, CEA-LETI (France); Jacques-Alexandre Dallery, Vistec Electron Beam GmbH (Germany); Laurent Pain, Michael May, Béatrice Hemard, Franck Garlet, Isabelle Servin, Chiara Sabbione, Univ. Grenoble Alpes (France)

Lunch Break 12:10 PM - 1:30 PM

## SESSION 3: MULTI-BEAM MASK WRITING

28 February 2023 • 1:30 PM - 3:30 PM | Convention Center, Room 211B

Session Chairs: Hans Loeschner, IMS Nanofabrication GmbH (Austria), Ines A. Stolberg, Vistec Electron Beam GmbH (Germany)

12497-9 • 1:30 PM - 2:00 PM

**MBMW (Multi-beam mask writer) : The way of realization for EUV masks for advanced nodes** (*Invited Paper*)

Author(s): Naoya Hayashi, Dai Nippon Printing Co., Ltd. (Japan)

12497-10 • 2:00 PM - 2:30 PM

**Multi-beam patterning technology and mask making beyond 5nm** (*Invited Paper*)

Author(s): Bassam Shamoun, Intel Corp. (United States)

12497-8 • 2:30 PM - 3:00 PM

**Current performance and future plans on electron multi-beam mask writers toward high-NA EUV era** (*Invited Paper*)

Author(s): Hiroshi Matsumoto, Haruyuki Nomura, Hayato Kimura, Keisuke Yamaguchi, Yoshinori Kojima, Masato Saito, Takao Tamura, Noriaki Nakayamada, NuFlare Technology, Inc. (Japan)

12497-12 • 3:00 PM - 3:30 PM

**MBMW-301: A revolutionary step for multi-beam mask writers** (*Invited Paper*)

Author(s): Christof Klein, Hans Loeschner, Elmar Platzgummer, IMS Nanofabrication GmbH (Austria)

Coffee Break 3:30 PM - 3:50 PM

## SESSION 4: NANOIMPRINT I

28 February 2023 • 3:50 PM - 5:30 PM | Convention Center, Room 211B

Session Chairs: Douglas J. Resnick, Canon Nanotechnologies, Inc. (United States), Sandip Halder, imec (Belgium)

12497-13 • 3:50 PM - 4:20 PM

**Nanoimprint post processing techniques to address edge placement error** (*Invited Paper*)

Author(s): Makoto Ogusu, Masaki Ishida, Masahiro Tamura, Canon Inc. (Japan); Hideki Kunugi, Tomohito Yamaji, Ryuichi Asako, Keisuke Tanaka, Shuhei Tamura, Tokyo Electron Ltd. (Japan); Keita Sakai, Toshiki Ito, Isao Kawata, Canon Inc. (Japan)

12497-14 • 4:20 PM - 4:50 PM

**Development of nanoimprint templates for dual damascene processing** (*Invited Paper*)

Author(s): Takaharu Nagai, Hisayoshi Watanabe, Koji Ichimura, Dai Nippon Printing Co., Ltd. (Japan)



12497-15 • 4:50 PM - 5:10 PM

## Replication of 3D patterns from a grayscale resin master by nanoimprint process

Author(s): Api Warsono, Diana Stephany Fernandez Rodas, Jérôme Rêche, Anaïs De Lehelle D'Affroux, Sébastien Bérard-Bergery, CEA-LETI (France)

12497-16 • 5:10 PM - 5:30 PM

## Next generation imprint equipment for patterning high quality micro-optical elements

Author(s): Vijay Ramya Kolli, Simon Drieschner, Fabian Kloiber, SUSS MicroTec Lithography GmbH (Germany)

### TUESDAY EVENING PLENARY

28 February 2023 • 5:30 PM - 6:15 PM | Convention Center, Grand Ballroom 220A

12498-502 • 5:30 PM - 6:00 PM

## Are 2D transition metal dichalcogenides transistors the future silicon replacement or hype? *(Plenary Presentation)*

Kevin P. O'Brien, Intel Corp. (United States)

6:15 PM - 7:15 PM

## Sustainability and Lithography's Role: A Panel Discussion

MODERATOR:

Dan Hutcheson, TechInsights (United States)

PANELISTS:

John Cahill, ASML-Cymer (United States)

Emily Gallagher, imec (Belgium)

Chris Jones, Edwards Vacuum (United Kingdom)

Mark Merrill, Lam Research (United States)

Ryan Russell, Intel (United States)

Akihisa Sekiguchi, Tokyo Electron LTD. (Japan)

It's become popular to make commitments to new business models and supply chain strategies for conservation and carbon neutrality in the semiconductor ecosystem, including initiatives to reduce greenhouse gases, conserve energy and water, and focus more on renewables and reusables. In addition to these, panelists will address the role lithography and patterning will play and has played in addressing these critical issues. For example: Koomey's law states that Compute-per-Watt improves exponentially over time. Lithography's critical role in making this possible in this is well established through its ability to make circuits more power efficient. This means that there is a long payback to lithography when considering Life-Cycle Sustainability Assessment (LCSA) methods to evaluate the chips they produce. This and more will be discussed.

### WEDNESDAY 1 MARCH

#### SESSION 5: NANOIMPRINT II

1 March 2023 • 8:10 AM - 10:00 AM | Convention Center, Room 211B

Session Chairs: Sandip Halder, imec (Belgium), Douglas J. Resnick, Canon Nanotechnologies, Inc. (United States)

12497-17 • 8:10 AM - 8:40 AM

## High transfer fidelity via nanoimprint lithography of patterns for bioelectronics applications *(Invited Paper)*

Author(s): Pau Guell, Mohamed Asbahi, Steve Smout, Myriam Willegems, Bogumila Kutrzebakotowska, Matthew Traub, Silvia Lenci, Eleonora Storace, Simone Severi, imec (Belgium)

12497-18 • 8:40 AM - 9:10 AM

## Overlay and defect improvements on nanoimprint tools for semiconductor device manufacturing *(Invited Paper)*

Author(s): Naoki Maruyama, Yoshio Suzuki, Satoru Jimbo, Isamu Yamashita, Kenji Yamamoto, Kiyohito Yamamoto, Mitsuru Hiura, Yukio Takabayashi, Canon Inc. (Japan)

12497-19 • 9:10 AM - 9:40 AM

## Fabrication of Dual Damascene structure with Nanoimprint lithography and Dry-etching structure with nanoimprint lithography and dry-etching *(Invited Paper)*

Author(s): Norikazu Takeuchi, KIOXIA Corp. (Japan)

12497-20 • 9:40 AM - 10:00 AM

## The FabSCIL platform: 200 and 300mm double side full wafer NIL

Author(s): Marc A. Verschuuren, Rob Voorkamp, SCIL Nanoimprint Solutions (Netherlands); Mohammad Ramezani, TeraNova B.V. (Netherlands); Gert-Jan Hurxkens, Jeroen Visser, SCIL Nanoimprint Solutions (Netherlands)

Coffee Break 10:00 AM - 10:30 AM

#### SESSION 6: NOVEL PATTERNING I

1 March 2023 • 10:30 AM - 12:10 PM | Convention Center, Room 211B

Session Chairs: Tito L. Busani, The Univ. of New Mexico (United States), Ivo W. Rangelow, Technische Univ. Ilmenau (Germany)

12497-21 • 10:30 AM - 10:50 AM

## Novel Approach of patterning technologies enabling monolithic micro-optical components

Author(s): Johannes Wolf, Susanne Gruetzner, Anja Voigt, Arne Schleunitz, Gabi Gruetzner, micro resist technology GmbH (Germany)

12497-22 • 10:50 AM - 11:10 AM

## Scalable digital atomic precision lithography

Author(s): John N. Randall, Ehud Fuchs, James H. G. Owen, Zyvex Labs, LLC (United States); Afshin Alipour, Emma L. Fowler, S.O. Reza Mohemani, The Univ. of Texas at Dallas (United States)

12497-23 • 11:10 AM - 11:30 AM

## High-localized nanolithography based on high-precision nanopositioning and nomeasuring machines

Author(s): Eberhard Manske, Technische Univ. Ilmenau (Germany); Ivo W. Rangelow, Technische Univ. Ilmenau (Germany), nano analytik GmbH (Germany); Jaqueline Stauffenberg, Thomas Kissinger, Ingo Ortlepp, Thomas Fröhlich, Technische Univ. Ilmenau (Germany); Denis Dontsov, SIOS Messtechnik GmbH (Germany); Alexander Reum, nano analytik GmbH (Germany)

12497-24 • 11:30 AM - 11:50 AM

## High-throughput additive manufacturing of microelectronics and advanced packaging

Author(s): Ahmed Busnaina, Northeastern Univ. (United States); Anthony Childress, Northeastern Univ. (United States); Ahmed Abdelaziz, Northeastern Univ. (United States)

12497-25 • 11:50 AM - 12:10 PM

## Key ingredients for manufacturing superconducting quantum processors at scale

Author(s): Thorsten Last, Orange Quantum Systems (Netherlands); Massimo Mongillo, Tsvetan Ivanov, imec (Belgium); Adriaan Rol, Garrelt Alberts, Orange Quantum Systems (Netherlands); Danny Wan,

Lunch Break 12:10 PM - 1:10 PM

# CONFERENCE 12497

## SESSION 7: DSA I

1 March 2023 • 1:10 PM - 3:30 PM | Convention Center, Room 211B  
Session Chairs: Chandrasekhar Sarma, Intel Corp. (United States),  
Gurpreet Singh, Intel Corp. (United States)

12497-26 • 1:10 PM - 1:40 PM

**Design, synthesis, and demonstration of multifunctional block copolymers for directed self-assembly applications with varying resolution and density multiplication of features** (*Invited Paper*)

Author(s): Paul F. Nealey, The Univ. of Chicago (United States)

12497-27 • 1:40 PM - 2:10 PM

**Mitigating stochasticity in EUV lithography by directed self-assembly** (*Invited Paper*)

Author(s): Lander Verstraete, Hyo Seon Suh, Julie Van Bel, Purnota Hannan Timi, Philippe Bezaud, Jelle Vandereyken, Matteo Beggiato, Amir-Hossein Tamaddon, Christophe Beral, Waikin Li, Mihir Gupta, Roberto Fallica, imec (Belgium)

12497-28 • 2:10 PM - 2:40 PM

**Pattern fidelity improvement of DSA hole patterns** (*Invited Paper*)

Author(s): Makoto Muramatsu, Takanori Nishi, Tokyo Electron Kyushu Ltd. (Japan); Kiyohito Ito, Yoshihito Takahashi, Yasunori Hatamura, Tokyo Electron Miyagi Ltd. (Japan); Takahiro Kitano, Tokyo Electron Ltd. (Japan); Tomohiro Iwaki, Micron Memory Japan Inc. (Japan)

12497-29 • 2:40 PM - 3:10 PM

**Continuing Moore's Law with next-gen DSA** (*Invited Paper*)

Author(s): Gurpreet Singh, Intel Corp. (United States)

12497-30 • 3:10 PM - 3:30 PM

**EUV lithography line-space pattern rectification using block copolymer directed self-assembly: A roughness and defectivity study**

Author(s): Julie Van Bel, imec (Belgium), KU Leuven (Belgium); Lander Verstraete, Hyo Seon Suh, Philippe Bezaud, Jelle Vandereyken, Waikin Li, Matteo Beggiato, Amir-Hossein Tamaddon, Christophe Beral, imec (Belgium); Stefan De Gendt, imec (Belgium), KU Leuven (Belgium); Andreia Santos, SCREEN SPE Germany GmbH (Germany); Boaz Alperon, EMD Electronics (United States); YoungJun Her, EMD Electronics (Belgium)

Coffee Break 3:30 PM - 4:00 PM

## SESSION 8: DSA II

1 March 2023 • 4:00 PM - 5:30 PM | Convention Center, Room 211B

Session Chairs: Gurpreet Singh, Intel Corp. (United States),  
Chandrasekhar Sarma, Intel Corp. (United States)

12497-31 • 4:00 PM - 4:30 PM

**Novel self-assembled patterns from complex block copolymer architectures** (*Invited Paper*)

Author(s): Caroline A. Ross, Massachusetts Institute of Technology (United States)

12497-32 • 4:30 PM - 5:00 PM

**Block copolymer nanopatterning for semiconductor and non-semiconductor applications** (*Invited Paper*)

Author(s): Sang Ouk Kim, KAIST (Republic of Korea)

12497-33 • 5:00 PM - 5:30 PM

**Chemically tailored block copolymers based on polystyrene-b-polymethacrylates for DSA patterning** (*Invited Paper*)

Author(s): Teruaki Hayakawa, Shinsuke Maekawa, Yuta Nabae, Tokyo Institute of Technology (Japan); Takehiro Seshimo, Takahiro Dazai, Kazufumi Sato, Tokyo Ohka Kogyo Co., Ltd. (Japan)

## POSTER SESSION

1 March 2023 • 5:30 PM - 7:00 PM | Convention Center, Hall 2

Conference attendees are invited to attend the Poster Session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the Poster Session.

**Poster Setup: Wednesday 10:00 AM - 4:30 PM**

Poster authors, view poster presentation guidelines and set-up instructions at <http://spie.org/ALPosterGuidelines>.

12497-45 • 5:30 PM - 7:00 PM

**Hierarchical patterning: sub-10  $\mu\text{m}$  3D structures nano-textured by block copolymer self-assembly**

Author(s): Raphaël Feougier, Maxime Argoud, Nicolas Posseme, Raluca Tiron, CEA-LETI (France)

12497-46 • 5:30 PM - 7:00 PM

**Overlay performances of wafer scale nanoimprint lithography**

Author(s): Jérôme Rêche, Api Warsono, Anaïs De Lehelle D'Affroux, CEA-LETI (France); Jonas Khan, Sebastian Haumann, Andrea Kneidinger, EV Group (Austria)

12497-47 • 5:30 PM - 7:00 PM

**A compensation methodology for pelicle deformation to improve overlay on nano semiconductor**

Author(s): Heng Wang, Yuxiang Wu, Shuliang Zhou, Meng-Hsuan Tsai, Chia-Hung Chen, Stone Zhao, Hao Cheng, Zhao Cheng, ChangXin Memory Technologies, Inc. (China); Bing Wang, Shaun Dai, ASML (China)

12497-48 • 5:30 PM - 7:00 PM

**Continuous large area metal oxide printing from liquid metal**

Author(s): Man Hou Vong, North Carolina State Univ. (United States); Minsik Kong, Unyong Jeong, Pohang Univ. of Science and Technology (Republic of Korea); Michael D. Dickey, North Carolina State Univ. (United States)

12497-49 • 5:30 PM - 7:00 PM

**Application of double exposure technique in plasmonic lithography**

Author(s): Huwen Ding, Lihong Liu, Lisong Dong, Zhishu Chen, Yayi Wei, Institute of Microelectronics (China)

12497-50 • 5:30 PM - 7:00 PM

**Computational study of 3-dimensional photo lithography on limitations and possibility for novel structures**

Author(s): Yoshihiko Hirai, Toshiaki Tanaka, Masaru Sasago, Masaaki Yasuda, Osaka Metropolitan Univ. (Japan)

12497-52 • 5:30 PM - 7:00 PM

**Resistless lithography on Si surfaces by EUV-induced surface modification**

Author(s): Prajith Karadan, Chien-Hsun Yu, Yasin Ekinci, Dimitrios Kazazis, Paul Scherrer Institut (Switzerland)

12497-53 • 5:30 PM - 7:00 PM

**Study on the releasing process of tilted grating structure for AR glasses using nanoimprint**

Author(s): Yoshihiko Hirai, Masaaki Yasuda, Osaka Metropolitan Univ. (Japan)

12497-54 • 5:30 PM - 7:00 PM

**Sequence-defined polymer brush monolayers for surface nanopatterning**

Author(s): Beihang Yu, Boyce Chang, Lawrence Berkeley National Lab. (United States); Whitney Loo, The Univ. of Chicago (United States); Scott Dhuey, Paul Ashby, Michael Connolly, Lawrence Berkeley National Lab. (United States); Kathleen Ryan, Grigory Tikhomirov, Univ. of California, Berkeley (United States); Ronald Zuckermann, Ricardo Ruiz, Lawrence Berkeley National Lab. (United States)

12497-55 • 5:30 PM - 7:00 PM

**Cross-functional photoresists and photopolymers enhancing micro- and nanofabrication**

Author(s): Arne Schleunitz, Christine Schuster, Anja Voigt, Maria Russew, Mirko Lohse, Marina Heinrich, Gabi Gruetzner, micro resist technology GmbH (Germany)

12497-56 • 5:30 PM - 7:00 PM

**Micro-nanostructuring of ZrO<sub>2</sub> sol-gel by optical and nanoimprint lithography on various substrate for optical applications.**

Author(s): Victor Vallejo Otero, Nicolas Crespo-Monteiro, Arnaud Valour, Marie Traynar, Emilie Gamet, Stephanie Reynaud, Yves Jourlin, Lab. Hubert Curien (France)

12497-157 • 5:30 PM - 7:00 PM

**Realization of high-Q Lamb wave resonator with smooth vertical etching profile for thin film lithium niobate**

Author(s): Arjun Aryal, Ravi Kiran Chityala, Isaac Stricklin, Ctr. for High Technology Materials, The Univ. of New Mexico (United States); Sidhant Tiwari, Aleem Siddiqui, Sandia National Labs. (United States); Tito Busani, Ctr. for High Technology Materials, The Univ. of New Mexico (United States)

**THURSDAY 2 MARCH**

**SESSION 9: DSA III**

2 March 2023 • 8:50 AM - 10:10 AM | Convention Center, Room 211B

Session Chair: Martha I. Sanchez, Applied Materials, Inc. (United States)

12497-34 • 8:50 AM - 9:20 AM

**Templating 3D hierarchical materials using bottlebrush block copolymers and nanoimprint lithography for optical and energy storage devices (Invited Paper)**

Author(s): James J. Watkins, Univ. of Massachusetts Amherst (United States)

12497-35 • 9:20 AM - 9:50 AM

**Advancing the capabilities of polymer blend directed self-assembly (Invited Paper)**

Author(s): Gregory S. Doerk, Aaron Stein, Suwon Bae, Brookhaven National Lab. (United States); Marcus Noack, Lawrence Berkeley National Lab. (United States); Masafumi Fukuto, Ashish A. Kulkarni, Brookhaven National Lab. (United States); Kristof Toth, Yale Univ. (United States); Chinedum Osuji, Univ. of Pennsylvania (United States); Kevin Yager, Brookhaven National Lab. (United States)

12497-36 • 9:50 AM - 10:10 AM

**A holistic approach to high precision patterning science**

Author(s): Ricardo Ruiz, Lawrence Berkeley National Lab. (United States); Stacey F. Bent, Stanford Univ. (United States); Samuel M. Blau, Brett A. Helms, Frances A. Houle, Oleg Kostko, Patrick P. Naulleau, Lawrence Berkeley National Lab. (United States); Paul F. Nealey, The Univ. of Chicago (United States); Christopher K. Ober, Cornell Univ. (United States); Dahyun Oh, San José State Univ. (United States); Rachel A. Segalman, Univ. of California, Santa Barbara (United States); Cheng Wang, Lawrence Berkeley National Lab. (United States)

**Coffee Break 10:10 AM - 10:40 AM**

**SESSION 10: NOVEL PATTERNING III**

2 March 2023 • 10:40 AM - 12:30 PM | Convention Center, Room 211B

Session Chairs: Mark A. van de Kerkhof, ASML Netherlands B.V. (Netherlands), Niels Wijnaendts van Resandt, Heidelberg Instruments Inc. (United States)

12497-37 • 10:40 AM - 11:10 AM

**Reconfigurable unpatterned metasurfaces via acoustoelectric gating of graphene (Invited Paper)**

Author(s): Aleem Siddiqui, Amun Jarzembski, Scott W. Schmucker, Robynn-Lynne Paldi, Sidhant Tiwari, Justine Koepke, Aaron M. Katzenmeyer, Patrick S. Finnegan, Robert Reyna, Michael Wood, Joseph P. Klesko, Sandia National Labs. (United States); Thomas E. Beechem, Purdue Univ. (United States); Darren W. Branch, Sandia National Labs. (United States)

12497-38 • 11:10 AM - 11:30 AM

**Lensless holographic endoscopes realized with direct laser writing**

Author(s): Willi G. Mantei, Jonas Wiedenmann, Benedikt Stender, Multiphoton Optics GmbH (Germany); Elias Scharf, Robert Kuschmierz, Jürgen Czarske, TU Dresden (Germany)

12497-39 • 11:30 AM - 11:50 AM

**Seamless micro and nanopatterned drum molds based on ultrasonic indentation**

Author(s): Stephen Furst, Nichole Cates, Lauren Micklow, Smart Material Solutions, Inc. (United States)

12497-40 • 11:50 AM - 12:10 PM

**Advancing high resolution photolithography with hybrid polymers for waferscale manufacture of microoptics and patterned passivation layers**

Author(s): Matthias F. Koch, EMD Electronics (Germany); Maria Russew, Ludwig Scharfenberg, micro resist technology GmbH (Germany); Andreas Benker, EMD Electronics (Germany); Arne Schleunitz, Gabi Grützner, micro resist technology GmbH (Germany)

# CONFERENCE 12497

12497-41 • 12:10 PM - 12:30 PM

## **Optimization of dual phase change material mask with sub-diffraction resolution for novel photolithography technology**

Author(s): Shinill Kang, Donghyun Kim, Ika Oktavia Suryani, Yonsei Univ. (Republic of Korea)

Lunch Break 12:30 PM - 2:00 PM

### **SESSION 11: GREYSCALE LITHOGRAPHY**

2 March 2023 • 2:00 PM - 3:00 PM | Convention Center, Room 211B

Session Chairs: J. Alexander Liddle, National Institute of Standards and Technology (United States), Ricardo Ruiz, Lawrence Berkeley National Lab. (United States)

12497-42 • 2:00 PM - 2:20 PM

## **Impact of optical mask variability on 3D grayscale lithography patterning**

Author(s): Sébastien Bérard-Bergery, Univ. Grenoble Alpes (France), CEA-LETI (France); Gaby Bélot, STMicroelectronics S.A. (France), Univ. Grenoble Alpes (France), CEA-LETI (France); Ujwol Palanchoke, Aurélien Fay, Univ. Grenoble Alpes (France), CEA-LETI (France); Elodie Sungauer, Charlotte Beylier, STMicroelectronics S.A. (France); Florian Tomaso, Rémi Coquand, Univ. Grenoble Alpes (France), CEA-LETI (France)

12497-43 • 2:20 PM - 2:40 PM

## **Ultra-thick positive photoresist layers for maskless grayscale lithography**

Author(s): Dominique Collé, Gerda Ekindorf, Heidelberg Instruments Mikrotechnik GmbH (Germany)

12497-44 • 2:40 PM - 3:00 PM

## **Pushing deep grayscale lithography beyond 100 $\mu\text{m}$ pattern depth with a novel photoresist**

Author(s): Christine Schuster, micro resist technology GmbH (Germany); Gerda Ekindorf, Heidelberg Instruments Mikrotechnik GmbH (Germany); Anja Voigt, Arne Schleunitz, Gabi Gruetzner, micro resist technology GmbH (Germany)

# Advances in Patterning Materials and Processes XL

27 February - 1 March 2023 | Convention Center, Grand Ballroom 220C

Conference Chair: **Douglas Guerrero**, Brewer Science, Inc. (United States)

Conference Co-Chair: **Gilles R. Amblard**, SAMSUNG Austin Semiconductor LLC (United States)

Program Committee: **Ramakrishnan Ayothi**, JSR Micro, Inc. (United States); **Luisa D. Bozano**, Applied Materials, Inc. (United States); **Robert L. Brainard**, SUNY Polytechnic Institute (United States); **Ryan Callahan**, FUJIFILM Electronic Materials U.S.A., Inc. (United States); **James F. Cameron**, DuPont Electronics & Imaging (United States); **Sonia Castellanos**, imec (Belgium); **Ralph R. Dammel**, EMD Electronics (United States); **Anuja De Silva**, Lam Research Corp. (United States); **Danilo De Simone**, imec (Belgium); **Roel Gronheid**, KLA Corp. (Belgium); **Masahiko Harumoto**, SCREEN Semiconductor Solutions Co., Ltd. (Japan); **Clifford L. Henderson**, The Univ. of Alabama (United States); **Craig D. Higgins**, GlobalFoundries (United States); **Christoph K. Hohle**, Fraunhofer-Institut für Photonische Mikrosysteme IPMS (Germany); **Xisen Hou**, DuPont Electronics & Imaging (United States); **Dario L. Goldfarb**, IBM Thomas J. Watson Research Ctr. (United States); **Scott W. Jessen**, Texas Instruments Inc. (United States); **Jing Jiang**, Applied Materials, Inc. (United States); **Yoshio Kawai**, Shin-Etsu Chemical Co., Ltd. (Japan); **Marie E. Krysak**, Intel Corp. (United States); **Qinghuang Lin**, Lam Research Corp. (United States); **Nobuyuki N. Matsuzawa**, Panasonic Corp. (Japan); **Warren Montgomery**, Irresistible Materials Ltd. (United States); **Tomohiro Oikawa**, Tokyo Ohka Kogyo America, Inc. (United States); **Daniel P. Sanders**, IBM Research - Almaden (United States); **Jara . Garcia-Santaclara**, ASML Netherlands B.V. (Netherlands); **Mark H. Somervell**, Tokyo Electron America, Inc. (United States); **Jason K. Stowers**, Inpria Corp. (United States); **Raluca Tiron**, CEA-LETI (France); **Aiwen Wu**, Entegris, Inc. (United States); **Ankit Vora**, Meta (United States)

CONFERENCE CO-SPONSOR:



## MONDAY 27 FEBRUARY

### WELCOME AND MONDAY PLENARY SESSION

27 February 2023 • 8:00 AM - 10:00 AM | Convention Center, Grand Ballroom 220A

Session Chairs: **Kafai Lai**, The Univ. of Hong Kong (United States), **Qinghuang Lin**, Lam Research Corp. (United States)

#### 8:00 AM: Symposium Welcome and Opening Remarks

**Kafai Lai**, University of Hong Kong (United States) and **Qinghuang Lin**, LAM Research Corp. (United States)

#### 8:05 AM: Introduction of New SPIE Fellows

#### 8:15 AM: 2023 SPIE Rudolf and Hilda Kingslake Award in Optical Design

Presented in recognition of significant achievement in the field of optical design, including the theoretical or experimental aspects of optical engineering.

#### 8:25 AM: 2023 SPIE Frits Zernike Award for Microlithography

Presented in recognition of outstanding accomplishments in micro-lithographic technology, especially those furthering the development of semiconductor lithographic imaging solutions.

#### 8:35 AM: Presentation of the Nick Cobb Memorial Scholarship

The Nick Cobb Memorial Scholarship is awarded to an outstanding graduate student studying advanced lithography or a related field. The scholarship is jointly funded by Siemens EDA and SPIE.

12494-505 • 8:40 AM - 9:20 AM

#### Driving Moore's Law into the next decade (Plenary Presentation)

**Martin van den Brink**, ASML Netherlands B.V. (Netherlands)

12496-504 • 9:20 AM - 10:00 AM

#### Update on CHIPS Act implementation (Plenary Presentation)

**Laurie E. Locascio**, National Institute of Standards and Technology (United States)

Coffee Break 10:00 AM - 10:30 AM

### SESSION 1: MATERIALS FOR HIGH NA EUV LITHOGRAPHY

27 February 2023 • 10:30 AM - 12:10 PM | Convention Center, Grand Ballroom 220C

Session Chairs: **Jing Jiang**, Applied Materials, Inc. (United States), **Warren Montgomery**, EMD Electronics (United States)

12498-1 • 10:30 AM - 10:50 AM

#### Dry resist patterning readiness towards high-NA EUV lithography

Author(s): **Hyo Seon Suh**, **Danilo De Simone**, **Christophe Beral**, **Mihir Gupta**, **Nadia Vandebroek**, imec (Belgium); **Anuja De Silva**, **Ali Haider**, **Ching-Chung Huang**, **Mohand Brouri**, **Francesco Gullo**, **Shruti Jambaldinni**, **Benjamin Kam**, **Hicham Zaid**, **Elisseos Verveniotis**, Lam Research Belgium BV (Belgium); **Samantha Tan**, **Tim Weidman**, **Jengyi Yu**, **Da Li**, **Jun Xue**, **Younghee Lee**, Lam Research Corp. (United States)

12498-2 • 10:50 AM - 11:10 AM

#### MOx resist formulation and process advances towards high-NA EUV lithography

Author(s): **Peter De Schepper**, Inpria Corp. (Belgium); **Brian Cardineau**, **Amrit K. Narasimhan**, **Lauren McQuade**, Inpria Corp. (United States); **Jan Doise**, Inpria Corp. (Belgium); **Michael Kocsis**, Inpria Corp. (United States); **Kazuki Kasahara**, JSR Micro, Inc. (United States); **Stephen T. Meyers**, Inpria Corp. (United States)

12498-3 • 11:10 AM - 11:30 AM

#### EUV interference lithography resist screening activity in H2-2022

Author(s): **Aysegul Develioglu**, **Timothee Paul Allenet**, **Michaela Vockenhuber**, Paul Scherrer Institut (Switzerland); **Lidia van Lent-Protasova**, ASML Netherlands B.V. (Netherlands); **Yasin Ekinci**, **Dimitrios Kazazis**, Paul Scherrer Institut (Switzerland)

# CONFERENCE 12498

12498-4 • 11:30 AM - 11:50 AM

## Advanced development methods for high-NA EUV lithography

Author(s): Cong Que Dinh, Tokyo Electron Kyushu Ltd. (Japan); Seiji Nagahara, Tokyo Electron Ltd. (Japan); Yuhei Kuwahara, Arnaud Dauendorffer, Soichiro Okada, Seiji Fujimoto, Shinichiro Kawakami, Satoru Shimura, Makoto Muramatsu, Tokyo Electron Kyushu Ltd. (Japan); Kathleen Nafus, Michael A. Carcasi, Mark H. Somervell, Tokyo Electron America, Inc. (United States); Lior Huli, Kanzo Kato, TEL Technology Ctr., America, LLC (United States); Xiang Liu, Tokyo Electron Ltd. (Japan); Michael Kocsis, Peter De Schepper, Stephen T. Meyers, Inpria Corp. (United States); Kazuki Kasahara, JSR Micro, Inc. (United States); Jara Garcia Santaclara, Rik Hoefnagels, ASML Netherlands B.V. (Netherlands); Patrick Naulleau, Lawrence Berkeley National Lab. (United States)

12498-5 • 11:50 AM - 12:10 PM

## Development on main chain scission resists for high-NA EUV lithography

Author(s): Akihide Shirotori, Manabu Hoshino, Makoto Fujimura, Zeon Corp. (Japan); SinFu Yeh, Zeon Corp. (Belgium); Danilo De Simone, Geert Vandenberghe, imec (Belgium); Hideaki Sanuki, Zeon Corp. (Japan)

Lunch Break 12:10 PM - 1:20 PM

### SESSION 2: PROCESS IMPROVEMENTS

27 February 2023 • 1:20 PM - 3:00 PM | Convention Center, Grand Ballroom 220C

Session Chairs: Ankit Vora, Meta (United States), Nobuyuki N. Matsuzawa, Panasonic Corp. (Japan)

12498-6 • 1:20 PM - 1:40 PM

## Process signature correction through film thickness modification of a spin-on glass film

Author(s): Jodi Grzeskowiak, Michael Murphy, Daniel Fulford, David Conklin, TEL Technology Ctr., America, LLC (United States)

12498-7 • 1:40 PM - 2:00 PM

## Track integrated backside cleaning solution: Impact of backside contamination on printing distortions

Author(s): Andreia Santos, Wesley Zanders, Elke Caron, SCREEN SPE Germany GmbH (Belgium); Masahiko Harumoto, SCREEN Semiconductor Solutions Co., Ltd. (Japan); Jelle Vandereyken, Jan V. Hermans, Vincent Truffert, Sandip Halder, imec (Belgium); Ronald Otten, ASML Netherlands B.V. (Netherlands); Leon van Dijk, ASML Belgium N.V. (Belgium); Richard van Haren, ASML Netherlands B.V. (Netherlands)

12498-8 • 2:00 PM - 2:20 PM

## Continued optimization of point-of-use filtration in metal oxide photoresist to reduce defect density

Author(s): Tetsu Kohyama, Nihon Entegris G.K. (Japan); Shu-Hao Chang, Jan Doise, Michael Kocsis, Peter de Schepper, Inpria Corp. (United States); Philippe Foubert, imec (Belgium)

12498-9 • 2:20 PM - 2:40 PM

## Development of a novel cleaner for contaminant removal in equipment used in semiconductor manufacturing which reduces time and solvent waste

Author(s): Isao Hirano, Motoki Takahashi, Kuniteru Soeda, Masaki Kadowaki, Komei Hirahara, Takayuki Hosono, Jun Koshiyama, Tomoyuki Yazawa, Tokyo Ohka Kogyo Co., Ltd. (Japan)

12498-10 • 2:40 PM - 3:00 PM

## Modification of organic underlayers by plasma during dry etching and its effect on the film properties

Author(s): Soojung C. Leem, Jae Hwan Sim, Youngeun Bae, DuPont (Republic of Korea)

Coffee Break 3:00 PM - 3:20 PM

### SESSION 3: EUVL STOCHASTICS

Joint Session with 12494 and 12498

#### NOTE ROOM CHANGE

27 February 2023 • 3:20 PM - 5:00 PM | Convention Center, Grand Ballroom 220A

Session Chairs: Thomas I. Wallow, ASML (United States), Robert L. Brainard, SUNY Polytechnic Institute (United States)

12494-3 • 3:20 PM - 3:40 PM

## Distribution of defective sub-cluster formation probability for stochastic hotspot prediction

Author(s): Hiroshi Fukuda, Hitachi High-Tech Corp. (Japan)

12498-11 • 3:40 PM - 4:00 PM

## A novel formulated developer for negative-tone imaging with EUV exposure to improve chemical stochastic

Author(s): Toru Fujimori, Nishiki Fujimaki, Keiyu Ou, Kazuhiro Marumo, Nobuhiro Hiura, Satomi Takahashi, Naohiro Tango, FUJIFILM Corp. (Japan)

12494-4 • 4:00 PM - 4:20 PM

## Chemical approach to make the most of EUVL: stochastic effect mitigation with developer and rinse

Author(s): Hyungju Ryu, Dokyeong Kwon, Jiho Song, Wongi Park, Jinseong Gwak, Haram Ko, Jiyoung Lee, Jinpyoung Kim, Kyungseok Ryu, Sungjo Hwang, Taemin Jeong, Heeyoung Go, Yigwon Kim, Kyoungyong Cho, Sangjin Kim, Changmin Park, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12498-12 • 4:20 PM - 4:40 PM

## Towards molecular-scale kinetic Monte Carlo simulation of pattern formation in photoresist materials for EUV nanolithography

Author(s): Lois Fernandez Miguez, Peter A. Bobbert, Reinder Coehoorn, Technische Univ. Eindhoven (Netherlands)

12498-13 • 4:40 PM - 5:00 PM

## Photoresists with precisely controlled molecular weight, composition and sequence

Author(s): Christopher K. Ober, Florian Käfer, Cornell Univ. (United States); Zoey Meng, Rachel A. Segalman, Javier Read de Alaniz, Univ. of California, Santa Barbara (United States)

## TUESDAY 28 FEBRUARY

### TUESDAY PLENARY SESSION

28 February 2023 • 8:00 AM - 9:50 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Kafai Lai, The Univ. of Hong Kong (United States), Qinghuang Lin, Lam Research Corp. (United States)

8:00 AM - 8:10 AM

#### Introduction and Announcements

8:10 AM - 8:30 AM

#### 50th anniversary of Micralign: A retrospective

12495-500 • 8:30 AM - 9:10 AM

#### Accelerated computing for silicon leadership (*Plenary Presentation*)

Vivek K. Singh, NVIDIA Corp. (United States)

12497-501 • 9:10 AM - 9:50 AM

#### Pushing the limits of nano-imprint lithography for immersive displays (*Plenary Presentation*)

Bernard C. Kress, Google (United States)

Coffee Break 9:50 AM - 10:20 AM

### SESSION 4: KEYNOTE SESSION AND AWARDS PRESENTATION

28 February 2023 • 10:20 AM - 12:00 PM | Convention Center, Grand Ballroom 220C

Session Chairs: Douglas J. Guerrero, Brewer Science, Inc. (Belgium), Gilles R. Amblard, SAMSUNG Austin Semiconductor LLC (United States)

10:20 - 10:40 AM: Awards Presentations

#### 2022 C. Grant Willson Award for Best Paper

#### 2022 Hiroshi Ito Memorial Award for the Best Student Paper

#### 2022 Jeffrey Byers Memorial Best Poster Award

12498-14 • 10:40 AM - 11:20 AM

#### EUV resist chemical stochastics and approaches to control it (*Keynote Presentation*)

Author(s): Gregory H. Denbeaux, SUNY Polytechnic Institute (United States)

12498-15 • 11:20 AM - 12:00 PM

#### Challenges and opportunities in material development and understanding that enables advanced photolithography (*Keynote Presentation*)

Author(s): Mingqi Li, Emad Aqad, Tomas Marangoni, James F. Cameron, Paul LaBeaume, DuPont Electronics & Industrial (United States); Jung-June Lee, Jae Hwan Sim, DuPont Electronics & Industrial (Republic of Korea); Choong Bong Lee, Xisen Hou, DuPont Electronics & Industrial (United States); Michael J. Eller, California State Univ., Northridge (United States); Stanislav V. Verkhorurov, Emile A. Schweikert, Texas A&M Univ. (United States); Peter Trefonas, Chengbai Xu, DuPont Electronics & Industrial (United States)

Lunch Break 12:00 PM - 1:30 PM

### SESSION 5: RESISTS FUNDAMENTALS I

28 February 2023 • 1:30 PM - 3:10 PM | Convention Center, Grand Ballroom 220C

Session Chairs: Ramakrishnan Ayothi, JSR Micro, Inc. (United States), Luisa D. Bozano, Applied Materials, Inc. (United States)

12498-16 • 1:30 PM - 1:50 PM

#### Effects of photoacid generator decomposition on dissolution kinetics of poly(4-hydroxystyrene) in tetraalkylammonium hydroxide aqueous solutions

Author(s): Yutaro Iwashige, Yuko Ito, Takahiro Kozawa, Osaka Univ. (Japan); Kazuo Sakamoto, Makoto Muramatsu, Tokyo Electron Kyushu Ltd. (Japan)

12498-17 • 1:50 PM - 2:10 PM

#### Mean free path of electrons in EUV photoresist in the range 20-450 eV

Author(s): Roberto Fallica, imec (Belgium); Nicola Mahne, Stefano Nannarone, Consiglio Nazionale delle Ricerche, Istituto Officina dei Materiali (Italy)

12498-183 • 2:10 PM - 2:30 PM

#### Computational reaction networks applied to reaction cascades in EUV lithography

Author(s): Samuel Blau, Eric Sivonxay, Brett Helms, Frances Houle, Patrick Naulleau, Lawrence Berkeley National Lab. (United States)

12498-19 • 2:30 PM - 2:50 PM

#### Understanding polymer distribution in the photoresist materials using liquid chromatography

Author(s): Kyuhyun Im, Younhyun Kwak, Minsang Kim, Changheon Lee, SAMSUNG Advanced Institute of Technology (Republic of Korea)

12498-20 • 2:50 PM - 3:10 PM

#### Role of counter-anion chemistry, free volume, and reaction byproducts in chemically amplified resists

Author(s): Christopher M. Bottoms, Manolis Doxastakis, Gila E. Stein, The Univ. of Tennessee Knoxville (United States)

Coffee Break 3:10 PM - 3:40 PM

### SESSION 6: UNDERLAYERS AND TOP COATS

28 February 2023 • 3:40 PM - 5:20 PM | Convention Center, Grand Ballroom 220C

Session Chairs: Masahiko Harumoto, SCREEN Semiconductor Solutions Co., Ltd. (Japan), Tomohiro Oikawa, Tokyo Ohka Kogyo America, Inc. (United States)

12498-21 • 3:40 PM - 4:00 PM

#### Novel assist layer to enhance EUV lithography performance of photoresists on different substrate

Author(s): Si Li, Joyce Lowes, Ruimeng Zhang, Ming Luo, Brewer Science, Inc. (United States); Kelsey Brakensiek, Brewer Science (United States); Veerle van Driessche, Douglas J. Guerrero, Brewer Science, Inc. (Belgium)

12498-22 • 4:00 PM - 4:20 PM

#### New functional surface treatment process and primers for high-NA EUV lithography

Author(s): Wataru Shibayama, Shuhei Shigaki, Makoto Nakajima, Rikimaru Sakamoto, Satoshi Takeda, Kodai Kato, Nissan Chemical Corp. (Japan)

# CONFERENCE 12498

12498-23 • 4:20 PM - 4:40 PM

## Understanding the metal oxide resist and underlayer interaction for EUV lithography

Author(s): Sudha Rathi, Bharati Neelamraju, Rajaram Narayanan, Shuchi Ojha, Abdul Aziz Khaja, Prashant Kulshreshtha, Praket Jha, Harry Whitesell, Karthik Janakiraman, Applied Materials, Inc. (United States); Peiqi Wang, Larry Gao, Nancy Fung, Yung-Chen Lin, Applied Materials (United States)

12498-24 • 4:40 PM - 5:00 PM

## Chemical trimming overcoat: An advanced spin-on process for photoresist enhancement in EUV lithography

Author(s): Xisen Hou, Yinjie Cen, Paul Baranowsky, Doris Kang, Cong Liu, Chengbai Xu, DuPont Electronics & Imaging (United States)

12498-73 • 5:00 PM - 5:20 PM

## Scaled-down deposited underlayers for EUV lithography

Author(s): Mihir Gupta, imec (Belgium); Joao Antunes Afonso, ASM Belgium N.V. (Belgium); Philippe Bézard, Roberto Fallica, Hyo Seon Suh, Sandip Halder, Danilo De Simone, imec (Belgium); Zecheng Liu, Fanyong Ran, Hideaki Fukuda, ASM Japan K.K. (Japan); Yiting Sun, David De Roest, Daniele Piumi, ASM Belgium N.V. (Belgium)

### TUESDAY EVENING PLENARY

28 February 2023 • 5:30 PM - 6:15 PM | Convention Center, Grand Ballroom 220A

12498-502 • 5:30 PM - 6:00 PM

## Are 2D transition metal dichalcogenides transistors the future silicon replacement or hype?

*(Plenary Presentation)*

Kevin P. O'Brien, Intel Corp. (United States)

6:15 PM - 7:15 PM

## Sustainability and Lithography's Role: A Panel Discussion

MODERATOR:

Dan Hutcheson, TechInsights (United States)

PANELISTS:

John Cahill, ASML-Cymer (United States)

Emily Gallagher, imec (Belgium)

Chris Jones, Edwards Vacuum (United Kingdom)

Mark Merrill, Lam Research (United States)

Ryan Russell, Intel (United States)

Akihisa Sekiguchi, Tokyo Electron LTD. (Japan)

It's become popular to make commitments to new business models and supply chain strategies for conservation and carbon neutrality in the semiconductor ecosystem, including initiatives to reduce greenhouse gases, conserve energy and water, and focus more on renewables and reusables. In addition to these, panelists will address the role lithography and patterning will play and has played in addressing these critical issues. For example: Koomey's law states that Compute-per-Watt improves exponentially over time. Lithography's critical role in making this possible in this is well established through its ability to make circuits more power efficient. This means that there is a long payback to lithography when considering Life-Cycle Sustainability Assessment (LCSA) methods to evaluate the chips they produce. This and more will be discussed.

## WEDNESDAY 1 MARCH

### SESSION 7: RESISTS FUNDAMENTALS II

1 March 2023 • 8:10 AM - 9:50 AM | Convention Center, Grand Ballroom 220C

Session Chairs: Anuja De Silva, Lam Research Corp. (Belgium), Ryan Callahan, FUJIFILM Electronic Materials U.S.A., Inc. (United States)

12498-26 • 8:10 AM - 8:30 AM

## Dissociative photoionization of EUV lithography photoresist models

Author(s): Fabian Holzmeier, Marziogiuseppe Gentile, imec (Belgium); Marius Gerlach, Julius-Maximilians-Univ. Würzburg (Germany); Robert Richter, Elettra-Sincrotrone Trieste S.C.p.A. (Italy); Michiel J. van Setten, John S. Petersen, Paul A. W. van der Heide, imec (Belgium)

12498-27 • 8:30 AM - 8:50 AM

## EUV-induced activation mechanism of photoacid generators: Key factors modulating EUV sensitivity

Author(s): Ji Young Park, Thanh-Cuong Nguyen, Deakeon Kim, Hyun Ji Song, Suk Koo Hong, Won-Joon Son, Hyoshin Ahn, Inkook Jang, Dae Sin Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12498-28 • 8:50 AM - 9:10 AM

## Fundamental studies of interactions between polymer substrate and precursor in sequential infiltration synthesis

Author(s): Andrew K. Whittaker, Francis J. McCallum, Jiacheng Zhao, Daloar Hossain, The Univ. of Queensland (Australia); Joshua A. Kaitz, James F. Cameron, Peter Trefona, DuPont Electronics & Industrial (United States); Idriss Blakey, Hui Peng, The Univ. of Queensland (Australia)

12498-29 • 9:10 AM - 9:30 AM

## Switching the solubility of polymers using intermolecular reactions and diffusion of small molecules

Author(s): Jacob Sitterly, Justin Nhan, Moira Niluxsshun, Stephen Smith, Robert L. Brainard, SUNY Polytechnic Institute (United States)

12498-30 • 9:30 AM - 9:50 AM

## A scientific framework for establishing ultrafast molecular dynamic research in imec's AttoLab

Author(s): Laura Galleni, Faegheh S. Sajjadian, imec (Belgium), KU Leuven (Belgium); Thierry S. Conard, Ivan Pollentier, Kevin M. Dorney, Fabian Holzmeier, Esben W. Larsen, imec (Belgium); Daniel Escudero, KU Leuven (Belgium); Geoffrey Pourtois, Michiel J. van Setten, Paul A. W. van der Heide, John S. Petersen, imec (Belgium)

Coffee Break 9:50 AM - 10:20 AM

### SESSION 8: NON CHEMICALLY AMPLIFIED RESISTS FOR EUV LITHOGRAPHY I

1 March 2023 • 10:20 AM - 12:00 PM | Convention Center, Grand Ballroom 220C

Session Chairs: Aiwen Wu, Entegris, Inc. (United States), Yoshio Kawai, Shin-Etsu Chemical Co., Ltd. (Japan)

12498-31 • 10:20 AM - 10:40 AM

## Enhancing the sensitivity of a high resolution negative-tone metal organic photoresist for extreme ultra violet lithography

Author(s): Scott M. Lewis, Guy A. DeRose, California Institute of Technology (United States)



12498-32 • 10:40 AM - 11:00 AM

## **MOx resist formulation, chemistry, and processing impacts on the power spectral density of line-edge roughness**

Author(s): Amrit K. Narasimhan, Inpria Corp. (United States); Chris A. Mack, Fractilia, LLC (United States); Peter De Schepper, Inpria Corp. (Belgium); Kai Jiang, Michael Kocsis, Jason K. Stowers, Inpria Corp. (United States); Kazuki Kasahara, JSR Micro, Inc. (United States)

12498-33 • 11:00 AM - 11:20 AM

## **Influence of the anion in tin-based EUV photoresists properties**

Author(s): Quentin Evrard, Univ. of Amsterdam (Netherlands); Najmeh Sadegh, Advanced Research Ctr. for Nanolithography (Netherlands); Nicola Mahne, Angelo Giglia, Stefano Nannarone, Istituto Officina dei Materiali, Consiglio Nazionale delle Ricerche (Italy); Yasin Ekinci, Michaela Vockenhuber, Paul Scherrer Institut (Switzerland); Takuo Sugiyoka, Nippon Shokubai (Japan); Albert M. Brouwer, Univ. of Amsterdam (Netherlands)

12498-34 • 11:20 AM - 11:40 AM

## **Atomic layer deposition derived organic-inorganic hybrid EUV photoresists**

Author(s): Ashwanth Subramanian, Stony Brook Univ. (United States); Dan N. Le, Su Min Hwang, The Univ. of Texas at Dallas (United States); Nikhil M. Tiwale, Brookhaven National Lab. (United States); Won-Il Lee, Stony Brook Univ. (United States); Kim Kisslinger, Ming Lu, Aaron Stein, Brookhaven National Lab. (United States); Jiyoung Kim, The Univ. of Texas at Dallas (United States); Chang-Yong Nam, Brookhaven National Lab. (United States)

12498-35 • 11:40 AM - 12:00 PM

## **Indium Nitrate Hydrate Films as EUV Resists by Evaluating with 92-eV Electron Beam**

Author(s): Jesse Grayson, Marisol Valdez, Julia Hsu, The Univ. of Texas at Dallas (United States)

**Lunch Break 12:00 PM - 1:30 PM**

### **SESSION 9: NON CHEMICALLY AMPLIFIED RESISTS FOR EUV LITHOGRAPHY II**

1 March 2023 • 1:30 PM - 3:10 PM | Convention Center, Grand Ballroom 220C

Session Chairs: Sonia Castellanos, imec (Belgium), Jara Garcia-Santa Clara, ASML Netherlands B.V. (Netherlands)

12498-36 • 1:30 PM - 1:50 PM

## **EUV lithography patterning using multi-trigger resist**

Author(s): Carmen Popescu, Greg O'Callaghan, Alex McClelland, Catherine Storey, Irresistible Materials Ltd. (United Kingdom); John Roth, Ed A. Jackson, Nano-C, Inc. (United States); Alex P. G. Robinson, Univ. of Birmingham (United Kingdom)

12498-37 • 1:50 PM - 2:10 PM

## **Negative-tone resists for EUV lithography**

Author(s): Masato Suzuki, EMD Electronics (Japan); YoungJin Kim, YoungJun Her, EMD Electronics (Belgium); Hengpeng Wu, Kun Si, EMD Electronics (United States); Mark Maturi, Philipp-Hans . Fackler, EMD Electronics (Germany); Mansour Moinpour, Ralph Dammel, Yi Cao, EMD Electronics (United States)

12498-38 • 2:10 PM - 2:30 PM

## **Single-component silicon-based patterning materials for EUV lithography**

Author(s): Julius Joseph Santillan, Akihiro Konda, Motoharu Shichiri, Toshiro Itani, Osaka Univ. (Japan)

12498-39 • 2:30 PM - 2:50 PM

## **Potential of biomass EUV non-car resist for high-NA EUV lithography**

Author(s): Kazuyo Morita, Yasuaki Tanaka, Oji Holdings Corp. (Japan); Yuji Tanaka, Masaya Asai, SCREEN Semiconductor Solutions Co., Ltd. (Japan)

12498-40 • 2:50 PM - 3:10 PM

## **Fluoroalkylated tin-oxo nano clusters as resist candidates for EUV lithography**

Author(s): Yejin Ku, Hyungju Ahn, Jin-Kyun Lee, Inha Univ. (Republic of Korea); Jiho Kim, Byeong-Gyu Park, Sangsul Lee, Pohang Accelerator Lab. (Republic of Korea); Yu Ha Jang, Byung Jun Jung, The Univ. of Seoul (Republic of Korea); Chawon Koh, Tsunehiro Nishi, Hyun-Woo Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

**Coffee Break 3:10 PM - 3:40 PM**

### **SESSION 10: NOVEL PATTERNING MATERIALS**

1 March 2023 • 3:40 PM - 5:40 PM | Convention Center, Grand Ballroom 220C

Session Chairs: Xisen Hou, DuPont Electronics & Imaging (United States), Marie E. Kryszak, Intel Corp. (United States)

12498-41 • 3:40 PM - 4:00 PM

## **Sequence-defined polypeptoid CARs for electron-beam and EUV lithography**

Author(s): Florian H. Käfer, Christopher K. Ober, Cornell Univ. (United States); Zoey Meng, Rachel A. Segalman, Javier Read de Alaniz, Univ. of California, Santa Barbara (United States)

12498-42 • 4:00 PM - 4:20 PM

## **Chitosan as a water-based photoresist for DUV lithography**

Author(s): Isabelle Servin, Univ. Grenoble Alpes (France), CEA-LETI (France); Alexandre Teolis, Univ. Claude Bernard Lyon 1 (France), CNRS (France); Arnaud F. Bazin, Aurélien Sarrazin, Univ. Grenoble Alpes (France), CEA-LETI (France); Paule Durin, Univ. de Lyon (France), Institut National des Sciences Appliquées de Lyon (France), Ecole Centrale de Lyon (France); Olha Sysova, Univ. de Haute Alsace (France), Institut de Sciences des Matériaux de Mulhouse, CNRS (France); Benoît Saudet, Univ. Grenoble Alpes (France), CEA-LETI (France); Didier Léonard, Univ. de Lyon (France), Institut des Sciences Analytiques, Univ. Claude Bernard Lyon 1 (France), CNRS (France); Olivier Soppera, Univ. de Haute Alsace (France), Institut de Sciences des Matériaux de Mulhouse, CNRS (France); Jean-Louis Leclercq, Univ. de Lyon (France), Univ. Claude Bernard Lyon 1 (France), Ecole Centrale de Lyon (France); Yann Chevolut, Univ. de Lyon (France), Ecole Centrale de Lyon (France), Univ. Claude Bernard Lyon 1 (France); Raluca Tiron, Univ. Grenoble Alpes (France), CEA-LETI (France); Thierry Delair, Univ. de Lyon (France), Univ. Claude Bernard Lyon 1 (France); Stéphane Trombottto, Univ. de Lyon (France), Univ. Claude Bernard Lyon 1 (France), CNRS (France)

12498-43 • 4:20 PM - 4:40 PM

## **Micro-nanostructuring by optical lithography and nitridation of photo-patternable TiO<sub>2</sub> sol-gel to obtain micro-nanostructured TiN**

Author(s): Victor Vallejo Otero, Nicolas N. Crespo-Monteiro, Emilie Gamet, Stephanie Reynaud, Yves Jourlin, Christophe Donnet, Lab. Hubert Curien (France)

# CONFERENCE 12498

12498-44 • 4:40 PM - 5:00 PM

## Hybrid positive-tone resist synthesis via vapor phase infiltration for contact-hole patterning

Author(s): Nikhil M. Tiwale, Brookhaven National Lab. (United States); Ashwanth Subramanian, Won-Il Lee, Stony Brook Univ. (United States); Ming Lu, Aaron Stein, Brookhaven National Lab. (United States); Jiyoung Kim, The Univ. of Texas at Dallas (United States); Chang-Yong Nam, Brookhaven National Lab. (United States), Stony Brook Univ. (United States)

12498-45 • 5:00 PM - 5:20 PM

## Molecular layer deposition of an Al-based hybrid resist for electron-beam and EUV lithography

Author(s): Ajay Ravi, Jingwei Shi, Jacqueline Lewis, Stacey F. Bent, Stanford Univ. (United States)

12498-46 • 5:20 PM - 5:40 PM

## The novel materials for pattern growing on EUV resists

Author(s): Hiroshi Yanagita, Kazuma Yamamoto, EMD Electronics (Japan)

### POSTER SESSION

1 March 2023 • 5:30 PM - 7:00 PM | Convention Center, Hall 2

Conference attendees are invited to attend the Poster Session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the Poster Session.

### Poster Setup: Wednesday 10:00 AM - 4:30 PM

Poster authors, view poster presentation guidelines and set-up instructions at <http://spie.org/ALPosterGuidelines>.

12498-47

## Metal purifier for TMAH developer solution

Author(s): Jinhong Yu, Hangzhou Cobetter Filtration Equipment Co. (China); Robb Fang, Yoshiaki Yamada, Hangzhou Cobetter Filtration Equipment Co., Ltd. (Japan)

12498-48

## Wet etch process for high resolution DSA patterning for advanced node DRAM

Author(s): Hsing-Chen Wu, Min-Chieh Yang, Ming-Chi Liao, Entegris Asia, LLC (Taiwan); Hiroki Kawada, ASL Technologies Japan Corp. (Japan); Tomohiro Iwaki, Micron Memory Japan Inc. (Japan); Eri Hirahara, Nihon Entegris G.K. (Japan)

12498-49

## Fundamentals of EUV stack for improving patterning performance

Author(s): Nanoka Miyahara, Soichiro Okada, Hiroyuki Fujii, Satoru Shimura, Tokyo Electron Kyushu Ltd. (Japan)

12498-50

## Establishment of new process technology for EUV lithography

Author(s): Yuhei Kuwahara, Shinichiro Kawakami, Tokyo Electron Kyushu Ltd. (Japan); Kanzo Kato, TEL Technology Ctr., America, LLC (United States); Cong Que Dinh, Soichiro Okada, Tomoya Onitsuka, Takashi Yamauchi, Nanoka Miyahara, Tokyo Electron Kyushu Ltd. (Japan); Lior Huli, TEL Technology Ctr., America, LLC (United States); Satoru Shimura, Tokyo Electron Kyushu Ltd. (Japan)

12498-51

## Recent advances in EUV patterning in preparation towards high-NA EUV

Author(s): Seiji Nagahara, Tokyo Electron Ltd. (Japan); Arnaud Dauendorffer, Tokyo Electron Kyushu Ltd. (Japan); Arame Thiam, Tokyo Electron Europe Ltd. (Belgium); Xiang Liu, Tokyo Electron Ltd. (Japan); Yuhei Kuwahara, Cong Que Dinh, Soichiro Okada, Shinichiro Kawakami, Hisashi Genjima, Noriaki Nagamine, Makoto Muramatsu, Satoru Shimura, Tokyo Electron Kyushu Ltd. (Japan); Atsushi Tsuboi, Tokyo Electron Ltd. (Japan); Kathleen Nafus, Tokyo Electron Kyushu Ltd. (Japan); Yannick Feurprier, Marc Demand, Rajesh Ramaneti, Tokyo Electron Europe Ltd. (Belgium); Philippe Foubert, Danilo De Simone, imec (Belgium)

12498-53

## Novel UPE filtration technology for advanced photolithography materials

Author(s): Ryo Yokoyama, Akihito Ui, Nihon Entegris G.K. (Japan); Christi Dawydiak, Vinay Kalyani, Entegris, Inc. (United States)

12498-54

## Demonstrating a spin-on antispacer double patterning process to achieve sub-resolution isolated trench features

Author(s): Michael Murphy, Charlotte A. Cutler, Jacob Dobson, Jodi Grzeskowiak, David Power, David Conklin, Anton Devilliers, TEL Technology Ctr., America, LLC (United States)

12498-55

## Profile control in conductor metal wet etch with advanced photoresists

Author(s): Ashley Moore, EMD Electronics (United States); Julia Modl, Infineon Technologies Austria AG (Austria); Zhong Li, Hung-Yang Chen, Chunwei Chen, EMD Electronics (United States); Andreas Behrendt, Katharina Schmoelzer, Infineon Technologies Austria AG (Austria)

12498-56

## Positive tone i-line photoresist with controlled undercut profile for advanced packaging

Author(s): Walter Liu, Chunwei Chen, PingHung Lu, EMD Electronics (United States); Sookmee Lai, Merck Electronics Pte Ltd. (Singapore); Yoshiharu Sakurai, Merck Electronics, Ltd. (Japan)

12498-57

## Metallic contamination reduction in polymer solution using membrane purification technology

Author(s): Pranesh Muralidhar, Entegris, Inc. (United States); Antonio Ramirez, Aiwen Wu, Lawrence Chen, Entegris (United States); Sabrina Wong, Dupont Electronics & Industrial (United States)

12498-58

## Thin underlayer materials for metal oxide resist patterning

Author(s): Satoshi Dei, Yuya Hayashi, Shumpei Akita, Shuhei Yamada, Kazunori Sakai, Tatsuya Kasai, Akitaka Nii, Ayaka Furusawa, Kazuya Takada, JSR Corp. (Japan); Tetsuro Kaneko, JSR Micro, Inc. (United States); Tomoaki Seko, Eiji Yoneda, Tatsuya Sakai, JSR Corp. (Japan)

12498-59

## Use of highly EUV absorbing element in chemically amplified resist

Author(s): Yejin Ku, Gayoung Kim, Jin-kyun Lee, Inha Univ. (Republic of Korea); Jong-Won Lee, Byeong-Gyu Park, Sangsul Lee, Pohang Accelerator Lab. (Republic of Korea)

12498-60

**Design of a positive tone organometal chemically amplified resist to enhance the sensitivity and etching durability for high resolution EUV single patterning**

Author(s): Satoshi Enomoto, Kohei Machida, Michiya Naito, Toyo Gosei Co., Ltd. (Japan); Takahiro Kozawa, Osaka Univ. (Japan)

12498-61

**Identification for microbridge precursor in EUV resist filtration**

Author(s): Toru Umeda, Nihon Pall Ltd. (Japan); Yiren Zhang, Pall Corp. (United States); Tetsuya Murakami, Nihon Pall Ltd. (Japan); Leong Voon, Pall Filtration Pte Ltd. (Singapore)

12498-62

**EUV photoresist development for line and space patterning with reduced defects**

Author(s): Jeong Ho Mun, Seong Hwan Park, Ho Geun Lee, Hyun Ji Song, Song Se Yi, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12498-63

**Novel polymer design for ultra-low stress material for advanced packaging applications**

Author(s): Matthias F. Koch, Frank Meyer, EMD Electronics (Germany); Kenichi Nishikawa, Katsuo Taniguchi, EMD Electronics (Japan)

12498-65

**Electron beam and optical patterning of polymerizable ionic liquid based resists**

Author(s): Katarzyna Komorowska, Natalia Turek, Aleksandra Szymańska, Lukaszewicz Research Network - Institute of Microelectronics and Photonics (Poland); Adrian Zajac, Andrea Szpacht, Marcin Smiglak, Poznan Science and Technology Park (Poland)

12498-66

**Ultra-high carbon fullerene based spin-on-carbon hardmasks**

Author(s): Alan G. Brown, Guy Dawson, Irresistible Materials Ltd. (United Kingdom); Ed A. Jackson, Bryan Schofield, Tom Lada, Nano-C, Inc. (United States); Alex P. G. Robinson, Univ. of Birmingham (United Kingdom)

12498-67

**Predicting the critical features of the chemically amplified resist profile based on machine learning**

Author(s): Pengjie Kong, Lisong Dong, Univ. of Chinese Academy of Sciences (China); Xu Ma, Beijing Institute of Technology (China); Yayi Wei, Univ. of Chinese Academy of Sciences (China)

12498-68

**Considerations in the design of photoacid generators**

Author(s): Conner Hoelzel, Li Cui, Benjamin D. Naab, Jong Keun Park, DuPont Electronics & Imaging (United States); Philjae Kang, DuPont Korea (Republic of Korea); Kenneth Hernandez, Suzanne M. Coley, Stefan Alexandrescu, Rochelle Rena, Emad Aqad, James F. Cameron, DuPont Electronics & Imaging (United States)

12498-69

**Spin speed impact on photoresist thin film properties and EUV lithographic performance**

Author(s): Yinjie Cen, Choong Bong Lee, Li Cui, Suzanne M. Coley, Jong Keun Park, Benjamin D. Rafael-Naab, Emad Aqad, Rochelle Rena, Tyler Paul, Thomas G. Penniman, Jason Behnke, DuPont Electronics & Imaging (United States)

12498-70

**Impact of EUV absorption increase of CAR polymers on lithographic performance**

Author(s): Choong Bong Lee, Yinjie Cen, Emad Aqad, Li Cui, Suzanne M. Coley, Jong Keun Park, Benjamin D. Naab-Rafael, Rochelle Rena, Tyler Paul, Sylvie Eckert, Chunyi Wu, Michael Finch, DuPont Electronics & Imaging (United States); KwangHwy Im, Jin Hong Park, Philjae Kang, DuPont Electronics & Industrial Korea Technology Ctr. (Republic of Korea); Thomas G. Penniman, Jason Behnke, DuPont Electronics & Imaging (United States)

12498-71

**Manipulation of polymer solubility: crosslinking, thermal activation and variable-temperature bakes**

Author(s): Jacob Sitterly, Justin Nhan, Robert L. Brainard, SUNY Polytechnic Institute (United States)

12498-74

**Defectivity reduction in EUV resists through novel high-performance point-of-use (POU) filters**

Author(s): Yiren Zhang, Pall Corp. (United States); Toru Umeda, Hirokazu Sakakibara, Nihon Pall Ltd. (Japan); Sheik Ansar Usman Ibrahim, Pall Corp. (Belgium); Amarnauth Singh, Robert Shick, Karl Skjonnemand, Pall Corp. (United States); Philippe Foubert, Waut Drent, imec (Belgium)

12498-77

**Electron induced chemical transformations in model resist materials**

Author(s): Oleg Kostko, Terry McAfee, Patrick Naulleau, The Ctr. for X-Ray Optics, Lawrence Berkeley National Lab. (United States)

12498-78

**Direct measurements of acid diffusion in chemically amplified resists**

Author(s): Gregory H. Denbeaux, Ruiwen Ai, Ankit Choudhary, Eshan Dilina, Robert L. Brainard, SUNY Polytechnic Institute (United States); Gregg Gallatin, Applied Math Solutions, LLC (United States)

12498-80

**Coater and developer-based techniques to achieve tight pitches towards high NA EUV**

Author(s): Kanzo Kato, TEL Technology Ctr., America, LLC (United States); Lior Huli, Nathan Antonovich, David Hetzer, Steven Grzeskowiak, Eric Liu, Akiteru Ko, TEL Technology Ctr. (United States); Satoru Shimura, Shinichiro Kawakami, Tokyo Electron Kyushu Limited (Japan); Takahiro Kitano, Seiji Nagahara, Tokyo Electron Limited (Japan); Luciana Meli, Indira Seshadri, Martin Burkhardt, Karen Petrillo, IBM Corporation (United States)

12498-81

**Optimization of spin-on metal oxide resist performance via new development techniques on sub 30nm pitch patterning**

Author(s): Lior Huli, TEL Technology Ctr., America, LLC (United States)

12498-64

**Track hardware as a EUV lithography booster: A deep-dive into SCREEN's DT-3000 platform capabilities**

Author(s): Andreia Santos, Wesley Zanders, Elke Caron, SCREEN SPE Germany GmbH (Belgium); Yuji Tanaka, Masaya Asai, Masahiko Harumoto, SCREEN Semiconductor Solutions Co., Ltd. (Japan); Jelle Vandereyken, Lander Verstraete, Ashish Rathore, Hyo Seon Suh, imec (Belgium)

# CONFERENCE 12498

12498-196

## **Aluminium-Containing Resists for Extreme Ultraviolet (EUV) and Electron Beam Lithographies**

Author(s): Mohammad Saifullah, Vitaliy A. Guzenko, Andrea Testino, Prajith Karadan, Dimitrios Kazazis, Michaela Vockenhuber, Yasin Ekinci, Paul Scherrer Institut (Switzerland)

12498-97

## **Chemical information extraction from scanning electron microscopy images on the basis of image recognition**

Author(s): Yuqing Jin, Takahiro Kozawa, Kota Aoki, Tomoya Nakamura, Yasushi Makihara, Yasushi Yagi, SANKEN, Osaka Univ. (Japan)

12498-99

## **Reaction mechanisms and EB patterning evaluation of Sn-complex-side-chain polymer used for EUV lithography**

Author(s): Yui Takata, Yusa Muroya, Takahiro Kozawa, SANKEN, Osaka Univ. (Japan); Satoshi Enomoto, Toyo Gosei Co. (Japan); Bilal Naqvi, Danilo De Simone, IMEC (Belgium)

12498-100

## **Study on irradiation effects by femtosecond-pulsed extreme ultraviolet in resist materials**

Author(s): Hiroki Yamamoto, National Institutes for Quantum and Radiological Science and Technology (Japan)

12498-102

## **Filters with New Pleating Technology (NPT): Next-generation filtration with defect reduction for advance lithography and patterning applications**

Author(s): Varun Vakharia, Pall Corp. (United States); Ta-Wei Wu, Pall Singapore Taiwan Branch Holding Co. Pte. Ltd. (Taiwan); Hirokazu Sakakibara, Nihon Pall Ltd. (Japan); Bill Peri, Terry Wolff, Tim Pierce, Pall Corp. (United States); Mark Shih, Pall Singapore Taiwan Branch Holding Co. Pte. Ltd. (Taiwan); Tricia Lee, Pall Corp. (Singapore); Yuji Honma, Nihon Pall Ltd. (Japan); Robert Shick, Karl Skjonnemand, Pall Corp. (United States)

12498-104

## **Dependence of swelling and dissolution kinetics of poly(4-hydroxystyrene) in alkaline aqueous solution on alkyl chain length of tetraalkylammonium hydroxide**

Author(s): Hitomi Betsumiya, Yuko T. Ito, Osaka Univ. (Japan); Takahiro Kozawa, SANKEN, Osaka Univ. (Japan); Kazuo Sakamoto, Makoto Muramatsu, Tokyo Electron Kyushu Ltd. (Japan)

# Advanced Etch Technology and Process Integration for Nanopatterning XII

28 February - 2 March 2023 | Convention Center, Room 210C

Conference Chair: **Nihar Mohanty**, Meta (United States)

Conference Co-Chair: **Efrain Altamirano-Sánchez**, imec (Belgium)

Program Committee: **John C. Arnold**, IBM Thomas J. Watson Research Ctr. (United States); **Keun Hee Bai**, SAMSUNG Electronics Co., Ltd. (Republic of Korea); **Julie Bannister**, Tokyo Electron America, Inc. (United States); **Robert L. Bruce**, IBM Thomas J. Watson Research Ctr. (United States); **Maxime Darnon**, Lab. Nanotechnologies Nanosystemes (Canada); **Sebastian U. Engelmann**, IBM Thomas J. Watson Research Ctr. (United States); **Eric A. Hudson**, Lam Research Corp. (United States); **Catherine B. Labelle**, Intel Corp. (United States); **Qinghuang Lin**, Lam Research Corp. (United States); **Ru-Gun Liu**, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan); **Jake O’Gorman**, Hitachi High-Tech America, Inc. (United States); **Prem Kumar Panneerchelvam**, KLA Texas (United States); **Erwine Pargon**, Lab. des Technologies de la Microélectronique (France); **Nicolas Posseme**, CEA-LETI (France); **Angélique Raley**, TEL Technology Ctr., America, LLC (United States); **Ricardo Ruiz**, Lawrence Berkeley National Lab. (United States); **Yuyang Sun**, Siemens EDA (United States); **Richard S. Wise**, Lam Research Corp. (United States); **Ying Zhang**, NAURA (United States)

## MONDAY 27 FEBRUARY

### WELCOME AND MONDAY PLENARY SESSION

27 February 2023 • 8:00 AM - 10:00 AM | Convention Center, Grand Ballroom 220A

Session Chairs: **Kafai Lai**, The Univ. of Hong Kong (United States), **Qinghuang Lin**, Lam Research Corp. (United States)

8:00 AM: **Symposium Welcome and Opening Remarks**

**Kafai Lai**, University of Hong Kong (United States) and **Qinghuang Lin**, LAM Research Corp. (United States)

8:05 AM: **Introduction of New SPIE Fellows**

8:15 AM: **2023 SPIE Rudolf and Hilda Kingslake Award in Optical Design**

Presented in recognition of significant achievement in the field of optical design, including the theoretical or experimental aspects of optical engineering.

8:25 AM: **2023 SPIE Frits Zernike Award for Microlithography**

Presented in recognition of outstanding accomplishments in micro-lithographic technology, especially those furthering the development of semiconductor lithographic imaging solutions.

8:35 AM: **Presentation of the Nick Cobb Memorial Scholarship**

The Nick Cobb Memorial Scholarship is awarded to an outstanding graduate student studying advanced lithography or a related field. The scholarship is jointly funded by Siemens EDA and SPIE.

12494-505 • 8:40 AM - 9:20 AM

**Driving Moore’s Law into the next decade (Plenary Presentation)**

**Martin van den Brink**, ASML Netherlands B.V. (Netherlands)

12496-504 • 9:20 AM - 10:00 AM

**Update on CHIPS Act implementation (Plenary Presentation)**

**Laurie E. Locascio**, National Institute of Standards and Technology (United States)

## TUESDAY 28 FEBRUARY

### TUESDAY PLENARY SESSION

28 February 2023 • 8:00 AM - 9:50 AM | Convention Center, Grand Ballroom 220A

Session Chairs: **Kafai Lai**, The Univ. of Hong Kong (United States), **Qinghuang Lin**, Lam Research Corp. (United States)

8:00 AM - 8:10 AM

**Introduction and Announcements**

8:10 AM - 8:30 AM

**50th anniversary of Micralign: A retrospective**

12495-500 • 8:30 AM - 9:10 AM

**Accelerated computing for silicon leadership (Plenary Presentation)**

**Vivek K. Singh**, NVIDIA Corp. (United States)

12497-501 • 9:10 AM - 9:50 AM

**Pushing the limits of nano-imprint lithography for immersive displays (Plenary Presentation)**

**Bernard C. Kress**, Google (United States)

### SESSION 1: ADVANCED PATTERNING INTEGRATION I

28 February 2023 • 1:50 PM - 3:10 PM | Convention Center, Room 210C

Session Chairs: **Nihar Mohanty**, Meta (United States), **Efrain Altamirano-Sánchez**, imec (Belgium)

12499-1 • 1:50 PM - 2:20 PM

**Monolithic CFET patterning challenges for ultimate CMOS device scaling (Invited Paper)**

Author(s): **Naoto Horiguchi**, imec (Belgium)

12499-2 • 2:20 PM - 2:50 PM

**Enabling process technologies for advanced logic devices beyond FinFET era (Invited Paper)**

Author(s): **Tomonari Yamamoto**, Tokyo Electron Ltd. (Japan)

# CONFERENCE 12499

12499-3 • 2:50 PM - 3:10 PM

## Gate patterning development for monolithic CFET integration

Author(s): Emmanuel Dupuy, Zheng Tao, Hans Mertens, Steven Demuyne, Maryam Hosseini, Daisy Zhou, Shouhua Wang, Farid Sebaai, Dmitry Batuk, Naoto Horiguchi, B.T. Chan, Frédéric Lazzarino, imec (Belgium)

Coffee Break 3:10 PM - 3:40 PM

### SESSION 2: MATERIALS AND ETCH INTEGRATION

28 February 2023 • 3:40 PM - 5:00 PM | Convention Center, Room 210C

Session Chair: Efrain Altamirano-Sánchez, imec (Belgium)

12499-5 • 3:40 PM - 4:00 PM

## Etch optimization for defect reduction of EUV photoresists

Author(s): Alexandra Krawicz, Katie Lutker-Lee, Sophie Thibaut, Eric Liu, TEL Technology Ctr., America, LLC (United States); Danilo De Simone, imec (Belgium); Arnaud Dauendorffer, Tokyo Electron Ltd. (Japan); Yannick Feurprier, Kathleen Nafus, Tokyo Electron Europe Ltd. (Belgium); Philippe Bézard, Philippe Foubert, imec (Belgium); Noriaki Oikawa, Tokyo Electron Ltd. (Japan)

12499-48 • 4:00 PM - 4:20 PM

## Enabling new era of heterogeneous integration solutions

Author(s): Manish Ranjan

12499-44 • 4:20 PM - 4:40 PM

## AppliedPRO: Process recipe optimizer for R&D acceleration and beyond

Author(s): Deepak Gupta, Applied Materials, Inc. (United States); Sravan Nandakumar, Applied Materials (United States); Takemasa Miyagi, Applied Materials, Inc. (United States); Waheb Bishara, Applied Materials (United States); Youngje Um, Applied Materials Korea Ltd (Republic of Korea); Keun Hee Bai, Samsung Electronics (Republic of Korea)

12499-8 • 4:40 PM - 5:00 PM

## Evaluation of TiN hardmask films to prevent line wiggling due to plasma-induced film stress

Author(s): Amelia Turnquist, Naoyuki Kofuji, Joseph Sebastian, Hitachi High-Tech America, Inc. (United States); Zecheng Liu, Hiroshi Kou, Hideaki Fukuda, ASM Japan K.K. (Japan); Yoann Tomczak, Yiting Sun, Daniele Piumi, David De Roest, ASM Belgium N.V. (Belgium)

### TUESDAY EVENING PLENARY

28 February 2023 • 5:30 PM - 6:15 PM | Convention Center, Grand Ballroom 220A

12498-502 • 5:30 PM - 6:00 PM

## Are 2D transition metal dichalcogenides transistors the future silicon replacement or hype? (Plenary Presentation)

Kevin P. O'Brien, Intel Corp. (United States)

6:15 PM - 7:15 PM

## Sustainability and Lithography's Role: A Panel Discussion

MODERATOR:

Dan Hutcheson, TechInsights (United States)

PANELISTS:

John Cahill, ASML-Cymer (United States)

Emily Gallagher, imec (Belgium)

Chris Jones, Edwards Vacuum (United Kingdom)

Mark Merrill, Lam Research (United States)

Ryan Russell, Intel (United States)

Akihisa Sekiguchi, Tokyo Electron LTD. (Japan)

It's become popular to make commitments to new business models and supply chain strategies for conservation and carbon neutrality in the semiconductor ecosystem, including initiatives to reduce greenhouse gases, conserve energy and water, and focus more on renewables and reusables. In addition to these, panelists will address the role lithography and patterning will play and has played in addressing these critical issues. For example: Koomey's law states that Compute-per-Watt improves exponentially over time. Lithography's critical role in making this possible in this is well established through its ability to make circuits more power efficient. This means that there is a long payback to lithography when considering Life-Cycle Sustainability Assessment (LCSA) methods to evaluate the chips they produce. This and more will be discussed.

### WEDNESDAY 1 MARCH

### SESSION 3: ADVANCED PATTERNING INTEGRATION II

1 March 2023 • 8:00 AM - 9:40 AM | Convention Center, Room 210C

Session Chair: Julie Bannister, Tokyo Electron America, Inc. (United States)

12499-47 • 8:00 AM - 8:20 AM

## Process optimization for shallow trench isolation etch using computational models

Author(s): Shuo Huang, KLA Corp. (United States); Prem Panneerchelvam, Chad M. Huard, KLA Texas (United States); Shyam Sridhar, Peter L. G. Ventzek, Tokyo Electron America, Inc. (United States); Mark D. Smith, KLA Corp. (United States)

12499-11 • 8:20 AM - 8:40 AM

## High-aspect-ratio amorphous carbon mask etch profile control through plasma and surface chemistry optimization

Author(s): Du Zhang, Shihsheng Chang, Pingshan Luan, Andrew Metz, Jeffrey Shearer, Minjoon Park, Peter Biolsi, Akiteru Ko, TEL Technology Ctr., America, LLC (United States)

12499-45 • 8:40 AM - 9:00 AM

## A method for achieving sub-2nm across-wafer uniformity performance

Author(s): Leandro Medina, Sebastian Naranjo, Michael Da Silva, Roger Bonnacaze, Meghali J. Chopra, SandBox Semiconductor (United States)

12499-13 • 9:00 AM - 9:20 AM

## Challenges for spacer and source and drain cavity patterning in CFET devices

Author(s): Geert Mannaert, Hans Mertens, Maryam Hosseini, Steven Demuyne, Vy Thi Hoang Nguyen, imec (Belgium); Ziad el Otell, David Hellin, Haseeb Kazi, Lam Research Corp. (United States); B.T. Chan, Frédéric Lazzarino, imec (Belgium)

12499-14 • 9:20 AM - 9:40 AM

## Middle-of-line plasma dry etch challenges for CFET integration

Author(s): Dunja Radisic, Maryam Hosseini, Hans Mertens, Daisy Zhou, Victor Vega Gonzalez, Shouhua Wang, B.T. Chan, Dmitry Batuk, Emmanuel Dupuy, Zheng Tao, Eugenio Dentoni Litta, Naoto Horiguchi, imec (Belgium)

Coffee Break 9:40 AM - 10:10 AM

### SESSION 4: COMPUTATIONAL PATTERNING AND PROCESS CONTROL

1 March 2023 • 10:10 AM - 11:50 AM | Convention Center, Room 210C

Session Chairs: Yuyang Sun, Siemens EDA (United States), Jake O'Gorman, Hitachi High-Tech America, Inc. (United States)

12499-15 • 10:10 AM - 10:30 AM

## Computational patterning and process variation impact on photonics devices *(Invited Paper)*

Author(s): Lawrence S. Melvin, Synopsys, Inc. (United States); Maryvonne Chalony, Synopsys, Inc. (France); Rainer Zimmermann, Bernd Küchler, Synopsys, Inc. (Germany); Emilie Viasnoff, Robert Scarmozzino, Daniel Herrmann, Synopsys, Inc. (United States); Yves Saad, Synopsys, Inc. (Switzerland); Phil Stopford, Thuc Dam, Synopsys, Inc. (United States); Ulrich Klostermann, Wolfgang Demmerle, Synopsys, Inc. (Germany)

12499-16 • 10:30 AM - 10:50 AM

## Variability study of 18nm metal pitch semi-damascene interconnects with fully self-aligned Vias

Author(s): Assawer Soussou, Coventor Inc., A Lam Research Co. (France); Giulio Marti, Zsolt Tokei, Seongho Park, imec (Belgium); Gosia Jurczak, Lam Research Belgium BV (Belgium); Benjamin Vincent, Coventor Inc., A Lam Research Co. (France)

12499-17 • 10:50 AM - 11:10 AM

## A ML based OPC model pattern down-selection method with mask and wafer contours

Author(s): Xuefeng Zeng, Yuansheng Ma, Yixiao Zhang, Yuyang Sun, Siemens EDA (United States)

12499-18 • 11:10 AM - 11:30 AM

## A novel approach to etch-process-aware intensive layout retarget

Author(s): Jeeyong Lee, Sooyong Lee, Seongtae Jeong, Seung-Hune Yang, Kyoil Koo, Sangwook Kim, Dongho Kim, Joonsung Kim, Changmook Yim, Jungmin Kim, Ji-Suk Hong, Ryanggeun Lee, Yangwoo Heo, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12499-19 • 11:30 AM - 11:50 AM

## Realistic process simulation of high aspect ratio etching process

Author(s): Yeon Ho Im, Jeonbuk National Univ. (Republic of Korea)

Lunch Break 11:50 AM - 1:20 PM

### SESSION 5: EMERGING APPLICATIONS

1 March 2023 • 1:20 PM - 3:00 PM | Convention Center, Room 210C

Session Chair: Prem Kumar Panneerchelvam, KLA Texas (United States)

12499-49 • 1:20 PM - 1:40 PM

## Fabrication of optical gratings on various substrate sizes and geometries by reactive ion beam etching

Author(s): Philipp Böttger, Mandy Göring, scia Systems GmbH (Germany)

12499-21 • 1:40 PM - 2:00 PM

## Foundry compatible 300 mm process flows for Si spin and superconducting qubits *(Invited Paper)*

Author(s): Danny Wan, Stefan Kubicek, Tsvetan Ivanov, Shana Massar, Massimo Mongillo, Anton Potocnik, Ruoyu Li, Clement Godfrin, Daniel Perez Lozano, Xiaoyu Piao, Julien Jussot, Yann Canvel, Antoine Pacco, Andriy Hikavyi, Henri Jansen, Asser Elsayed, Mohamed Shehata, Jeroen Verjauw, Rohith Acharya, Jacques Van Damme, George Simion, Kristiaan De Greve, imec (Belgium)

12499-22 • 2:00 PM - 2:20 PM

## Advances in VCSEL technologies and integrated optics *(Invited Paper)*

Author(s): Jason Tan, Coherent Corp. (United States)

12499-23 • 2:20 PM - 2:40 PM

## Challenges in advanced 300mm silicon photonics technology

Author(s): Massud A. Aminpur, Erik Geiss, Vijayalakshmi Seshashalam, Brendan O'Brien, Jean Raymod Fakhoury, Joerg Paufler, San Leong Liew, Ken Shea, Keith Donegan, Ryan Sporer, Wenhe Lin, GlobalFoundries (United States)

12499-24 • 2:40 PM - 3:00 PM

## Advanced process technologies for photonics waveguide patterning

Author(s): Erik Geiss, Massud A. Aminpur, Brendan O'Brien, Padraig R. Timoney, Vijayalakshmi Seshachalam, Ryan Sporer, GlobalFoundries (United States); Joshua D. LaRose, TEL Technology Ctr., America, LLC (United States); Eitan Barlaz, Tokyo Electron America, Inc. (United States); Cameron Werner, Tokyo Electron Ltd. (United States); Katie Lutker-Lee, TEL Technology Ctr., America, LLC (United States); Luis Fernandez, TEL NEXX, Inc. (United States); Brian Pfeifer, Tokyo Electron America, Inc. (United States); Angélique Raley, TEL Technology Ctr., America, LLC (United States)

Coffee Break 3:00 PM - 3:30 PM

### SESSION 6: NOVEL ATOMIC SCALE PROCESSES

1 March 2023 • 3:30 PM - 5:30 PM | Convention Center, Room 210C

Session Chairs: Sebastian U. Engelmann, IBM Thomas J. Watson Research Ctr. (United States), Keun Hee Bai, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12499-25 • 3:30 PM - 4:00 PM

## Ultra-low energy radical treatments for advanced 3D device structures *(Invited Paper)*

Author(s): Seung Park, Yong Hee Choi, David Lo, Mark Kawaguchi, Christine Das, Lam Research Corp. (United States)

# CONFERENCE 12499

12499-26 • 4:00 PM - 4:30 PM

## Highly selective radical etch, continuous thermal etch and thermal atomic layer etch *(Invited Paper)*

Author(s): Andreas Fischer, Thorsten Lill, Mark Kawaguchi, Lam Research Corp. (United States)

12499-27 • 4:30 PM - 4:50 PM

## Radical based surface treatment and selective etch enabled by high density ICP remote plasma source

Author(s): Haichun Yang, Ting Xie, Qi Zhang, Shanyu Wang, Hua Chung, Mattson Technology, Inc. (United States)

12499-29 • 4:50 PM - 5:10 PM

## Selective isotropic atomic-layer etching of thin films by using dry chemical removal tool

Author(s): Kazunori K. Shinoda, Nobuya Miyoshi, Hiroyuki Kobayashi, Hitachi, Ltd. (Japan); Masaru Izawa, Hitachi High-Tech Corp. (Japan); Kenji Ishikawa, Masaru Hori, Nagoya Univ. (Japan)

12499-30 • 5:10 PM - 5:30 PM

## Anisotropic atomic layer etching of ruthenium with fluorination using fluorocarbon and hydrofluorocarbon

Author(s): Yongjae Kim, Hojin Kang, Heeyeop Chae, Sungkyunkwan Univ. (Republic of Korea)

### POSTER SESSION

1 March 2023 • 5:30 PM - 7:00 PM | Convention Center, Hall 2

Conference attendees are invited to attend the Poster Session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the Poster Session.

### Poster Setup: Wednesday 10:00 AM - 4:30 PM

Poster authors, view poster presentation guidelines and set-up instructions at <http://spie.org/ALPosterGuidelines>.

12499-38 • 5:30 PM - 7:00 PM

## Radical etching of high-k and low-k dielectrics for three-dimension device manufacturing with microwave-ECR etching system

Author(s): Yusuke Nakatani, Yasushi Sonoda, Hitachi High-Tech Corp. (Japan); Taku Iwase, Yi Lin, Hitachi High-Tech Taiwan Corp. (Taiwan); Masashi Kawabata, Motohiro Tanaka, Hitachi High-Tech Corp. (Japan)

12499-40 • 5:30 PM - 7:00 PM

## The damage control of sub layer while ion-driven etching with vertical carbon profile implemented

Author(s): Lina Yoo, Hyunwoo Choi, Jongdeok Hong, Junyeong Ahn, Yeajoon Cho, Seungjin Mun, Kyung Yub Jeon, Keunhee Bai, SAMSUNG Electronics Co., Ltd. (Republic of Korea)

12499-43 • 5:30 PM - 7:00 PM

## Study of selective isotropic etching effects of Si1-xGex in gate-all-around nanosheet transistor process

Author(s): Qi Yan, Univ. of Chinese Academy of Sciences (China); Hua Shao, Junjie Li, Zhenzhen Kong, Xiaobin He, Junfeng Li, Tao Yang, Rui Chen, Institute of Microelectronics (China); Yayi Wei, Univ. of Chinese Academy of Sciences (China)

12499-46 • 5:30 PM - 7:00 PM

## Modeling of SiNx growth by chemical vapor deposition in nanosheet indentation

Author(s): Hua Shao, Institute of Microelectronics (China); Panpan Lai, Institute of Microelectronics (China); Junjie Li, Guobin Bai, Institute of Microelectronics (China); Qi Yan, Univ. of Chinese Academy of Sciences (China); Junfeng Li, Tao Yang, Rui Chen, Institute of Microelectronics (China); Yayi Wei, Univ. of Chinese Academy of Sciences (China)

## THURSDAY 2 MARCH

### SESSION 7: SUSTAINABILITY IN ETCH AND PATTERNING INTEGRATION

2 March 2023 • 8:00 AM - 9:40 AM | Convention Center, Room 210C

Session Chairs: Robert L. Bruce, IBM Thomas J. Watson Research Ctr. (United States), Ying Zhang, NAURA (United States)

12499-31 • 8:00 AM - 8:30 AM

## Sustainable semiconductor manufacturing: Lessons for lithography and etch *(Invited Paper)*

Author(s): Emily E. Gallagher, imec (Belgium)

12499-32 • 8:30 AM - 9:00 AM

## Engineering chemical processes for sustainability in patterning nano-electronics *(Invited Paper)*

Author(s): Jane P. Chang, Univ. of California, Los Angeles (United States)

12499-33 • 9:00 AM - 9:20 AM

## Advances in low GWP etch gasses *(Invited Paper)*

Author(s): Colin Jennings, Phong Nguyen, Scott Biltek, Nathan Stafford, Air Liquide Electronics (United States)

12499-34 • 9:20 AM - 9:40 AM

## Characterization of TSV etch from a sustainability standpoint *(Invited Paper)*

Author(s): Osakpolo Isowamwen, Nathan Marchack, Hien Nguyen, IBM Thomas J. Watson Research Ctr. (United States); Devi Koty, Scott LeFevre, Qingyun Yang, TEL Technology Ctr., America, LLC (United States); Steve Molis, Marinus Hopstaken, Robert Bruce, IBM Thomas J. Watson Research Ctr. (United States); Andrew Metz, Jeffrey Shearer, TEL Technology Ctr., America, LLC (United States)

Coffee Break 9:40 AM - 10:10 AM



## SESSION 8: EUV INTEGRATION

**Joint Session with 12494 and 12499**

**NOTE ROOM CHANGE**

2 March 2023 • 10:10 AM - 11:50 AM | Convention Center, Grand Ballroom 220A

Session Chairs: Eric A. Hudson, Lam Research Corp. (United States), Moshe E. Preil, Carl Zeiss AG (United States)

12494-41 • 10:10 AM - 10:30 AM

### **EUV single patterning of random logic via using bright field mask**

Author(s): Ling Ee Tan, Werner Gillijns, Dongbo Xu, Jae Uk Lee, Jeroen van de Kerckhove, Vicky Philipsen, Ryoung-Han Kim, imec (Belgium)

12494-42 • 10:30 AM - 10:50 AM

### **Improvement of CD uniformity using a new selective exposure focusing method**

Author(s): Seonho Lee, Jaewoong Sohn, Hyosung Lee, Jaehyung Jung, Youngjun Kim, Heehong Lee, Hyoungwha Jin, Harim Oh, Yongchan Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Maarten Boogaarts, Nataliya Nishchenko, ASML Netherlands B.V. (Netherlands); Jin-Sung Kim, ASML Korea Co., Ltd. (Republic of Korea); Noh-Kyoung Park, ASML Netherlands B.V. (Netherlands); Sang-Jin Kim, ASML Korea Co., Ltd. (Republic of Korea); Javier L. Rivas, Jens Wustefeld, Martin de Nivel, Valerio Altini, ASML Netherlands B.V. (Netherlands)

12499-35 • 10:50 AM - 11:10 AM

### **Plasma etch challenges and innovations to enable sub-26nm pitch L/S patterning with high-NA EUV**

Author(s): Nafees A. Kabir, Intel Corp. (United States)

12499-36 • 11:10 AM - 11:30 AM

### **Understanding etch properties of advanced chemically amplified EUV resist**

Author(s): Jong Keun Park, Emad Aqad, Conner Hoelzel, DuPont Electronics & Industrial (United States); Philjae Kang, You Rim Shin, DuPont Electronics & Industrial (Republic of Korea); Yinjie Cen, Choong Bong Lee, Li Cui, Suzanne Coley, Benjamin Naab, Rochelle Rena, DuPont Electronics & Industrial (United States); Lei Zhang, DuPont Science & Innovation (United States)

12499-37 • 11:30 AM - 11:50 AM

### **Challenges and innovations in EUV patterning: Lithography and etch outlook (*Invited Paper*)**

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# SPIE EVENT POLICIES

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## Acceptance of policies and registration conditions

The following policies and conditions apply to all SPIE events, both online and in person. As a condition of registration, you will be required to acknowledge and accept the SPIE policies and conditions contained herein.

SPIE has established a confidential reporting system for all SPIE event participants to raise concerns about possible unethical or inappropriate behavior within our community. When at an SPIE event, you may contact any SPIE staff with concerns. If you feel that you are in immediate danger, please dial the local emergency number for police intervention.

## Agreement to hold harmless

Attendee agrees to release and hold harmless SPIE from any and all claims, demands, and causes of action arising out of or relating to your participation in the event you are registering to participate in and use of any associated facilities or hotels.

## Be well agreement

Any public space where other people are present holds an inherent risk of exposure to COVID-19 and other communicable diseases. By attending this event, I agree to voluntarily assume all risk related to exposure and agree to not hold SPIE or any of their affiliates including partners and sponsors, directors, officers, employees, agents, contractors, volunteers, or sponsored venues liable for illness. I will take necessary precautions while at the event including, but not limited to, engaging in appropriate social distancing, wearing a mask in public areas when not consuming food or beverage if required, minimizing face touching, frequently washing hands, and avoiding risky environments such as overcrowded bars or restaurants. I agree to not attend any SPIE event if I feel ill or had recent exposure to a COVID-19 case.

## Anti-harassment policy

It is SPIE policy that all employees, volunteers, and participants are entitled to respectful treatment. Any form of bullying, discrimination, harassment, sexual or otherwise, is unacceptable and will not be tolerated. This policy applies to all locations and situations where SPIE business is conducted and to all SPIE-sponsored activities and events.

## Attendee registration and admission policies

SPIE, or their officially designated event management, in their sole discretion, reserves the right to accept or decline an individual's registration for an event. Further, SPIE, or event management, reserves the right to prohibit entry of or to remove any individual whether registered or not, be they attendees, exhibitors, representatives, or vendors, whose conduct is not in keeping with the character and purpose of the event. Without limiting the foregoing, SPIE and event management reserve the right to remove or refuse entry to anyone who has registered or gained access under false pretenses, provided false information, or for any other reason whatsoever that they deem is cause under the circumstances.

## Capture and use of a person's image

By registering for an SPIE event, you grant full permission to SPIE to capture, store, use, and/or reproduce your image or likeness, including incidental capture of any individuals in your household or workplace, by any audio and/or visual recording technique and create derivative works of these images and recordings in any SPIE media now known or later developed, for any legitimate SPIE purpose. By registering for an SPIE event, you waive any right to inspect or approve the use of the images or recordings or of any written copy. You also waive any right to royalties or other compensation arising from or related to the use of the images, recordings, or materials. By registering, you release, defend, indemnify, and hold harmless SPIE from and against any claims, damages, or liability arising from or related to the use of the images, recordings or materials, including but not limited to claims of defamation, invasion of privacy, or rights of publicity or copyright infringement, or any misuse, distortion, blurring, alteration, optical illusion, or use in composite form that may occur or be produced in taking, processing, reduction, or production of the finished product, its publication or distribution.

## Code of conduct

SPIE is committed to providing a harassment- and discrimination-free experience for everyone at our events, an experience that embraces the richness of diversity where participants may exchange ideas, learn, network, and socialize in the company of colleagues in an environment of mutual respect.

## Event cancellation policy

If for some unforeseen reason SPIE should have to cancel an event, processed registration fees will be refunded to registrants. Registrants will be responsible for cancellation of travel arrangements or housing reservations and the applicable fees.

## Family-friendly policy

**Conference events:** All conference technical and networking events require a badge for admission. Registered attendees may bring children with them if they have been issued a badge. Registration badges for children under 18 are free and available at the SPIE registration desk onsite. Children under 14 years of age must be accompanied by an adult at all times, and guardians are asked to help maintain a professional, disturbance-free conference environment.

**Exhibition hall:** Everyone who attends the exhibition must be registered and have a badge. Badges for children are free and available onsite at the registration desk. Children under 14 years of age must be accompanied by an adult at all times. Guardians are asked to help maintain a professional, disturbance-free exhibition environment. Children under 18 are not allowed in the exhibition area during exhibition move-in and move-out.

## Identification requirement

To verify registered participants and provide a measure of security, SPIE will ask attendees to present a government-issued photo identification at registration to collect registration materials. Individuals are not allowed to pick up badges for other attendees. Further, attendees may not have some other person participate in their place at any conference-related activity. Such other individuals will be required to register on their own behalf to participate.

For online events, SPIE requires individuals to register with their legal identity.

## Laser-pointer safety policy

SPIE events are subject to the applicable laser safety rules and regulations of the host location. SPIE supplies industry standard Class 2 presentation laser pointers for all conference and other meeting rooms. For safety reasons, SPIE requests that presenters use provided laser pointers. Use of a personal laser pointer represents the user's acceptance of liability for any damage or injuries to presenter or others.

## No smoking policy

Attendees will observe all non-smoking regulations that are publicly posted by the facilities used by the event.

## Online commenting policy

SPIE moderates all comments posted in an online event. We encourage robust discussion, the exchange of scientific ideas, and the sharing of multiple, diverse perspectives. We expect the discussion to be consistent with the norms of scholarly research community interactions at events. Online event participants should report any comments or content that falls short of those community norms. We will remove comments, content, or people that are considered inappropriate by SPIE standards or that:

- are defamatory, libelous, obscene, indecent, abusive, or threatening to others
- infringe the copyright, trademark, or other rights of a third party
- upload viruses or are a cybersecurity hazard
- are off topic or inappropriately commercial in nature
- are in violation of any applicable laws or regulations

## Payment policy

Registrations must be fully paid before access to the conference is allowed. SPIE accepts VISA, MasterCard, American Express, Discover, Diner's Club, checks, and wire transfers. Onsite registrations can also be paid with cash.

## Recording policy

**Conferences, courses, and poster sessions:** For copyright reasons, recordings of any kind are prohibited without prior written consent of the presenter or instructor. Attendees may not capture or use materials presented in any meeting/course room or in course notes on display without written permission. Consent forms are available at speaker check-in, SPIE registration, or from SPIE online event hosts. Individuals not complying with this policy will be asked to leave a given session and/or asked to surrender their recording media. Refusal to comply with such requests is grounds for expulsion from the event.

**Exhibition hall:** Recordings of any kind are prohibited without explicit permission from on-site company representatives. Individuals not complying with this policy will be asked to surrender their recording media and to leave the exhibition hall. Refusal to comply with such requests is grounds for expulsion from the event.

## Unauthorized solicitation

Unauthorized solicitation in the exhibition hall is prohibited. Any non-exhibiting organization observed to be distributing information or soliciting business in the aisles, or in another company's booth, will be asked to leave immediately.

## Unsecured items

Personal belongings should not be left unattended in meeting rooms or public areas. Unattended items are subject to removal by security. SPIE is not responsible for items left unattended.

## Wireless internet service

At most events, SPIE provides wireless access for attendees. Properly secure your computer before accessing the public wireless network. SPIE is not responsible for computer viruses or other kinds of computer damage.

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### ABOUT THE EDITOR



**Harry Levinson**  
is a consultant for  
HJL Lithography



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