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Particulate Study on Materials for Cleanroom Assembly of SRF Cavities

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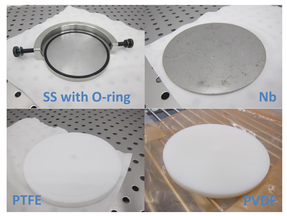
Abstract

Reducing particulates is an important aspect for cleanroom operation. Knowing that it is impossible to completely eliminate all particulates in a clean room, efforts have been made to prevent particulate from entering SRF cavities during high pressure rinsing (HPR) and assembly. At Jefferson Lab, one practice to achieve this goal has been clamping covers to cavity open flanges during assembly. Several cover materials that have been used are examined and alternative candidate materials are under development. Clamps as a known particulate generator are carefully examined and cleaning efficiency of different methods is studied. Cover tests were done on different cavity flanges, including LCLS-II beam pipe flange, which helps the selection of cover materials for prototype and production of the project.

Background of covers

- During HPR and assembly, open ports on cavities are covered to prevent particulates entering clean cavities.
- Cover materials:
- Past - Stainless steel blank with O-ring (used on C50, C100, SNS)
- Present - Niobium blank (ILC)
- Future candidates - Plastic (PTFE, PVDF, etc.)

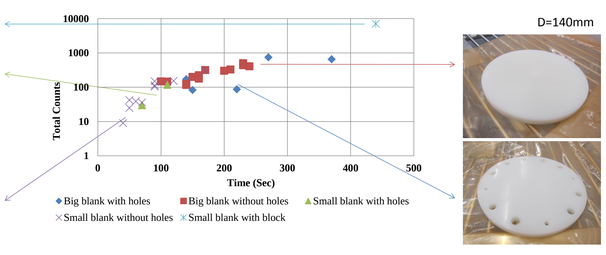


PVDF covers

Various dimension

- Evaluation method: Total counts and time needed to blow clean both sides.
- Lower left means better, upper right means worse.
- Simpler geometry and smaller dimension has lower particle counts.

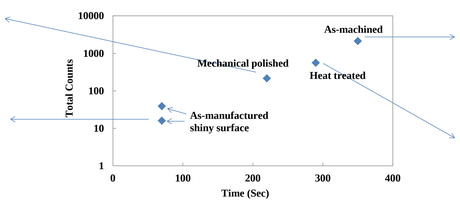
D=70mm

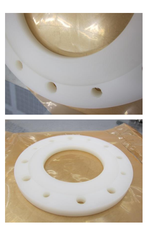


D=140mm

Various surface finish

Smoother surface has lower particle counts.





Testing covers on cavity flange

Step 1: Clamp cover onto cavity flange. Step 2: Blow connection. Step 3: Remove cover. Compare the maximum count per cycle for different covers in all three steps.

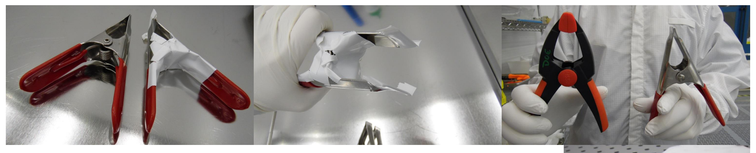
C-50 design beam pipe flange

Cover type	Step1	Step2	Step3
Niobium blank	0	9	1
SS and O-ring	2	74	20
Unpolished PVDF	13	34	0
Polished PVDF	28	23	0
PTFE blank	0	4	0
Gore-Tex and polished PVDF	0	12	0
Gore-Tex (ring) and niobium blank	0	9	0

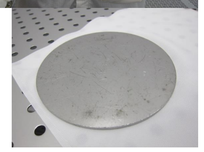
TESLA design beam pipe flange

Cover type	Step1	Step2	Step3
Nb blank	12	474	1
Medium Gore-Tex ring (thick) and Nb blank	0	13	3
Large Gore-Tex ring (thin) and Nb blank	0	196	7
Gore-Tex blank (thick) and Nb blank	0	1	0
Polished groved side of PVDF blank	0	307	3
Unpolished PVDF blank	0	27	0
PTFE blank	0	243	0

Sliding between clamps and covers

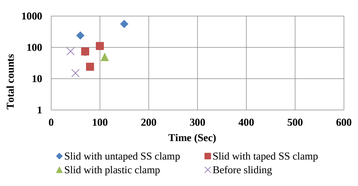


- Metal-to-metal vs. Plastic-to-metal
- Taped vs. un-taped clamps sliding on niobium blank
- No significant advantage found on plastic clamps or taped clamps over metal clamps.

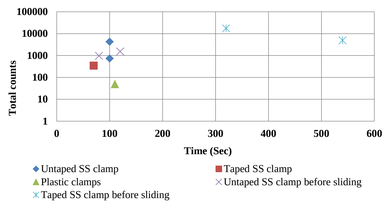


Particle counts recorded before/after sliding

Nb blanks: Total counts collected and time needed to clean one side



Clamps: Total counts collected and time need to clean tips

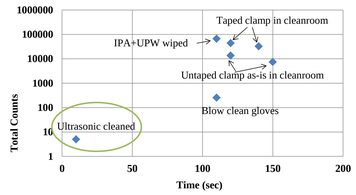


Particle counts recorded during sliding

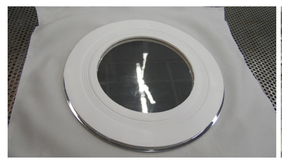
Sliding materials	Repeated runs	Maximum count per cycle
Un-taped stainless steel clamp sliding on niobium blank	#1	326
	#2	52
	#3	578
Taped stainless steel clamp sliding on niobium blank	#1	0
	#2	30
	#3	7
Plastic clamp sliding on niobium blank	#1	41

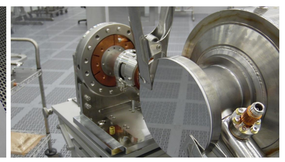
Cleaning of clamps

- Spring clamps generate particles from metal-to-metal friction on the spring when exercised.
- Particle counts on the entire clamp including tips and spring area were compared.
- Ultrasonic cleaning is the most effective way to remove particles.



Summary





- ❑ Surface particle count is material dependent and surface finish dependent. Metal is easier to blow clean than plastic. Polished surface is easier to blow clean than rough surface.
- ❑ Among all the tested material combinations, expanded PTFE combined with niobium blank provided best protection from particle contamination.
- ❑ Gore-Tex gasket combined with mirror finish stainless steel blank were used on LCLS-II cavity string assembly. Stainless steel clamps used for string cavity assembly are ultrasonic cleaned daily during cavity string assembly.

Acknowledgement

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Reference

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[2] D. Reschke, in *Proc. SRF'01*, pp. 144-151.
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