Vertical test results of plasma in-situ cleaning on low-beta HWR cavity

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Content

- Carbon contamination experiments on HWR cavity
  - Hydrocarbon adsorption at 4K
  - Carbon contaminants deposited by PECVD

- Plasma cleaning on the carbon contaminated HWR
  - Ar/O₂ RF plasma ignition
  - Vertical test results
Carbon contamination experiments on HWR

Binding energy between CH-contaminant and niobium surface

**Weak strength**
- SRF cavity is a cryogenic pump at 4K
- **Cryogenic adsorption** of residual gas and contaminants

**Strong strength**
- **Chemical deposited** on SRF cavity surface
Carbon contamination experiments on HWR

- Standard surface treatment as the baseline.
- \(\text{CH}_4\) contamination by cryogenic adsorption.
- Warm up to 300K and pump \(\text{CH}_4\) out.
Carbon contamination experiments on HWR

CH$_4$ cryogenic adsorption

- Performance degraded
- FE onset decreased by 12%.
- Quench point decreased by 18%.
Carbon contamination experiments on HWR

CH₄ cryogenic adsorption

- Performance degradation can be removed significantly by warm up to 300K and pumping.
Carbon contamination experiments on HWR

Plasma ignition for PECVD

Strong strength

- Carbon contaminant deposited by PECVD.
- Ar/CH\textsubscript{4}(3\%) RF plasma was used.
- Reaction: \[ \text{CH}_4 \xrightarrow{\text{Plasma}} \text{CH}_3, \text{CH}, \text{C}_2\text{H}_2 \ldots \ldots \]
Plasma cleaning on carbon deposited HWR

- In-situ cleaning by Ar/O$_2$ RF plasma

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Plasma cleaning on carbon deposited HWR

Residual gas analysis during cleaning of HWR
Carbon contamination experiments on HWR

Carbon Deposition

- Performance of HWR decreased
- FE onset decreased by 15%.
- Quench point decreased by 16%.
Carbon contamination experiments on HWR

RF conditioning

-Not significantly to remove FE.
Plasma cleaning experiments on HWR

Plasma Cleaning

- Contaminants was removed and performance was recovered significantly.

- Compared with standard surface treatment, FE onset and quench point increased by 83% and 28% respectively.
Plasma cleaning experiments on HWR

Plasma Cleaning

- Contaminants was removed and performance was recovered.

- X-ray dose of HWR cavity was decreased from several hundred to 4.5 μSv/h significantly.
Welcome to discussion

POSTER INFORMATION

- TUPO036
- Today 16:00 – 18:00
- Conference Room 3&4

PUBLICATION


[2] A.D. Wu, L. Yang et al., In-situ plasma cleaning to decrease the field emission effect of half-wave superconducting radio-frequency cavities, Nuclear Inst. and Method, A 905 (2018) 61–70

[3] A.D. Wu et al., Carbon contamination mechanism and performance recovery principle for superconducting radio frequency cavities: in submitting to NIMA.
Thanks