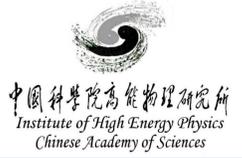


STUDY OF SURFACE TREATMENT OF 1.3GHz SINGLE-CELL COPPER CAVITY FOR NIOBIUM SPUTTERING

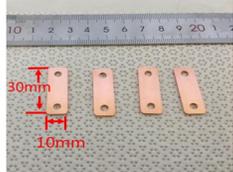
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Abstract

A R&D program on niobium sputtering on copper cavities has started at IHEP in 2017. Single-cell 1.3 GHz copper cavity has been chosen as a substrate. A chemical polishing system has subsequently developed and commissioned recently to accommodate the etching of both copper samples and a cavity. Different polishing agents have been tested on copper samples and later characterized. The results of these surface treatment tests are presented.

1. Dilute Sulfuric Acid Etching



Dimension of copper samples

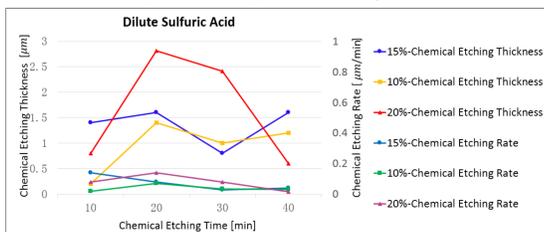


Copper samples before chemical polishing



Copper samples after chemical polishing (10%)

- Involved chemical reaction:
 $\text{CuO} + \text{H}_2\text{SO}_4(\text{dilute}) = \text{CuSO}_4 + \text{H}_2\text{O}$ (1)
- Three sulfuric acid concentrations were tried, 10%, 15%, 20% respectively.
- The surface of the copper samples soaked in the sulfuric acid was not significantly improved by visual inspection.
- The roughness before chemical polishing is $0.587\mu\text{m}$, and the roughness after chemical polishing is $0.533\mu\text{m}$.

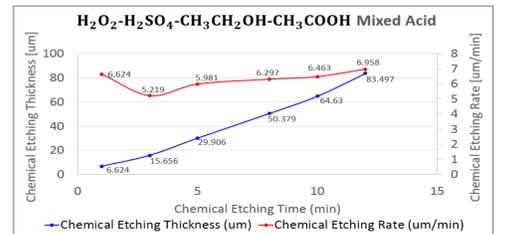


Variation curve of the chemical etching thickness and rate with elapsed time

2. H₂O₂ – H₂SO₄ Mixed Acid Solution

Composition	Content
H ₂ SO ₄	200g/l
H ₂ O ₂	70ml/l
CH ₃ CH ₂ OH	40 ml/l
CH ₃ COOH	40 ml/l

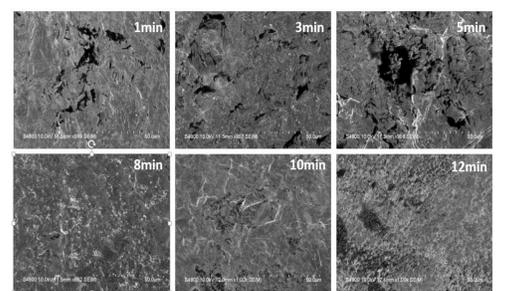
Compositions and contents of the mixed acid agent [1]



Variation curve of the chemical etching thickness and rate with elapsed time

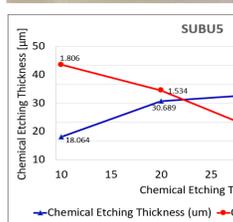
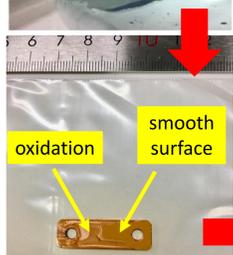


Copper samples after chemical polishing

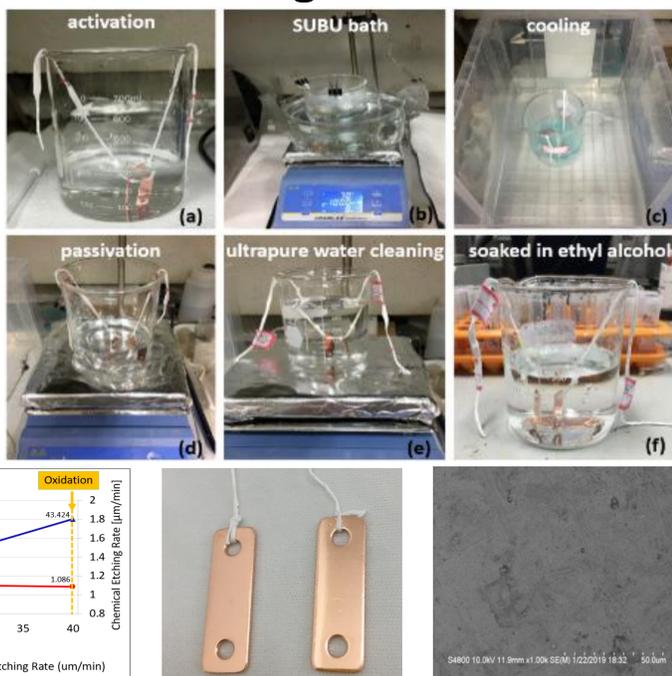


SEM surface pictures of copper samples after chemical polishing at different time

3. SUBU5 Chemical Etching



Variation curve of the chemical etching thickness and rate with elapsed time



Specific processing steps :

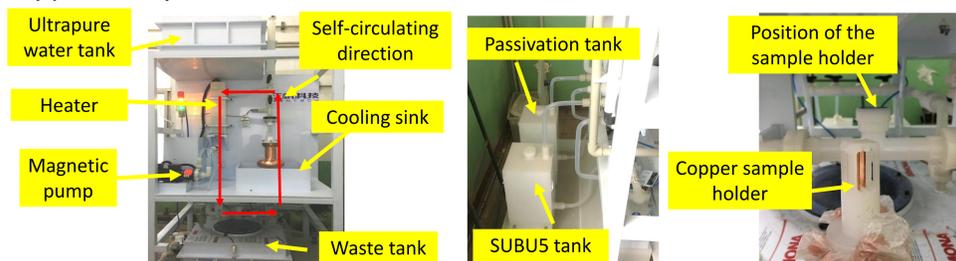
- Mechanical polishing.
 - Degreasing.
 - Activation pretreatment with dilute sulfamic acid [2].
 - Chemical polishing (SUBU5) with bath agitation.
 - Cooling to room temperature.**
 - Passivation with dilute sulfamic acid [2].
 - Ultrapure water cleaning.
 - Soaked in absolute ethyl alcohol.
 - Drying with high purity nitrogen and packing in plastic bag under high purity nitrogen.
- The surface roughness of copper samples before SUBU chemical polishing is around $0.5\mu\text{m}$. And the surface after SUBU bath chemical polishing presents an average roughness R_a of $0.1\mu\text{m}$.
 - The oxygen-free copper samples that are successfully chemical polished can be able to obtain a surface close to that of a mirror.
 - There are some pitting and slight scratches on the copper sample surface according to the SEM image.

4. Chemical polishing circulation system



Chemical polished copper cavity substrate

- A closed cycle system was established for the copper cavity substrate chemical polishing.
- The self-circulating pipe volume of this system is 6 liters, and the volume occupied by 1.3GHz copper cavity is 4 liters.
- We are now adjusting the setup of the chemical polishing system to obtain a larger volume of pipe.



5. Conclusion

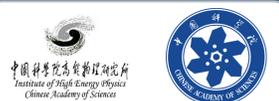
- Up to now, the chemical polishing agent and specific procedure have been determined. Meanwhile, the chemical polishing system for the copper cavity substrate has been built.
- We seek to expand the volume of the circulation pipe to remove thicker copper layer [3].

6. References

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