

Large Grain DESY Cavities and Crystallographic Orientation of the Niobium Discs

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Abstract

Eleven 9-cell Large Grain LG cavities have been produced and successfully RF tested at DESY. Analysis of the LG niobium discs for these cavities from the crystallographic orientation point of view will be presented. Surface behavior and roughness of the LG samples of different crystallographic orientation after buffered chemical polishing BCP have been studied by light microscope and Atom Force Microscope AFM. Oxidation behavior of large grain samples with different orientations after BCP was studied by X-ray photoelectron spectroscopy XPS and compared to polycrystalline niobium. The thickness of oxide layer on LG niobium is smaller than on fine grain material. The thickness of the oxide layer also depends on crystal orientation. Electron beam welding of LG samples has shown that two crystals grow in one crystal together, if the crystallographic orientations are matched at the EB seam. Relationship between the crystallographic orientation of the main central crystal of LG cavities and RF-data are analyzed. It seems that the orientations (221) and (211) is more preferable for cavity performance

Light microscope, AFM images and surface roughness of Nb LG with different crystallographic orientations. BCP etched up to 100 µm.









The thickness of the oxide layer is smaller in single crystals compare to fine grain sheet and depends on the crystal orientation of substrate bulk niobium

Surface contamination by fluorine depends on the crystal orientation of substrate bulk niobium

- 100

The oxide layer is thicker in polycrystalline Nb compare to single crystal

Influence of crystallographic orientation on cavity performance





Light microscope images of EB welded LG samples with not matched crystallographic orientation (a), not sufficiently matched orientation (b), matched (within 2-3 degree) orientation (C). EB welding of three LG (matched and not matched)



Comparison of Q0 at 2 K for 11 EP-treated LG cavities (red) with Q0 at 2 K of XFEL prototype cavities (AC115–AC129, best result) treated according to XFEL recipe (blue).



🗖 10 MV/m 🛛 🗖 15 MV/m



Summary

- Topography and surface roughness of BCP etched LG samples depends on crystallographic orientations
- * Thickness of the oxide layer of BCP etched LG samples depends on crystallographic orientation and is thinner compare to fine grain sample
- Two LG of sufficiently matched crystallographic orientation grow together during electron beam welding
- Analysis of maximal accelerating gradient and Qo of 11 DESY LG cavities produced at RI from HERAEUS material has shown that the orientations (221) and (211) seams to be more preferable.

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