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Thick Film Morphology and SC Characterizations of 6 GHz Nb/Cu Cavities

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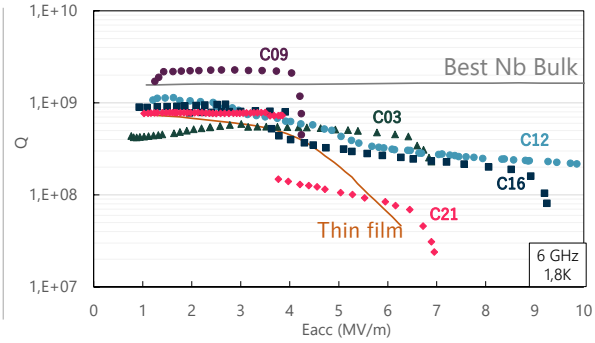
Introduction

Thick films deposited in long pulse DCMS deposition mode onto 6 GHz cooper cavities have demonstrated the mitigation of the Q-slope at low accelerating fields. The aim goal of the deposition of thick films is to reproduce the superconducting properties of the Nb bulk. In this work, different characterization techniques have been applied to Nb thick films on Cu to study the morphology, the response to a DC magnetic field and RF performances.

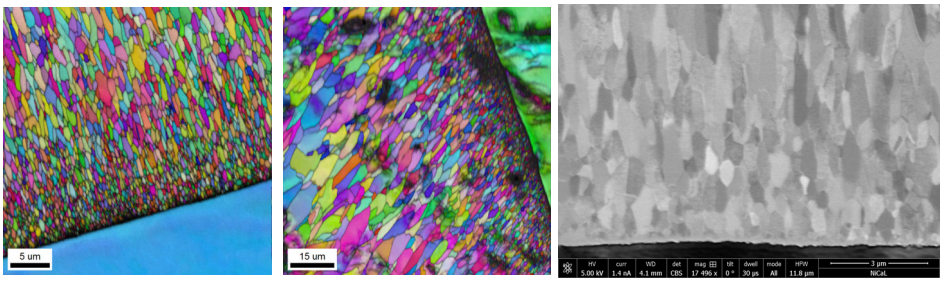


RF performances on 6 GHz elliptical cavities

Cavities sputtered with thick films between 45 and 70 µm demonstrated the possibility to mitigate the Q-slope at low accelerating fields, presenting flat quality factors.

Morphology

The thick films of around 70 microns showed a homogeneous columnar morphology after 30 microns grown by long pulse DCMS. The thick films showed a dense and without void growth on copper. The structure present grains that reached tens of microns of longitude. Furthermore, the grain size histograms indicate a low dispersion.

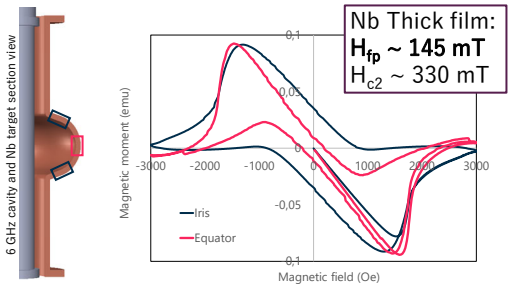


Courtesy of Reza Valizadeh (STFC)

Scanning Electron Microscopy (SEM) and Electron Backscatter Diffraction (EBSD) characterizations to cut coated 6 GHz cavity.

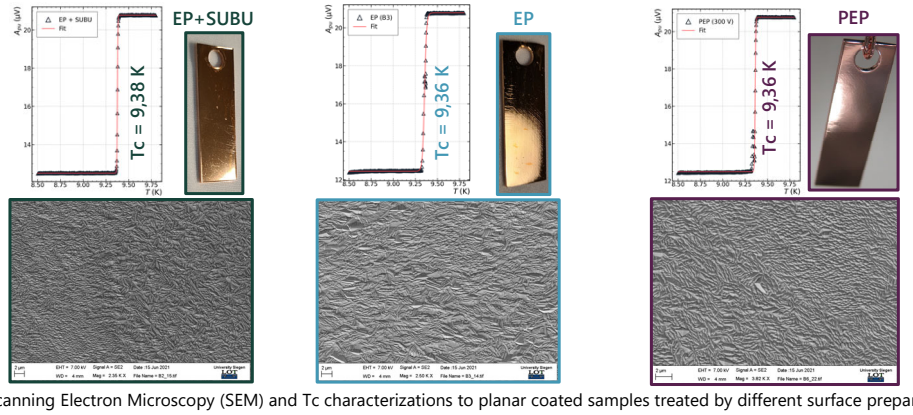
DC magnetometry

The magnetizations loop showed very poor flux trapping. The different growing morphology between iris and equator influence flux trapping. The full penetration field and the upper critical field can be estimated to be Hfp ~ 148 mT and Hc2 ~ 330 mT. While for the thin films produced by the ARIES collaboration to be Hfp ~ 15 mT and Hc2 ~ 290 mT.



Substrate preparation effect

The samples coated in the same cylindrical configuration as the 6 GHz cavities with thick films of 45 microns and prepare with different surface treatments showed a Nb bulk-like critical temperature with sharp transition. The SEM images demonstrate a homogeneous and dense films where non contribution is evident for the different surface preparation techniques.

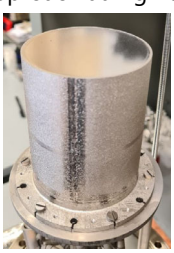


Tc measurements courtesy of Dorothea Fonnesu (CERN)
SEM images courtesy of Michael Vogel (University of Siegen)

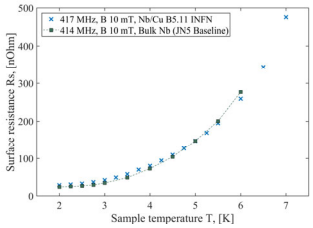
Scanning Electron Microscopy (SEM) and Tc characterizations to planar coated samples treated by different surface preparation.

Thick film performances in QPR sample

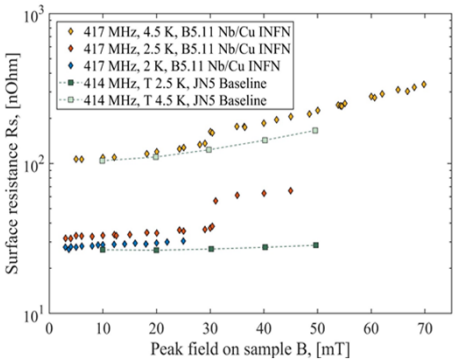
A QPR sample (B-5) was coated in a planar configuration with the adjusted coating parameters using the 6 GHz long pulsed DCMS approach at high temperature (550°C).



B-5 sample after Nb thick film coating.



The sample showed a similar behavior to the Nb bulk baseline (JN5) for the surface resistance during cooling down. The sample presented Q-switch around 32 mT, what was seen before in coated 6 GHz in the past. The maximum peak field was achieved was 70mT at 4,5K. These results are comparable to the QPR samples coated by ECR technique at JLab (reported in thin film workshop 2021). The sample was characterized at 417 MHz.



QPR sample RF characterization courtesy of Dmitry Tikhonov (HZB)

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