

Thin-Film Deposition for Surface Characterization Studies for Superconducting Radio Frequency Cavity Application

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Primary CNF Tools Used: AJA Sputter Deposition 1 & 2

Abstract:

Superconducting radio-frequency (SRF) cavities are a key component of particle accelerators (with applications ranging from fundamental physics research to synchrotron X-ray sources, to e-beam microscopy and lithography) and are also being developed for applications in dark matter detection and quantum computing. We are developing next-generation surface treatments to enhance the performance of niobium superconducting surfaces. By using facilities at the CNF, we investigate the effect of metallic doping on the niobium surface. We highlight our recent success in growing Nb₃Al superconducting alloys and ZrO₂ passivation layers.

Summary of Research:

We used CNF's AJA sputter deposition tools to deposit zirconium on niobium samples for ZrO₂ passivation layer development. Continued progress on this work has led to some of the highest-quality passivation layers demonstrated so far on a superconducting substrate. Additionally, we used the same tools to deposit aluminum on niobium samples for Nb₃Al layer growth. An Nb₃Al sample we grew maintained superconductivity in an RF field of over 80mT, making Nb₃Al just the third superconducting material to reach this threshold.

Conclusions and Future Steps:

We plan to continue optimizing our successful Nb₃Al and ZrO₂ layer recipes, while also returning to earlier work on Nb-Zr alloy formation.

References:

[1] <http://arxiv.org/abs/2606.10144>

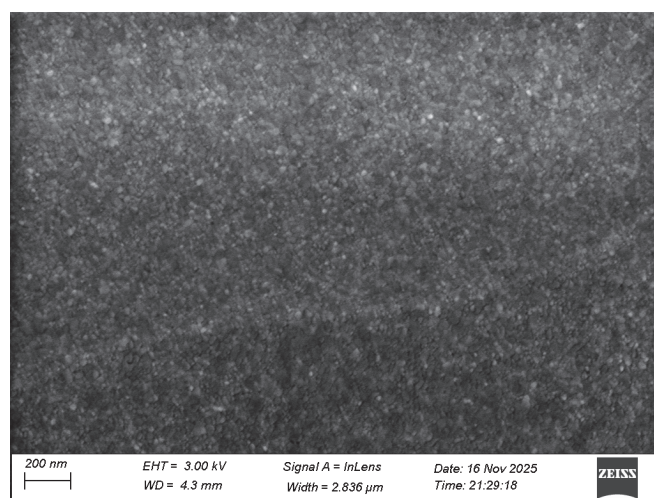


Figure 1: SEM image of ZrO₂-passivated Nb surface, showing a continuous and crystalline ZrO₂ layer.

