WILLIAM & MARY

APPLIED SCIENCES

PH.D. DEFENSE

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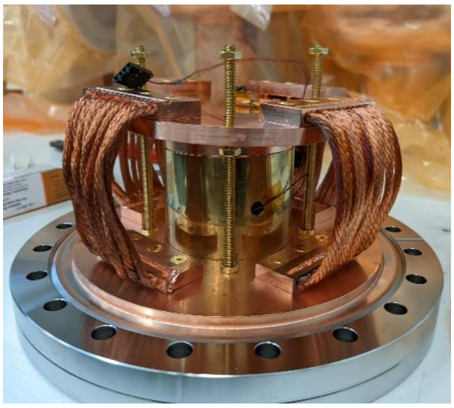
Superconducting Niobium Titanium Nitride Films and Structures for Accelerator Applications

Location: ISC 0280

Date: Dec 6th, 2024

Time: 10:30 am

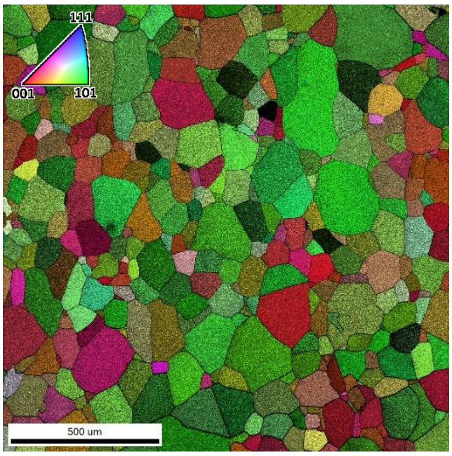


Problem Addressed

This work presents the characterization of the surface, material, and superconducting properties of high-quality thin films deposited with reactive direct current magnetron sputtering (DCMS). Developing specialized materials such as these is essential to surpassing the limitations of bulk Nb superconducting radio frequency (SRF) cavities used in modern accelerators. The performance of these cavities is constrained by the magnetic field strength at which flux enters the surface, known as H_{c1}.

How it Works

Although many compounds exhibit higher superconducting transition temperatures (T_c) than Nb, their lower H_{c1} has limited their practical application. Depositing higher Tc compounds in multilayer superconductor/insulator/superconductor (SIS) structures on bulk Nb can delay magnetic flux penetration. The higher T_c can reduce operational expenses of cooling, and a stronger H_{c1} allows for a higher acceleration gradient through an SRF cavity.



Impact

Implementing thin film structures on accelerating cavities can reduce the operational and construction expenses of accelerators. Additionally, this research relates to detectors and metamaterial technologies in a parallel strategy. Multilayer thin NbTiN and AlN films exhibited hyperbolic metamaterial properties and demonstrated an increase in T_c compared to single layers. SIS structures of thick NbTiN with AlN interlayers can increase the screening of magnetic fields to the bulk superconductor.

Check out all of Reed 's collaborations at D. Reed Beverstock - Google Scholar