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Studies as a function of different ALD capping layers on cavity losses for QIS and accelerators

Thursday 25 September 2025 09:30 (20 minutes)

Niobium-based bulk SRF cavities have demonstrated exceptional performance. To further improve niobium cavity performance, we present studies involving a novel surface engineering process designed to prevent the formation of amorphous niobium oxides on the surface. This is achieved by encapsulating the niobium surface using thermal Atomic-Layer-Deposition (ALD). This technique has been shown to enhance the properties of niobium cavities and 2D resonators. This study not only aims to improve SRF performance at high fields but also has the potential to enhance the quality factor in low-field regimes, particularly for quantum applications. For the method to be effective, it is essential to have a clean interface between the encapsulating layer and the bulk niobium. Achieving this requires a uniform coating across the entire cavity surface and efficient removal of the underlying niobium oxides. To optimize the process, a variety of material characterization tools have been utilized to refine parameters such as thin film thickness and annealing conditions. Cavity RF measurements were performed at the vertical test facilities at FNAL to assess the Q vs. Eacc curves for accelerator applications, as well as at the SQMS dilution refrigerators to investigate the full two-level system (TLS) losses at milliKelvin and single-photon levels. Based on the results, we characterized the loss of different oxides in various regimes and applications, comparing them to natural niobium pentoxide.

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Yes

Footnotes

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