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Recent Advances in Enhancing SRF Cavity Performance from IMP: Thermal Management via Inner-Wall AlN Coatings and Mechanism of Medium-Temperature Bake (MTB)

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Enhancing the accelerating gradient and intrinsic quality factor (Q_0) of SRF cavities is critical for next-generation accelerators. This work reports two advances from IMP: (1) Thermal Management with AlN Coatings: To address thermal limitations, this study demonstrates enhanced thermal diffusivity in SRF cavities via inner-wall aluminum nitride (AlN) coatings. Innovative thermal conductivity measurements using perpendicular laser heating (simulating RF dissipation) combined with COMSOL simulations quantitatively reveal the superior dynamic thermal response of AlN-coated Nb substrates. Future work integrates this laser system for optimized testing. (2) Medium-Temperature Bake (MTB) Mechanism: In-situ high-resolution TEM on small samples reveals the MTB process physically enhances SRF performance by decomposing surface oxides. Direct observation confirms oxygen diffusion and associated lattice defect formation during MTB, clarifying its operational pathway. Future research targets defect impacts on RF resistance and MTB protocol optimization. Together, these studies provide methodologies and insights supporting SRF cavity design for future accelerators.

Footnotes

Funding Agency

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