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Nb3Sn coatings for RF cavities

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To address the challenges of helium and energy consumption in next-generation particle accelerators such as the Future Circular Collider (FCC), it is essential to reduce the demands placed on cryogenic infrastructure. This has spurred a growing interest within the scientific community in advancing technologies that support operation at temperatures above 2 K. Within this framework, alternatives to conventional bulk niobium and niobium-on-copper superconducting radio frequency (SRF) cavities are under active investigation. Among these, the A15 phase of Nb_3Sn has emerged as a highly promising material, offering a significantly higher critical temperature (18.2 K versus 9.2 K for niobium) and reduced BCS surface resistance, making it a strong candidate for thin-film applications on copper substrates.

In this work, we present our recent advances in the development of thin Nb_3Sn films using High-Power Impulse Magnetron Sputtering (HiPIMS). We report the successful fabrication of QPR samples exhibiting RF performance up to three times higher than current state-of-the-art niobium-on-copper coatings, as measured at 4.5 K and 800 MHz. These promising results represent a significant step toward meeting the FCC requirements and have driven the launch of two major developments: (1) a custom deposition system optimized for 800 MHz cavities, and (2) a novel cylindrical Nb_3Sn cathode designed to minimize target cracking during sputtering.

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