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Improvement of Nb Thin FIlm MIcrostructure by HiPIMS

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Bulk Niobium (Nb) SRF (superconducting radio frequency) cavities are currently the preferred method for acceleration of charged particles at accelerator facilities around the world. However, bulk Nb cavities suffer from variable RF performance, have high cost and impose material & design restrictions on other components of a particle accelerator. Since SRF phenomena occurs at surfaces within a shallow depth of <1 m, a proposed solution to this problem has been to deposit a superconducting Nb thin film on the interior of a cavity made of a suitable alternative material such as copper or aluminum. While this approach has been attempted in the past using DC magnetron sputtering (DCMS), such cavities have never performed at the bulk Nb level. However, new energetic condensation techniques for film deposition offer the opportunity to create suitably thick Nb films with improved density, microstructure and adhesion compared to traditional DCMS. One such technique that has been developed somewhat recently is High Power Impulse Magnetron Sputtering (HiPIMS). In order to test HiPIMS, a systematic study was performed in which Nb films were deposited on coupon samples in multiple "series"where only one parameter (Ion Fraction, Average Condensation Energy, Temperature, Pressure…etc.) is varied at a time. Subsequently, the sample properties were measured using: XRD, AFM, SEM, EBSD and TEM, and correlations were made between deposition parameters and film properties. Here we present the results from the systematic studies performed and show the evolution of the Nb thin film properties as a function of the deposition parameters used across the HiPIMS regime.

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