

***Superconducting Thin Films for SRF Cavity Applications: A Route to***

***Higher Field Gradient Linacs***

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Abstract

Many linear accelerator (linac) applications rely on the use of superconducting radio frequency (SRF) cavities. In order to overcome the current field gradient limits imposed by the use of bulk niobium, a model involving the deposition of alternating superconducting-insulating-superconducting (SIS) thin films onto the interior surface of SRF cavities has been proposed. Since SRF performance is a surface phenomenon, the critical surface of these cavities is less than 1 micron thick, thus enabling the use of thin films. Before such approach can successfully be implemented fundamental studies correlating the microstructure and superconducting properties of thin films are needed. To this end the effect of grain boundary density and interfacial strain in thin films has been explored. Thin films with a smaller grain boundary density were found to have better superconducting properties than films with a larger grain boundary density. Interfacial strain due to a lattice mismatch between the film and substrate lead to two regions in films, one strained region near the interface and one relaxed region away from the interface. The presence of two regions in the film resulted in two types of superconducting behavior. Niobium films were deposited onto copper surfaces to help understand why previous attempts of implementing niobium coated copper cavities in order to exploit the better thermal properties of copper had varying degrees of success. It was found that an increased growth temperature produced niobium films with larger grains and correspondingly better superconducting properties. Proof of principle multilayer samples were prepared to test the SIS model. For the first time, multilayers were produced that were capable of shielding an underlying niobium film from vortex penetration beyond the lower critical field of bulk niobium. This result provides evidence supporting the feasibility of the SIS model.