ACCELERATOR SEMINAR

"Update of the SRF Work at Argonne: From Atomic Layer Deposition to Fundamental Dissipation Mechanism"

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I will summarize the ongoing effort at Argonne related to the Superconducting RF technology that spans from the fundamental dissipation mechanism responsible for the residual resistance to the latest developments of superconducting films made by Atomic Layer Deposition (ALD):

The presence of magnetic impurities in native niobium oxides have been confirmed by Point contact spectroscopy (PCT), SQUID magnetometry and Electron paramagnetic resonance (EPR). All niobium (Nb) samples displayed a small impurity contribution to the magnetic susceptibility at low temperatures which exhibited Curie-Weiss behavior, indicative of weakly coupled localized paramagnetic moments. By examining Nb samples with widely varying surface-to-volume ratios it was found that the impurity contribution is correlated with surface area. Tunneling measurements which use the native oxide layers as barriers exhibit a zero-bias conductance peak which splits in a magnetic field > 4T, consistent with the Appelbaum model for spin flip tunneling. Viewed together the experiments strongly suggest that the native oxides of Nb are intrinsically defective, and consistently exhibit localized paramagnetic moments caused by oxygen vacancies in Nb_2O_5.The computation of the surface impedance Rs in presence of magnetic impurities in the Shiba approximation reveals the saturation at low temperature of Rs, suggesting that magnetic impurities are responsible for the so-called residual resistance.

I will report the use of atomic layer deposition (ALD) to synthesize thin superconducting films and superconductor-insulator (S-I) heterostructures. ALD uses sequential self-saturating surface chemical reactions to produce uniform coatings with atomic scale control on substrates with arbitrary shape. The ALD process therefore offers the possibility of conformally coating complex shapes with precise, layered structures with tightly constrained morphology and chemical properties. Among other applications, such coatings may enable the production of superconducting radio frequency (SRF) structures with significantly better performance and yield than those obtained from bulk niobium. Furthermore, the atomic-scale thickness control afforded by ALD enables the study of superconductivity and associated phenomena in homogeneous layers in the ultra-thin film limit. In this respect, we will present results of ALD-grown $Nb_{1-x}Ti_xN$-based films and S-I heterostructures. Our program looks both at the metallurgy and superconducting properties of these coatings, and also their performance in working SRF structures.

Wednesday, April 6, 2011

11:00 a.m.

CEBAF Center, Room F113

Coffee before seminar beginning at 10:45 a.m.

Jefferson Lab

For further info, please contact Alex Bogacz at x5784 or Anne-Marie Valente at x6073