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In-situ electron paramagnetic resonance studies of performance-degrading defects in superconducting microwave resonators

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We have determined the physical nature and concentration of performance-degrading point defects in the dielectrics of superconducting planar microwave resonators using in-situ electron paramagnetic resonance (EPR) spectroscopy. This has been accomplished by measuring parallel plate and stripline resonator quality-factors as a function of the magnitude of a magnetic-field applied parallel to the electrode surfaces. YBa2Cu3O7-δ (YBCO) thin film electrodes proved to be a preferred choice over Nb and MgB2 because they are readily available and have a small surface resistance (Rs) up to high temperatures (~77 K) and magnetic fields (i.e. < 1 Tesla). Measurements of stripline resonators with Mn2+ and Co2+-doped Ba(Zn1/3Ta2/3)O3 and Ba(Zn1/3Nb2/3)O3 dielectrics are found to have losses dominated by spin-excitations (i.e. EPR absorption) in the dielectric, even without an applied magnetic field. Measurements of parallel-plate-resonators using very-pure sputtered Si dielectric layers on an unheated substrate are found to have a ~7 x 1018 cm-3 concentration of paramagnetic defects with properties similar to that reported in amorphous Si. Annealing is found to annihilate the paramagnetic defects to below measureable quantities.

Biography

Nathan Newman serves as the Lawrence Professor of Solid State Sciences and is a faculty member in the Materials Program at Arizona State University. His current work involves synthesis, characterization and modeling of novel superconductor junctions and materials, III-N semiconductors, low loss microwave dielectrics and novel photovoltaic material. He has authored or co-authored over 200 technical papers and 12 patents. He received the IEEE Van Duzer award and is a Fellow of the IEEE and the American Physical Society. He serves as an Editor for Materials in the IEEE Trans. of Appl. Superconductivity and has served as Chair of the US Committee on Superconductor Electronics and ASU's LeRoy Eyring Center for Solid State Sciences.

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