Pushing the Limits of RF Superconductivity Workshop

Abstract Submission Form for Contributed Talks

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Session: (choose one)

_X_ Ultimate Field Limits, New Materials, New Geometries

___ High Q, Field Emission, Q-Slopes

___ Future Research Paths to Ultimate Performance

ABSTRACT:

Title: A theoretical overview of multiscale mechanisms of rf superconductivity breakdown

Multiple mechanisms of rf breakdown of superconductivity on nanoscale, microscale and macroscale are discussed. On the nanoscale, the surface resistance $R_0(T,\omega)$ and kinetics of quasiparticles in rf field are analyzed for a general reflection mechanism from the sample surface and arbitrary relation between impurity mean free path ℓ and coherence length ξ_0. A nonlinear rf surface resistance is calculated for the clean limit $\ell >> \xi_0$ and large rf amplitudes H_0 for which the rf pairbreaking becomes important. This nonlinearity is more pronounced at lower temperatures at which $R(T,H_0,\omega)$ depends on the dc magnetic field even if there is no penetration of vortices in a superconductor.

On the microscale, dissipation strongly increases due to vortex penetration through surface barrier in oscillating magnetic field. To address the observed strong influence of defects on rf breakdown, dissipation due to vortex motion along grain boundaries in polycrystals is discussed.

On the macroscale, thermal rf breakdown is considered based on the calculated temperature dependence of the surface resistance. A formula for the rf breakdown magnetic field $H_b(T)$, as functions of temperature T_0, material parameters and cooling conditions is obtained. For high thermal conductivity of the superconductor, the breakdown field $H_p(T) = AT^3\exp(\Delta/2T)$ is minimum at $T_m = \Delta/6 \approx 2.9$K for Nb.

30 minutes