Abstract of Presentation

Multi-scale analysis of critical current and vortex dynamics in superconductors

Abstract :

Critical parameters in superconductors such as critical temperature, T_c, and critical current density, J_c, are usually measured by macroscopic measurements: four-probe transport measurement and/or magnetization measurement as an average value in the specimen. However, these superconducting characteristics are strongly influenced by local fluctuation such as compositional disorder, defects and grain boundaries. Namely, spatially resolved measurements on local superconducting properties are essential to understand real behavior of superconducting materials. We have developed several techniques which enable us to observe single vortex dynamics, local current flow, and in-field flux flow dissipation in micro-meter scale covering wide range of external field by use of the scanning SQUID microscopy, scanning Hall probe microscopy and the low temperature laser scanning microscopy, respectively. Based on these techniques, we can now combine mesoscopic vortex observation, local T_c-, J_c-measurement, and macroscopic four-probe measurements. We believe that the combination of these approach is quite effective to characterize novel superconducting materials and to optimize process conditions. For example, 1) effective search of optimum composition in two dimensional film samples obtained from combinatorial deposition method, 2) study on fundamental physical parameters from direct observation of single vortex, 3) understanding relationship among vortex pinning strength, local microstructure and global transport properties, and 4) detecting current limiting obstacles. In this contribution, as concrete examples of these combined multi-scale analysis, I would like to introduce our recent results on in-field current transport properties at an artificial low angle grain boundary, Bi-2223 multifilamentary wires and RE-123 coated conductors, respectively.