Moving Vortex States in BSCCO in Tilted Fields

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Abstract

The nonequilibrium vortex states have been investigated in single crystalline $Bi_2Sr_2CaCu_2O_{8+\delta}$ using high precision in-plane resistivity and magnetization measurements as functions of temperature, transport current density, magnetic field and its orientation. It was found that the first-order vortex-lattice melting transition (VLMT) phase line persists even in the dynamic vortex states in a wide range of driving forces for both orientations, H$\|$ c and tilted to the c-axis, and sharply separates the vortex solid and the vortex liquid phases. Using the relation $\rho = \rho_0 exp(-U/k_BT)$ the activation energy U is found to abruptly increase bellow VLMT, to strongly depend on transport currents and to be weakly influenced by the magnetic fields in the vortex solid state, whereas it is insensitive to the external forces in the liquid phase. As the in-plane field is raised, the resistivity in the vortex solid phase increases but the activation energy remains rather unaffected. We did not observe any sign of the dynamic plastic-elastic phase transitions or the pronounced peak-effect in our as-grown samples. However, it is interesting to note that recent result of magnetization measurements suggests the evidence of sharp peak effect in slightly disordered BSCCO sample.