Monte Carlo Study of Vortex State in Heavy-Ion Irradiated Bi-2212: Current-Driven Vortex Dynamics

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Abstract

We examine "current-driven" motion of flux-lines in $Bi_2Sr_2CaCu_2O_8$ in the presence of columnar defects, focusing on dynamical aspects of four different vortex phases: coupled or decoupled vortex liquid and Bose glass, in the "equilibrium" phase diagram which has recently been proposed by Sugano *et al.* [Phys. Rev. Lett. **80**, 2925 (1998)]. From a Monte Carlo simulation method using the tilt potential (transport current $\parallel$ ab-plane) [Ryu *et al.*, Phys. Rev. Lett. **71**, 4245 (1993)], we directly calculated the current-voltage (I-V) characteristics to find that, for the Bose glass phase, a temperature-independent "peak effect" appears in the critical current density ${J_c}^{ab}(B)$, at a fractional filling ($B/B_\Phi \simeq 1/3$) below the matching field B_Φ, while a dip-like (or reentrant) behavior is seen in the Ohmic resistivity $\rho^{ab}(B)$ for the liquid phase. These anomalous behaviors are closely related to a sudden change of interlayer coherence of of vortex state, which is remarkable near the melting line and $B/B_\Phi \simeq 1/3$. Correspondence to very recent experiments [Chikumoto *et al.*, Phys. Rev. B **57**, 14507 (1998); Hirata *et al.*, in *Advances in Superconductivity* (Springer Verlag, in press); Morozov *et al.*, Phys. Rev. B **57**, R8146 (1998)] and the scaling behavior of I-V characteristics are also discussed.