Anomalous magnetization behavior observed in BSCCO with columnar defects

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Abstract

The reversible (M_{rev}) and the irreversible magnetization of $Bi_2Sr_2CaCu_2O_{8+\delta}$ single crystals with columnar defects were measured as a function of field and temperature. In contrast to the conventional $\ln B$ dependence of M_{rev} observed in the unirradiated sample, the field dependence of M_{rev} for the irradiated samples exhibit anomalous dip, corresponding to the expulsion of vortices from the sample. By comparing the magnetization data with Josephson plasma resonance experiment [Kosugi *et al.*, Phys. Rev. Lett. **79**, 3763 (1997)], we show that the coupling transition, which has never been considered in the previous analysis of the magnetization, is very important to understand the anomalous behavior of M_{rev}. From the measurement, we obtain the almost temperature independent transition line $B_{cp}(T) \sim B_\Phi/3$, where B_Φ is a matching field. This is in good accordance with the recent computer simulation [Sugano *et al.*, Phys. Rev. Lett. **80**, 2925 (1998)].

We also observe anomalous peak effect at the same field, $B \sim B_\Phi/3$, in BG regime, which accompanies the re-entrant behavior of BG melting line.