

Crossover Phenomena Observed in Field Dependent Critical Currents of Grain Boundaries of $\text{Nd}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$ Films

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We investigated the critical current densities (J_{cb}) at grain boundaries (GB) of bicrystalline $\text{Nd}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$ films. We observed that these sharply dropped as the applied fields were increased from zero to $\sim 1 \text{ Oe}$ (H_{JA}) and then showed relatively small field dependences above H_{JA} . These contrasting field dependences of J_{cb} below and above H_{JA} clearly indicated crossover phenomena in the vortex states. Our experimental results were consistent with a theoretical model, which was based on the concept that the energy difference between Josephson (J-) vortices and Abrikosov (A-) vortices caused the generations of only J-vortices initially. This might result in an initial sharp increase of J-vortex densities at GB, as the field was increased from zero to H_{JA} . As the field is increased further, some J-vortices penetrated from GB to intra-grain regions and become A-vortices, that might change the field dependences of J_{cb} .

keywords : low magnetic field, critical current, grain boundary, Josephson vortex