

Field Dependence of Critical Currents and Vortex Densities at Grain Boundaries of HTSC Films

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The flexible HTSC tapes are important components for industrial power applications. They consist of thick polycrystalline HTSC films. There are two types of vortices in these polycrystalline films. One is Abrikosov vortices (A-) in intra-granular regions and the other is Josephson vortices (J-) at grain boundaries. The critical currents are determined by de-pinning of J-vortices, while their motion can be described by the Gurevich's non-local equation. However the pinning energy is strongly dependent on the density of J-vortices, which is proportional to the magnetic field at the grain boundary. Hence the distributions of magnetic fields at grain boundary regions and intra-grain regions are important. These are equivalent to the distributions of J-vortices and A-vortices and determined by the minimum conditions of the magnetic and superconductive free energy, i.e. GL-Maxwell equations. The structures, self free energies and the interaction energies of these vortices can be estimated from these equations as A. Gurevich expressed by simple formula. E. H. Brandt studied the field distributions by numerical method as well as analytical method.

We measured the field dependences of critical currents at the grain boundaries of various misorientation angles in $\text{Re}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$ films (Re=Y, Sm, Nd, Dy). Our data were analyzed using Brandt's method and Gurevich's formula. We found several material parameters related to the properties of vortices and compared them for the various conditions; temperatures, fields, misorientation angles, and types of materials. The details of the method of our analysis and the results will be explained in this lecture.

keywords : Field dependence, critical currents, vortex densities, grain boundaries, A. Gurevich, E. H. Brandt