ANGULAR DEPENDENCE OF CRITICAL FIELDS IN AS GROWN Y-Ba-Cu-O FILMS

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The angular dependence of the critical field and the transition temperature of the as grown films were measured at T near Tc. The superconducting critical fields, Hc2(T,θ) show a linear temperature dependence. The angular dependence of the critical field and the transition temperature are discussed in the framework of the GL anisotropic 3D model and Tinkham's 2D model of superconducting thin films.

The new CuO-based YBa2Cu3Oy superconductors are characterized by a very anisotropic, layered structure and short coherence lengths. The dimensional crossover from 3D to 2D behavior is an interesting subject. This crossover should be observable in both the temperature dependence of the parallel (to the Cu-O planes) upper critical fields and the angular dependence of the critical fields. In this work, we report the angular dependence of the transition temperature and critical fields, Hc2, of YBa2Cu3O7−y (1−2−3 phase) thin films.

The films were in situ grown in a high pressure magnetron sputtering system using a single YBa2Cu4.6Oy target. The sputtering gas is a flowing mixture of O2 and Ar (3:7) in a pressure of 150−200 mTorr. The sputtering power is 120 watts. The rate is about 0.8 A/sec. The substrates(MgO(100)) are heated to about 700°C using a quartz lamp. After deposition O2 (1 atm) is introduced to the system and the substrate temperature is kept at 600°C for one hour to increase the oxygen content. Finally the samples are cooled down to room temperature and removed from the chamber. The appearance of the sample is black and shiny. Their thicknesses are about 5600 Å. The X-ray diffraction pattern of the as grown films shows preferred orientation with c-axis perpendicular to the plane of the film and all diffraction peaks can be identified with 1−2−3 phase. The room temperature resistivity of the sample is 0.7 mΩ.cm and the critical current density is about 1x10^4 A/cm^2 at 77K. The transition temperature (50%) = 81K and a zero resistance = .78K.

Figure 1 shows the temperature dependence of resistivity for sample a in parallel and perpendicular magnetic fields. The increment in each curve is 0.5 T. The critical field obtained from the 50% resistive transition are observed to be linear for different orientation θ of the c axis with respect to the magnetic field. The Hc2 anisotropy data has been reported by many groups (1) for 1−2−3 single crystal and there is a general agreement for
Now we want to address the dimensional behavior for the layered compound with coupling between the layers. A transition from 30 to 20 is expected as one reduces the coupling between the Cu-O planes. Based on single crystal data, a 3D-behavior in the layers has been observed for the 90 K superconductors (4,5) while the oxygen deficient 60 K superconductor shows a 20 behavior (4). Our present data tend to indicate that the coupling of the Cu-O planes is weaker than that of 90K but stronger than that of 60K superconductor, so the dimensional behavior of the Cu-O planes lies between 30 and 20 for this sample which shows \( T_c (50\%) = 81 \) K and zero resistance at 78K.

In conclusion we have performed an anisotropy study for the c axis oriented 1-2-3 film. The results suggest that this coupling is depressed for the films \( T_c; \)zero \( = 78 \) K compared with that of 90 K Superconductor, resulting in a behavior lies between 3D and 2D in the coupling of the Cu-O planes.

REFERENCES
(1).See, for example, Iye et al., in Superconducting Materials, edited by S. Nakajima and H. Fukuyama, JJAP Series 1, P46(1988).