IRREVERSIBILITY LINE OF $YBa_2Cu_3O_7$ FILMS AS A FUNCTION OF ANGLE AND FIELD UP TO 50 TESLA

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Introduction

The study of the irreversibility line (resistivity=0) in high T_c superconductors is scientifically and technologically relevant since this line marks the upper limit for applications and is a solid-liquid phase transition of the vortex matter. The nature of the solid state and its properties strongly depend on the type of defects present, straightening up vortices or inducing entanglement if the predominant defects are correlated or random respectively [1]. Low current transport measurements were performed to map the irreversibility line of $YBa_2Cu_3O_7$ (YBCO) films in pulsed fields up to 50 T. The objective of this work was to study the coexistence of different type of defects in technologically relevant samples. The inclusion of $BaZrO_3$ (BZO) nanoparticles induces *c*-axis correlated defects and nano-sized particles [2]. By changing deposition conditions we are able to tune the amount of particles and correlated defects making YBCO+BZO an ideal model system.

Experimental

Thin films of YBCO and YBCO+BZO were grown by pulsed laser deposition on $SrTiO_3$ single crystal substrates. Transport measurements were performed in pulsed field (50 T Short Pulse) using an existing rotator probe. Resistivity vs field data was collected and H_{irr} obtained using a fixed resistivity criterion (2% of the resistivity at T= 95 K). Two films were measured, a plain YBCO and an YBCO+BZO. Angular dependence measurements over the limited range accessible with existing equipment were also performed. Repairs that will improve the rotational capability are in progress.

Results and Discussion

In Fig. 1 $H_{irr}(T)$ for two films measured are shown with the applied magnetic field parallel to the normal of the film (along the c-axis). At H~5-7 T a characteristic bump in the $H_{irr}(T)$ is found for the YBCO+BZO film, a fingerprint of correlated defects known as "matching field" [3]. At this field, the difference between the two H_{irr} lines is maximal, indicating that the effect of the correlated pinning on the vortex lattice is strongest. The enhancement in H_{irr} is maintained up to 50 T, showing that the effects of the columnar defects persist up to the highest accessible fields. However, this simple scenario does not take into account the role of particles. Therefore, to complete this picture, we will measure YBCO+BZO films with different correlated defects densities and perform detailed angular dependent measurements to determine where correlated defects are important.

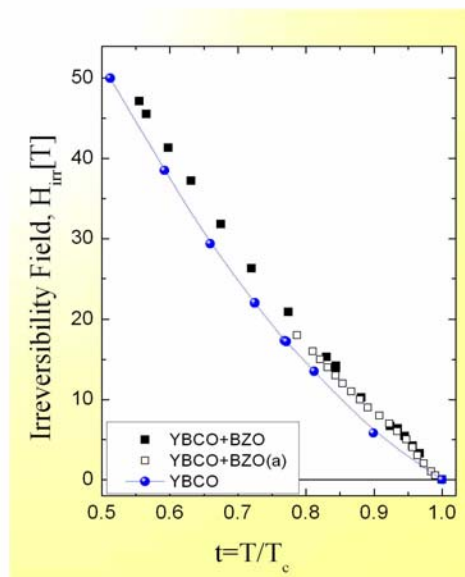

Fig. 1. $H_{irr}(t=T/T_c)$ for YBCO and YBCO+BZO films. Open squares, measurements of another YBCO+BZO films up to 18 T, performed in a DC magnet.

Conclusions

Defects created by introduction of $BaZrO_3$ particles enhance vortex pinning in fields up to 50 T. Angular dependent measurements in progress will allow us to determine the relative importance of correlated and random point-like pinning as well as the influence of nano-sized particles.

References

[1] G. Blatter *et al*. Rev. Mod. Phys. **66**, 1125 (1994).
[2] J.L. Macmanus-Driscoll *et al.* Nature Material **3**, 439 (2004); B. Maiorov *et al.* unpublished**.**
[3] L. Civale *et al*. Phys. Rev. Lett. **67**, 648 (1991); L.Civale and L.Krusin-Elbaum, Phys. Rev. Lett. **78**, 1829 (1997).