Irreversibility Field of High Temperature Superconductor Bi-2212

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Introduction

Bi-2212 round wire is one of our first choices as a conductor for new generations of superconducting magnets reaching 25-30 T fields well beyond those possible with Nb$_3$Sn. Present experiments are part of the R&D needed to build a 7T Bi-2212 insert magnet, which is to be tested in the NHMFL 195 mm 19.5T Bitter solenoid.

Experimental

Transport resistivity measurements of irreversibility field $H_{irr}$ using small currents were performed in the NHMFL 33T resistive magnet for Bi-2212 samples. We measured both round wire and tapes samples by fixing temperature and sweeping field. The critical state irreversibility field $H_K$ was measured by using a 14T Oxford VSM.

Results and Discussion

As seen in Fig. 1a, small current probing shows that $H_{irr}$ of round wire Bi-2212 falls between that of the two tape orientations (field perpendicular and parallel).

As shown in Fig 1b, $H_{irr}$ data suggest transitions at temperatures as much as 15K higher than those derived from extrapolations of a full critical state measured by VSM (e.g. the Kramer function fit to zero $J_c$ at $H_K$).

The $J_c$ of Bi-2212 conductor to 45T was measured by Trociewitz et al. in 2005 and these data showed the remarkable result that the pinning force $J_cB$ was not clearly peaking even at 45T. Scaling laws for $J_c$ are now becoming important for conductor designs and conductor quality has been getting better. It becomes important therefore to understand what $H_{irr}$ is more precisely. The data shown in Fig. 1b point to the inadequacy of measuring $H_{irr}$ by the usual small current measurements, perhaps because the round wire conductor is not textured and so more favorably oriented grains provide a percolative superconducting path for the less favorably oriented grains, which provide the cut off for $J_c$ at $H_K$ when they lose superconductivity.

References


Figure 1: Irreversibility fields of a polycrystalline Bi-2212 round wire and tape determined by transport resistivity and by extrapolation of the critical state magnetic moment to zero using a vibrating sample magnetometry (VSM), as compared to a recent NMR single crystal study (Chen, Halperin et al. Nature Physics 3 (4): 239-242 APR 2007.)