Flux Pinning at *ab* Planar Defects in Co-doped Ba-122 Thin Films

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Introduction

Co-doped $BaFe_2As_2$ (Ba-122) is a pnictide superconductor with relatively low anisotropy yet high upper critical fields, which makes it interesting for certain low-temperature applications. Recently, strong flux pinning at columnar oxide defects in Ba-122 thin films has been reported.[1] Here, the pinning properties at low temperatures and high magnetic fields of samples grown at low oxygen partial pressure are studied.

Experimental

The Co-doped Ba-122 film was grown by pulsed laser deposition on Fe-buffered (001)-oriented MgO single crystal substrate. A detailed description of the sample preparation can be found in Ref. [2]. A four-probe bridge of 90 µm width and 700 µm length was structured by laser cutting, and the critical current density J_c was defined by a criterion of 1 µV/cm in transport *V(I)* curves.

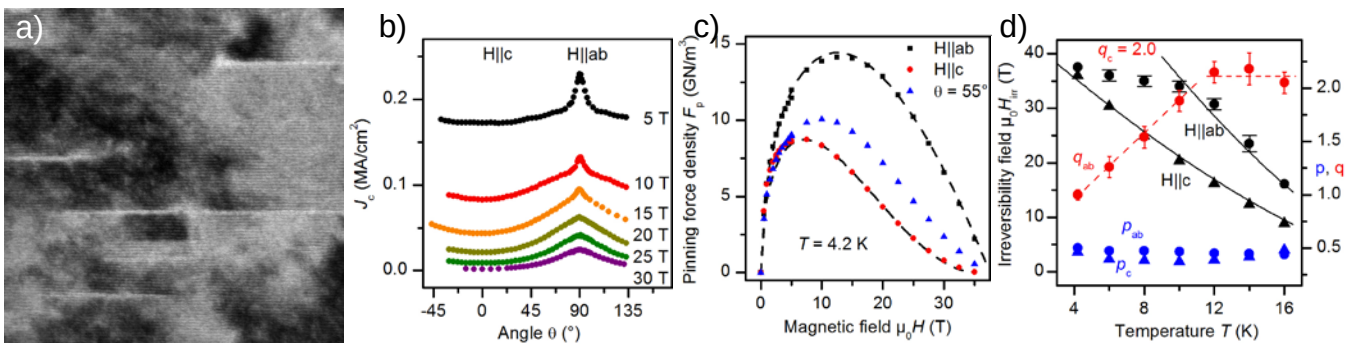

Figure 1: a) Cross sectional TEM (75nm)^2, **g**=(100), showing *ab*-planar defects, b) angular dependence of J_c for several fields at 4.2 K, c) pinning force density at 4.2 K for three field directions, d) temperature dependence of *p*, *q*, and H_{irr} for H||c and H||ab.

Results and Discussion

TEM investigations, **Figure 1 a**), revealed the presence of stacking-fault-like ab-planar defects as well as small-angle grain boundary networks ||c in between those defects. The angular dependence of J_c, **Figure 1b**), shows the effect of the *ab*-planar defects at 4.2 K. They manifest as an extra peak at θ = 90° in fields below 20 T on the underlying random-pinning contribution. At fields up to around 5 T, a small c-axis peak in $J_c(\theta)$ is observed as well, due to the dislocations. At high temperatures, both kinds of defects can be modeled by extended random rather than correlated defects and the pinning force density can be scaled with a modified Kramer formula $F_p \sim h^p*(1-h)^q$, $h = H/H_{irr}$, with (p,q)=(0.5,2) for both directions, indicating flux shearing as dominant depinning mechanism. As illustrated in **Figure 1c**) for T = 4.2 K and summarized in **Figure 1d**), the pinning behavior stays the same for H||c but changes for H||ab. Below 12 K, the parameter *q* is going towards 1.0 and the irreversibility field H_{irr} is nearly constant at around 35 T. The irreversibility field was cross-checked with *R(T)* and *R(B)* measurements. Possible reasons for this behavior are effective pinning at planar defects at low T and a concomitant stiffening of the flux line lattice, and a dimensional crossover between 2D and 3D pinning due to the finite film thickness.

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References

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