Field and Angular Dependence of J_c in $FeSe_{1-x}Te_x$ Thin Films

C. Tarantini, J. Jaroszynski (NHMFL, FSU) V. Braccini, S. Kawale, E. Bellingeri, C. Ferdeghini (CNR-SPIN)

Introduction

In order to exploit the huge tolerance of Fe-based superconductors to high magnetic fields in practical applications, such high field resilience must be understood and the possibility to alter the superconducting properties must be explored. The upper critical field, H_{c2}, of $FeSe_{1-x}Te_x$ films tuned by strain was characterized and found to exceed 50T [1], while the irreversibility field at 4.2 K was estimated above 35-40T.

Experimental

Thin films were deposited on different substrates in order to understand how we could tune the high field and pinning properties, in relationship with the lattice mismatch with the substrate. A film deposited on $LaAlO_3$ and patterned with a 1 mm long and x 290 μm wide bridge was thoroughly analyzed at the NHMFL up to 35 T. I-V measurements were performed in order to extract the field and angular dependence of J_c, at 4.2 K reported in Fig. 1a and 1b respectively. Both J_c(H//*ab*) and J_c(H//c) was measured as well as $J_c(\theta)$ at different fields.

Results and Discussion

H_{Irr} was estimated to be 31.5 T for H//*c* and 35 T for H//*ab*, and the pinning force was extracted (inset of Fig. 1a). The angular behavior of J_c at high fields is shown in Fig. 1b: we observe a maximum for *H*//*ab*, indicating intrinsic pinning arising from correlated *ab* planes, and also a small *c*-axis peak. This is different from what previously found on STO samples [2]: in low field measurements, the film deposited on STO showed a larger J_c for *H*//*c*. In Fig. 1c the normalized J_c angular dependence shows a large *c*-axis peak at various T and H. This was interpreted as due to strong correlated pinning and it was confirmed by the observation through STM of nanoscale threading dislocations which are absent in films grown on LAO [3], and by TEM imaging of defects that grow parallel to the *c*-axis (inset of Fig. 3c). In this case the estimated matching field is about 20T, suggesting a possible improvement of the pinning properties for films deposited on STO. More promising results are expected in $FeSe_{0.5}Te_{0.5}$ films deposited on CaF_2 which have high crystalline quality, excellent epitaxy, clean interface and enhanced T_c, while J_c measured at low fields already showed very weak field and angular dependence [4].

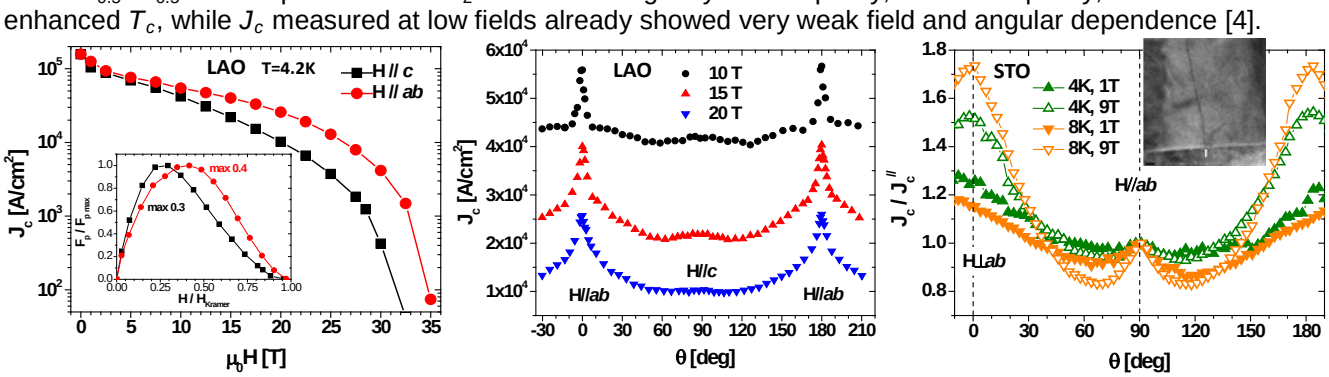

Figure 1 a) J_c(H) up to 35 T in two orientations at 4.2 K and (inset) the normalized pinning force (LAO); b) $J_c(\theta)$ at 4.2 K (LAO); c) Normalized $J_c(\theta)$ at various T and H (STO); inset of c) TEM image of a single defect growing parallel to the *c*-axis in the film grown on STO.

Conclusions

These preliminary results reveal strong correlation between this material properties and the employed substrate because of the different induced stress. High field measurements will be of great interest on samples grown on STO and CaF_2, too.

Acknowledgements

This work was supported at NHMFL by the NSF under DMR-0654118 and the State of Florida.

References

[1] Tarantini, C., *et al.*, Phys. Rev. B **84**, 184522 (2011).
[2] Bellingeri, E., *et al.*, Appl. Phys. Lett. **100**, 082601 (2012)
[3] Bellingeri, E., *et al.*, Supercond. Sci. Technol. **25**, 084022 (2012)
[4] Kawale, S., *et al.*, accepted for the publication on IEEE Trans. Appl. Supercond.