Strong vortex pinning in $FeSe_{0.5}Te_{0.5}$ epitaxial thin film

E. Bellingeri[1], S. Kawale[1], I. Pallecchi[1], A. Gerbi[1], R. Buzio[1], V. Braccini[1], A. Palenzona[1], M. Putti[1], M. Adamo[2], E. Sarnelli[2], and C. Ferdeghini[1]

[1] *CNR-SPIN, corso Perrone 24, 16152, Genova, Italy*
[2] *CNR-ICIB Via Campi Flegrei, 34 - Comprensorio "A.Olivetti" , Pozzuoli (NA) Italy*

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In this work, we present critical current density Jc curves of $FeTe_{0.5}Se_{0.5}$ thin films grown on $SrTiO_3$ as a function of magnetic field, temperature and orientation between the applied field and the crystalline axes. We find Jc values up to $4{\cdot}10^5$ A/cm^2 in self field at T=4K and weak field dependence (fig.1). Differently from what expected from the intrinsic mass anisotropy of the material and from previous measurements of films deposited on other substrates [1], the critical current is larger when the magnetic field is applied parallel to the c axis at all temperatures.
Both the analysis of the activation energy for vortex motion U_0 and of the angular dependence of Jc indicate the presence of strong correlated pinning for applied field parallel to the c axis. STM images (fig.2) suggest that evenly distributed nanoscale dislocations formed during the growth, possibly induced by the lattice mismatch with the substrate, may be identified as the effective pinning centers.
More generally, in this work and in previous publications, we showed how it is possible to tune the properties of $FeTe_{0.5}Se_{0.5}$ thin films enhancing its T_c up to 21 K [2], its upper critical field to more than 55T with low anisotropy [3] and its critical current density in-field dependence, by introducing strong correlated pinning centers. Such results, together with the fact that the 11 phase is quite simple to form and has a more handy chemistry as compared to other iron-bases superconducting families, make $FeTe_{0.5}Se_{0.5}$ appealing and suitable for applications.

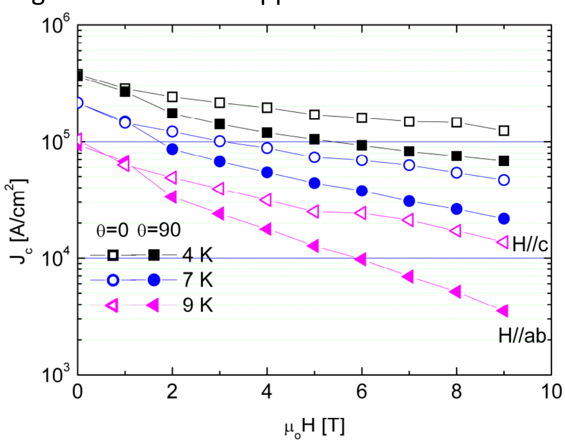

Figure 1. J_c as a function of field for H // c (open symbols) and H⊥ c (filled symbols)

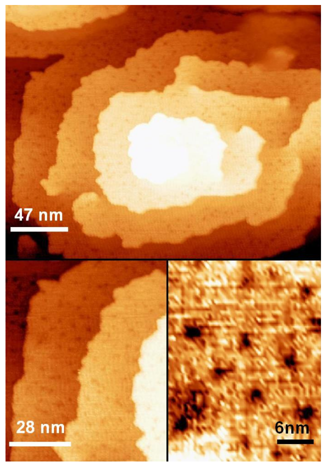

Figure 2. High density of randomly distributed nanorods , originating from the lattice mismatch with the $SrTiO_3$ substrate . These defects have a diameter of 2 nm, which matches very well the coherence length.

References

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