Robust Superconducting $FeSe_{0.5}Te_{0.5}$ Coated Conductors at 30 Tesla

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Introduction

Among the iron based superconductors, the '11' system $Fe_{1+x}R_yTe_{1-y}$ (R = Se, S) has the simplest structure. Although its transition temperature, T_c, is generally below 20K, it has a very low anisotropy (~2) with an upper critical field, $H_{c2}(0)$, ~50T. This makes it interesting for high field application. Here we study Fe(Te,Se) films grown on buffered metal substrates, such as the rolling assisted biaxially textured substrates (RABiTS).

Experimental

Fe(Se,Te) epitaxial thin films were grown by pulsed laser deposition in vacuum with a base pressure ~ 2×10^{-7} Torr. Structural characterizations were performed using X-ray diffraction (XRD). Resistivity and J_c were measured utilizing a standard four-probe method. High field measurements were conducted at the Cell 9 and 12 at NHMFL.

Results and Discussion

We have previously measured the J_c of high quality superconducting $FeSe_{0.5}Te_{0.5}$ (FST) tapes on MgO buffered Hastelloy substrates made by ion beam assisted deposition (IBAD) technique. Both XRD patterns and cross sectional HRTEM images have shown the texture growth of FST films, with in-plane and out-of-plane textures about 4.5° and 3.5° respectively. These tapes carry fairly high J_c's (~ 1×10^4A/cm^2) under magnetic fields up to 25T at about 4.2K [1]. A buffer layer of CeO_2 gives better lattice match with FST. We demonstrate that FST films on CeO_2 buffer layer on both single crystalline substrates and coated conductors, such as YSZ and RABiTS, significantly improves the superconducting properties of FST films with an enhanced T_c about 20K and J_c about 1MA/cm^2 in self field. As shown in **Figure 1**, nearly one magnitude of improvement of J_c (~ 1×10^5A/cm^2 at 4.2K with field up to 30T) compared to our previous data were achieved [2].

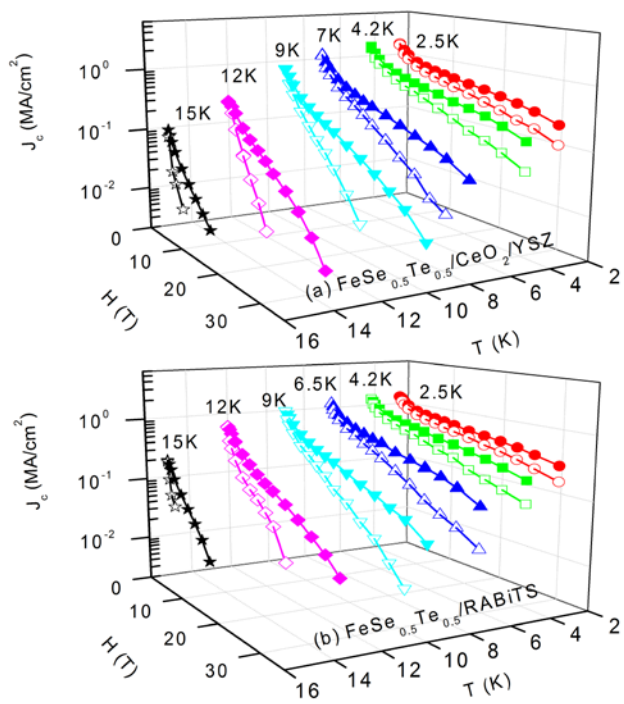

Figure 1. J_c's of $FeSe_{0.5}Te_{0.5}$ films on (a) CeO_2 buffer on a YSZ substrate and (b) RABiTS coated conductor at various temperatures with magnetic field parallel (solid symbols) and perpendicular (open symbols) to the *ab* plane (tape surface).

Conclusions

Robust *c*-axis oriented superconducting FST tapes on CeO_2 buffered single crystalline and RABiTS substrates were made by PLD. These tapes have a self-field J_c on the order of 1 MA/cm^2 and carry a nearly isotropic J_c ~ 10^5 A/cm^2 under 30T at 4.2K. The CeO_2 buffer dramatically improves the superconducting performance of the FST thin films. These properties show that iron chalcogenides have a very promising future for high field applications at liquid helium temperatures.

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References

[1] Si, W., *et al.*, Applied Physics Letters **98**, 262509 (2011)
[2] Si, W., *et al.*, submitted to Nature Communications.