MAR14-2013-002842

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Superconductivity and Critical Current of Iron-Based Superconductors in High Field

QIANG LI, Brookhaven National Laboratory

Although high-temperature superconducting cuprates have been discovered for more than 26 years, high-field applications are still based on low-temperature superconductors (LTS), such as Nb_3Sn. The high anisotropies, brittle textures and high manufacturing costs limit the applicability of the cuprates. Recently, we demonstrated that the iron superconductors, without most of the drawbacks of the cuprates, have a superior high-field performance over LTS at 4.2 K [Nat. Commun. **4**:1347 (2013); Rep. Prog. Phys. **74** 124510 (2011)]. In this presentation, I will discuss recent progress aimed at understanding the relationships between superconductivity, critical current, and nano-scaled structure defects in iron-based superconductors, with emphasis on the properties of superconducting iron chalcogenide films. Critical current densities $J_c \sim 10^7$ A/cm^2 were observed in $FeSe_{0.5}Te_{0.5}$ films grown on CeO_2 buffered single-crystalline and flexible metal substrates. These films are capable of carrying J_c exceeding 10^5 A/cm^2 under 30 T magnetic fields. Furthermore, we found that these films have significantly higher T_c (>20K) as compared to bulk samples (bulk $T_c \sim 15$ K) for the entire doping regime of $FeSe_{1-x}Te_x$. Structural analysis revealed that these films generally have significantly smaller c-axis and a-axis lattice constant than the bulk value, suggesting that the crystal structure changes have a dominating impact on the superconducting transition in iron-based superconductors. Large J_c enhancement can also be realized in iron based superconductors by irradiation with proton and heavy ions that opens a new avenue for a tailored landscape of effective vortex pinning defects.