Ion Irradiation to Iron-Chalcogenide Superconducting Films

Ozaki, T.; Si, W.; Cheng, Z. (BNL, PM); Jaroszynski, J. (FSU, NHMFL); Li, Q. (BNL, PM)

Introduction

Iron-chalcogenide is a fascinating iron-based superconducting system in terms of both fundamental physics and potential applications. We have grown iron-chalcogenide $FeSe_{0.5}Te_{0.5}$ (FST) films by pulsed laser deposition (PLD) method. The FST films on CeO_2 buffer layer show enhanced T_c (T_c^{onset} > 20 K, T_c^{zero} ~ 18 K), which is about 30% higher than that reported in the bulk materials and superior high field performance over the low temperature superconductors. These FST films are capable of carrying high critical current density J_c exceeding 1 MA/cm^2 in self-field and 0.1 MA/cm^2 under 30 T. Here, we show a route of strong pinning landscape in FST films produced by low-energy ion irradiation.

Experimental

The epitaxial FST films have been grown on single crystal substrates with CeO_2 buffer layer using PLD method. We have used ion irradiation to create new pinning centers in FST films. We measured the transport properties of the irradiated FST films under high magnetic fields at Cell 12.

Results and Discussion

Figure 1(a) and 1(b) show $J_c(H)$ of a irradiated FST film up to 34.5 T for *H//c* and *H//ab* at 4.2 K and 12 K, respectively. The data on the pristine film from ref.1 are also shown for comparison. The irradiated FST film has a better field performance compared to the pristine film for both *H//ab* and *H//c*. The J_c increased by one order of magnitude after irradiation over 15 T for *H//ab* and over 6 T for *H//c*. This proves created defects to be very effective in vortex pinning in FST films.

Conclusions

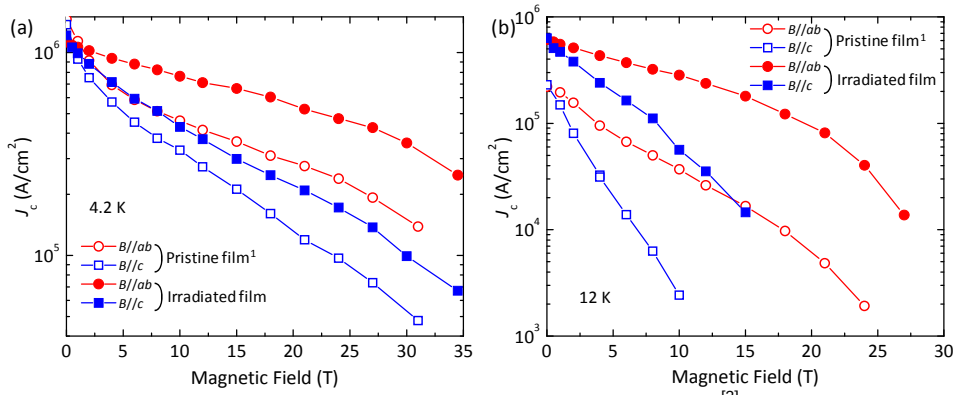

Fig.1 $J_c(B)$ curve before and after ion irradiation[2].

A robust enhancement of J_c has been found in the FST film irradiated with a low-energy ion. The created defects can contribute to a strong vortex pinning, especially in high field and high temperature. The irradiated FST film gives a better view of the pinning landscape in iron-based superconductors.

Acknowledgements

This work was funded by the DOE, Office of Basic Energy Science, under Contract No. DE-C0298CH10886. Work at NHMFL was supported by NSF Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. DOE.

References

[1] Si, W., *et al*., Nature Communication, 4, 1347 (2013).
[2] Ozaki, T., *et al*., (in preparation).