I_c Study of MOCVD REBCO Coated Conductors for High Field Magnet Applications

A. Xu (UH, TcSUH); J. Jaroszynski (FSU, NHMFL); D.C. Larbalestier (FSU, NHMFL); V. Selvamanickam (UH, Mechanical Engineering)

Introduction

Our previous $I_c(H, \theta)$ characterization done at the NHMFL has shown that the incorporation of $BaZrO_3$ (BZO) nanorods can substantially enhance J_c and effectively reduce J_c anisotropy of REBCO coated conductors (CC) at 4.2 K [1]. Recently, aiming to understand the pinning mechanism and further enhance J_c, we conducted $I_c(H//c)$ study on a REBCO CC containing higher density of BZO nanorods.

Experimental

High-quality REBCO thin films were grown on mechanically-strong Hastelloy substrates via metal-organic chemical vapor deposition (MOCVD). BZO nanorods were self-assembled in the epitaxial REBCO film by 15 mol % Zr-doping [2]. $I_c(H//c)$ characterization was conducted at 4.2 K and H up to 31.2 T using 31 T Bitter magnet at the NHMFL.

Results and Discussion

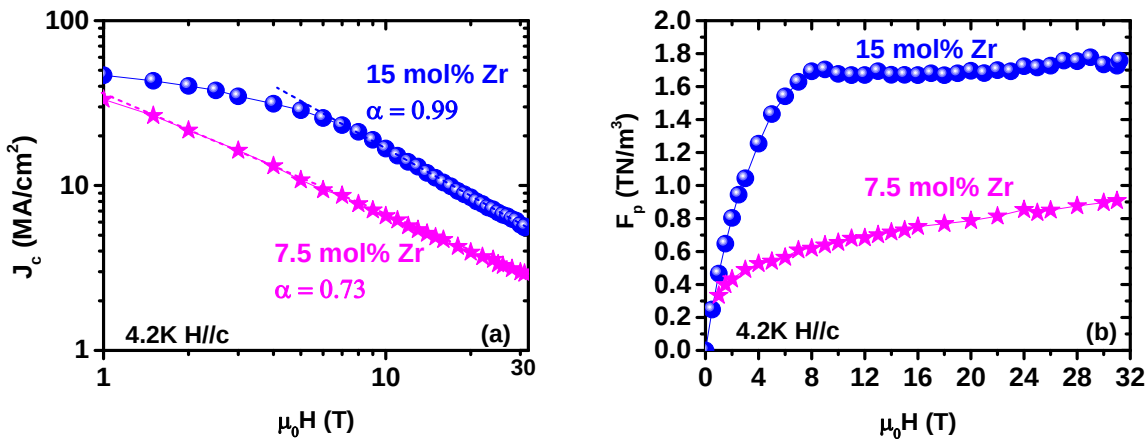

Figure 1 (a) $J_c(H||c)$ and (b) $F_p(H//c)$ of a ~1 μm thick, 15 % Zr-doped sample (spheres). A 7.5 % Zr-doped sample (stars) is also included for comparison. The dashed lines in (a) represent the field dependence of J_c defined by $J_c \propto H^{-\alpha}$.

Fig. 1 shows $J_c(H//c)$ in (a) and $F_p(H//c)$ in (b) at 4 K and H up to 31.2 T. In comparison with 7.5% Zr-doped CC, the 15% Zr-doped CC shows much higher α value for $J_c \propto H^{-\alpha}$, α~0.99 for 15% Zr-doped CC and 0.73 for 7.5% Zr-doped CC. Also, the 15% CC exhibits ~100% higher J_c than that of 7.5% CC at all H. Another new finding in this experiment is that high performance 15% Zr-added CC exhibits an ultra-high F_p ~1.7 TN/m^3 plateau extending from 8 T up to at least 32 T, as shown in Fig. 1 (b). This is the first reported F_p surpassing 1 TN/m^3.

Conclusions

We ascribe this excellent J_c to the huge weak uncorrelated pinning associated with higher density of BZO nanorods. The higher α value indicates a broader $J_c(\theta)$ in the vicinity of the *ab*-plane and lower J_c anisotropy based on the Ginzburg-Landau scaling. All these are highly beneficial for high field magnet applications.

Acknowledgements

The work at the University of Houston was partially funded by Advanced Research Projects Agency-Energy (ARPA-E) award DE-AR0000196. A portion of this work was performed at the National High Magnetic Field Laboratory, which is supported by NSF Cooperative Agreement No. DMR-1157490 and by the State of Florida.

References

[1] Xu, A., et al., Phys. Rev. B 86, 115416 (2012)
[2] Selvamanickam, V., et al., Supercond. Sci. Technol. 26, 035006 (2013)