Characterization of Superconducting Strands for High Field Magnet Applications over 25 T

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Introduction

One specific recommendation in the 2005 U.S. COHMAG report is the creation of a 30 T superconducting magnet for NMR[1]. Commercial high field superconducting magnets for NMR, made with Nb_3Sn strand, are available with fields up to 22.5 T at 2.2 K. While Nb_3Sn strand can probably enable 23.5 T for 1 GHz NMR, it is unlikely that such Nb_3Sn magnets can be pushed higher than 25 T because of intrinsic limitations on the upper critical field (B_{c2}). Efforts are underway to develop alternate superconducting materials with higher B_{c2} values and thus greater high field critical current density (J_c). Based on performance, available lengths, and potential for further improvement, the most likely material to enable superconducting magnets in the 25 – 30 T range is $Bi_2Sr_2CaCu_2O_{8-x}$ (Bi-2212). At Oxford Superconducting Technology, there is continuing development activity aimed at using Bi-2212 conductors for high field magnet applications.

Experimental

Round multifilament Bi-2212 strand with different configurations of sub-elements were fabricated at OST using a modified Powder-in-Tube method[2]. The samples were tested in the 25 T magnet system of NHMFL at 4.2 K.

Results, Discussion and Conclusion

In 2007, research on Bi-2212 at OST has been aimed at producing high quality multifilament Bi-2212/Ag round wires with different configurations for high field magnet insert coils. The results show a strong dependence of the wire J_E and J_c performance on wire's microstructure, in particular, the interface between the Bi-2212 cores and the Ag sheath. Significant improvements of microstructure and J_c have resulted from the optimization of wire size and number of sub-elements. The highest J_E of 320 A/mm^2 at 4.2 K, 25 T was obtained in 1.15 mm wire with 85 x 19 sube-element configuration, as shown in Fig. 1[3]. Including 0.25mm insulation build thickness for making Wind-React insert coils, the whole winding pack critical current density in this insulated wire reached 200 A/mm^2 at 25 T, sufficient for practical cryocooled magnet applications. Moreover, the Bi-2212 round wire displays no anisotropy with respect to applied field direction, which makes it a unique material in the field of high temperature superconductors. Our measurements at NHMFL in 2007 have improved our knowledge on this material and enhanced our ability to further improve Bi-2212 performance for high magnetic field insert coils.

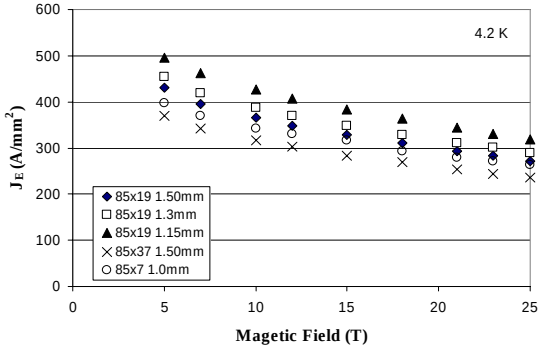

Fig. 1. J_E(B) performance for recent BSCCO-2212 round wire.

References

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[2] H. Miao, *et al*., IEEE Trans. Appl. Supercond. **15**, 2554-2561 (2005).
[3] H. Miao, et al., Advances in Cryogenic Engineering, (2008) (in press).