CHARACTERIZATION OF SUPERCONDUCTING STRANDS FOR HIGH FIELD MAGNET APPLICATIONS OVER 20 T

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Introduction

Significant J_c improvements in Nb_3Sn strand over the past few years have recently led to the introduction of a commercial 950 MHz NMR magnet[1,2], with GHz NMR on the horizon. To push beyond the GHz barrier will require still further superconducting wire improvements. We are developing two high field strand types: Nb_3Sn strand made by the internal tin process, and powder-in-tube BSCCO-2212 round wires. From the view point of practical application, Bi-2212 round wires have significant advantages over more typical HTS tape conductors, such as ease of handling and coil winding, allowing considerable flexibility in the magnet design.

Experimental

Round wire samples were mounted on either Ti (for Nb_3Sn strands) or stainless steel mandrels (BSCCO-2212). Samples were tested in liquid helium at 4.2 K, and pumped to 2.2 K and 1.8 K, in the 25 T magnet systems in either Cell 5 or Cell 6. Several small 2212 coils were tested in the large bore 20T system in Cell 4.

Results, Discussion, and Conclusion

The application of superconducting strand in a solenoid magnet is practical while the conductor J_E (engineering critical current density) values exceed ~100 A/mm^2 at the field of interest. In 2005, we used DC transport current measurements to study large diameter (2.0 mm) Nb_3Sn strand, which can give both a high critical current (>350 A) with J_E >100 A/mm^2 up to nearly 25 T when cooled to 1.8 K. This high performance is a result of optimization of Nb/Sn/Cu metal ratios, the level of Ta and/or Ti dopant incorporated into the Nb_3Sn, and the heat treatment used to give the best high field properties.[3]

BSCCO-2212 development efforts in 2005 have been aimed at optimizing heat treatments for round wire, and techniques for wind-and-react coils. Continued J_c and J_E improvements have been achieved by optimizing the heat treatment parameters.[4] The first successful wind-and-react coils were demonstrated using round 2212 wire, with some results shown in Fig. 2.[5]

References

[1] Oxford Instruments press release (http://www.oxford-instruments.com/SCNNWP768.htm) September 9, 2005.
[2] Hong, S., *et al.*, to appear in IEEE Trans. Appl. Supercond.(MT-19 proceedings) (2006).
[2] Field, M.B., *et al.*, to appear in Adv. Cryo. Engr. Materials (ICMC '05 proceedings) (2006).
[3] Miao, H., *et al.*, to appear in Adv. Cryo. Engr. Materials (ICMC '05 proceedings) (2006).
[4] Marken, K., *et al.*, to appear in IEEE Trans. Appl. Supercond. (MT-19 proceedings) (2006).

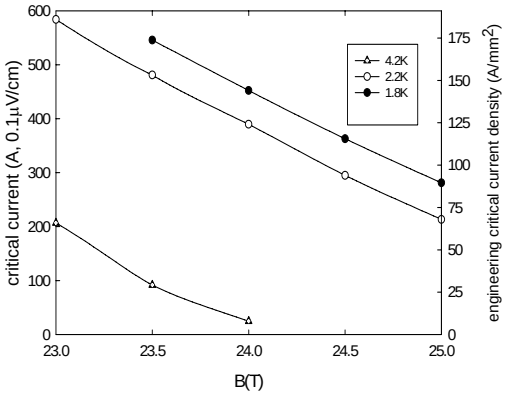

Fig. 1. Critical current and J_E values as a function of field and temperature for 2.0 mm diameter Nb_3Sn strand.

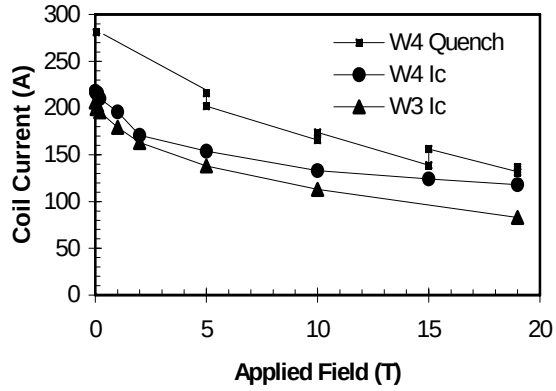

Fig. 2. Measured I_c and I_Q values in two wind-and-react test coils using 2212 round wire.