DEVELOPMENT OF WIRES FOR HIGH MAGNETIC FIELD APPLICATIONS


Introduction

We continue development of Nb3Sn RRP® strand and BSCCO-2212 round wires for high field magnet applications. This year we studied RRP strand utilizing a new Ti doping method, accomplished by using a mixture of pure Nb and Nb-47wt%Ti filaments within the precursor (subelement) billet. The objective is to learn if high-field performance exceeding that of Nb-Ta alloy can be achieved using the Nb+Nb-Ti approach, by fine-tuning the Ti doping level.

For the Bi-2212 HTS material, round wires are preferred because of strong advantages over tape, such as no anisotropy and ease of layer winding to fabricate coils. In 2006, BSCCO-2212 development efforts have been focused on fabricating kilometer long lengths of Bi-2122 round wires with improved \( J_c \) to enable high field magnet applications.

Experimental

RRP strand with Nb+Nb-Ti filaments replacing Nb-Ta was tested at NHMFL, along with round wire samples of Bi-2212. Samples were mounted on either Ti (for Nb3Sn strands) or stainless steel mandrels (Bi-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.

Results, and Discussion, and Conclusions

As shown in Figure 1, our first Nb+Nb-Ti RRP strand achieved ~80% of the performance of Nb-Ta wire, with a similar \( B_{c2} \) value. However, this comparison is between Nb-Ta strand reacted with a highly optimized heat treatment schedule, compared with a first attempt with Nb+Nb-Ti, and it may be possible to improve the Nb+Nb-Ti performance through heat treatment modification. New billets having different Ti:Nb ratios are also being fabricated for future study.

High field test results for a 1 meter long sample of 1 mm diameter Bi-2212 round wire are shown in Figure 2. Note the data shown in the plot is the engineering critical current density, defined as the critical current divided by the entire wire cross section. These \( J_c \) results on round wire, having no anisotropy, exceed our best values obtained in flat tape. Microstructural studies show the round wires contain many thin, highly aligned, whisker-like grains of 2212, and these are believed to be the source of the high \( J_c \) values in round wire.

References


Fig. 1. \( J_c \) as a function of field for 1.2 mm RRP strands, made from Nb-Ta and Nb + Nb-Ti.

Fig. 2. \( J_E \) as a function of field for 1.0 mm Bi-2212 round wire, 1 m sample length.