Comparative Study of I_c(B, 4K) for (Re)BCO, Bi-2223, and Bi-2212 Conductors From Various Sources

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Introduction

Recent success in engineering pinning centers made it possible for commercially available IBAD- MOCVD (Re)BCO to exhibit very high J_c in fields beyond 30T in high I_c conductors suitable for making user magnets. Practical implementation of overpressure process (OP) to Bi-2212 round wires led to large J_c and I_c increases in a round, isotropic wire, making it a potentially competitive technology. In order to successfully design high-field, all-superconducting magnets, it is necessary to know the I_c and engineering current density (J_E) of the conductor in a broad range of fields and field orientations.

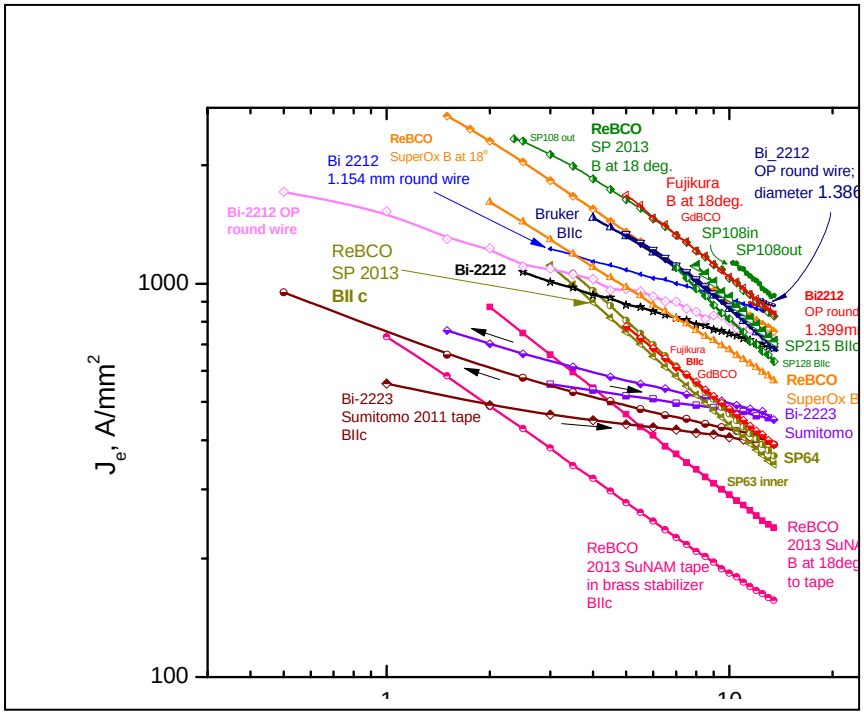

Fig.1 J_e(B) measured at LHe temperature for (Re)BCO tapes manufactured by Bruker, Fujikura, SuperPower Inc., SuperOx, SuNAM; Bi-2223 tape from Sumitomo, and variable diameter Bi-2212 round wire passed OP process. Arrors mark B direction.

Experimental

We tested the I_c(B, 4.2K) dependencies up to 13.5T at fixed field orientations for the (Re)BCO tapes, overpressure processed round wire Bi-2212 made by Oxford Superconducting Technology and flat tape Sumitomo Bi-2223. I_c was measured on full width conductors at currents up to 1.4kA immersed in LHe. (Re)BCO samples were measured at BIIc and 18° to tape plane, the critical angle for the 32 T magnet now in construction. I_c(B) values were measured in increasing and decreasing fields to detect possible magnetic hysteresis indicative of damage or weakly coupled regions in the tape.

Table I. The I_c~$B^{-\alpha}$ parameter α for different conductors.

Manufacturer	Material	α at BIIc	α at 18°
SuperPower	(Re)BCO	0.67-0.76	0.7-0.9
SuNAM		0.6	0.69-0.68
SuperOx		0.54	0.59
Fujikura		0.64-0.69	0.7
AMSC		0.74	-
Bruker		0.88	-
Sumitomo	Bi-2223	0.16-0.18	-
OP processed	Bi-2212	0.26-0.33	

Results and Discussion

The J_e(B) dependencies for selected samples are shown in Fig.1. Magnetic flux is clearly trapped in the 2223 tape due to weak links, making J_c dependent on magnetic history, unlike 2212 and REBCO which do not show this weakness. Most conductors show a good power law fit I_c~$B^{-\alpha}$. Calculated α values are shown in Table I.

Conclusions

Among (Re)BCO tapes at BIIc the largest J_e values were detected for SuperPower and Bruker. Bi-conductors have smaller α values than (Re)BCO. Among the (Re)BCO conductors SuperOx tapes have the smallest α. Lower α generally means weaker vortex pinning. Bi-2212 round wires outperform (Re)BCO tapes in J_e at B>17T.

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