Bi2212 SUPERCONDUCTORS IN HIGH FIELD APPLICATIONS

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Ag-clad Bi2212 superconductor is a potential candidate for the innermost sections of high–field magnets like the proposed 1.3 GHz (30 T) NMR magnet [1]. At 30 T, 4.2 K Bi2212 has very high J_c, which makes it not only the conductor of choice but also the only available conductor for this type of application. In a collaborative effort with Oxford Superconducting Technology (OST), the most recent generation of multifilament round wires is currently being studied in a variety of aspects in an effort to creating a data base to allow for reliable parameterization of new magnet designs. Round wire is isotropic and is not sensitive toward a specific field orientation. It can be manufactured in a variety of diameters, it can be aspected if necessary (with anisotropy) and above all has the obvious advantage being more easily implemented in a standard layer-wound approach.

A series of transport characterizations on short round and aspected samples has been completed providing an overview of $I_c(B)$ properties of Bi2212 round wires up to 45 T, as presented in Fig. 1. Several aspects become readily clear from the graphs: Bi2212 round wire offers excellent transport properties over a wide range of applied magnetic fields. At an aspect ratio of 1.5:1, Bi2212 wires show only small anisotropy when rotated in field, particularly in the high-field range, offering improved packing density in a winding pack at small trade-off in transport property. Though there is considerable scatter in I_c in the low field range, $I_c(B)$ curves of samples with various geometries and slight variations in composition as well as heat treatment parameters appear to converge at around 10 T where strongly linked current paths take over, which may alleviate some of the restrictions in processing control. At 25 T Bi2212 wire J_e at 4.2 K is higher than 350 A/mm^2 , which is more than double the J_e reported for the best Nb_3Sn wire in the same field range at 1.8 K (150 A/mm^2, 23.5 T, [2]). At 31 T the samples retained *n*-values between 14 and 21. Pinning force maximum is just being reached at about 45 T and a fit through the available data applying the Fietz-Webb law [3], and acknowledging the uncertainty due to extrapolation in the field range above 45 T, the upper critical field is in the range of around 100 T, as shown in Fig. 2.

A set of test coils with various numbers of turns have been wound to address a variety of processing issues with Bi2212 round wire, like heat-treatment procedures, coil winding approaches, insulation, and conductor homogeneity over longer lengths. Core leakage, which can occur during Bi2212 conductor heat-treatment, is also present in heat-treated Bi2212 wire to some degree. It, however, did appear to neither significantly degrade coil performance nor cause turn-to-turn shorts in coils that were manufactured with glass-fiber sleeve insulated wire. The coils have been successfully tested in a background field of 19 T. To address quench protection requirements of Bi2212 solenoids as part of a high-field magnet system, their quench behavior needs to be studied in detail. Quench experiments on short, 25 cm long, wire samples are currently being carried out in self-field. Quench experiments will be extended on small test-coils soon to study quench behavior of Bi2212 solenoids in a more realistic high field environment.

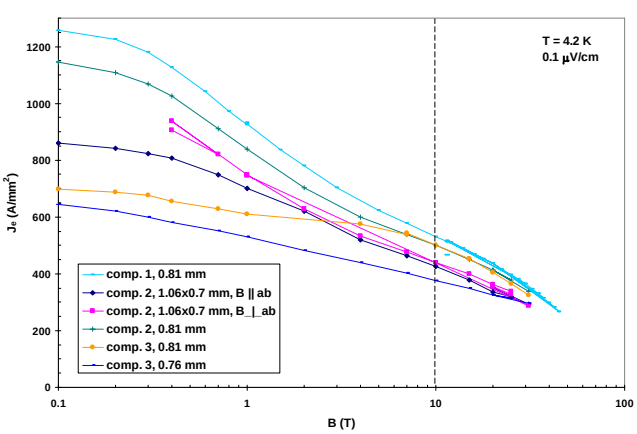

Figure 1. $J_e(B)$ curves for Bi2212 wires.

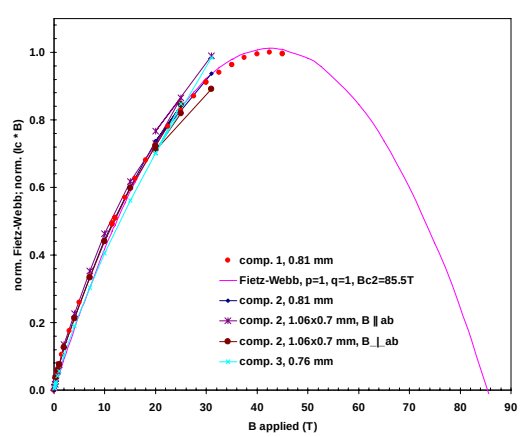

Figure 2. Pinning forces and B_{c2} extrapolation for Bi2212 wires.

References

[1] Weijers, H.W., *et al*., Supercond. Sci. Technol., **17**, 636-644 (2004).
[2] Superconductor Week, **19**, no. 21 (2005).
[3] Fietz, W.A. and Webb, W.W., Phys. Rev., **178**, 657 (1969).