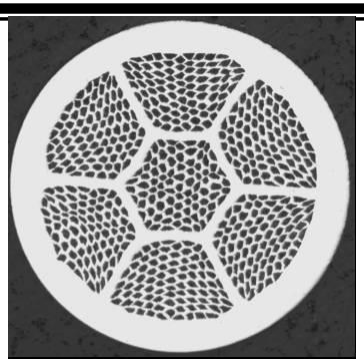
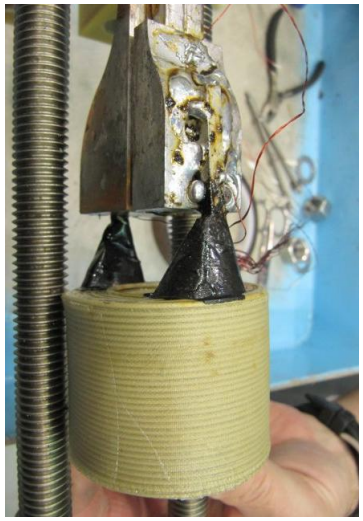
Progress on High Temperature Superconductors in Magnets

Gregory S. Boebinger, National High Magnetic Field Laboratory

DMR-Award 0654118

Applied Superconductivity Center, Florida State University



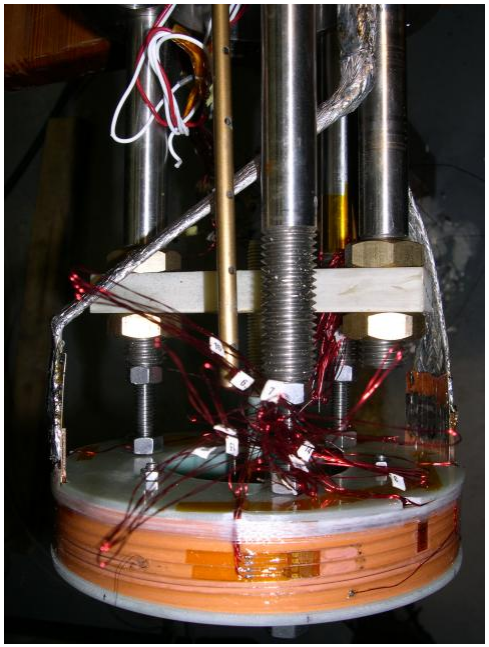


Top: Cross-section of the multifilamentary Bi-2212 wire used in small test coils (bottom) without silver leakage problems.

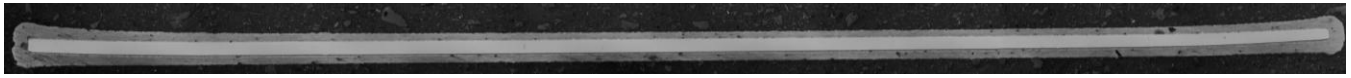
- Two different types of high-temperature superconductors (HTS) are being pursued for applications in superconducting magnets that are projected to exceed 30 T in the coming years: round wire Bi-2212 and YBCO tape conductor.

- Bi-2212 is unique among all HTS materials in that it can develop high current density in untextured form. However, processing is complex. Recent work has reduced leaks of Bi-2212 through the silver sheath around the HTS wires and resulted in clean multi-Tesla magnets.

- YBCO coils showed no degradation at stress levels (760MPa) that are twice that of the 32 T HTS magnet being constructed at the Magnet Lab. These high stresses are enabled by the substrate of high strength Nickel-based alloy tape on which the YBCO is deposited.



High stress YBCO coil operated at 760 MPa using the 4.0mm wide x 0.1 mm thick conductor shown in cross-section below



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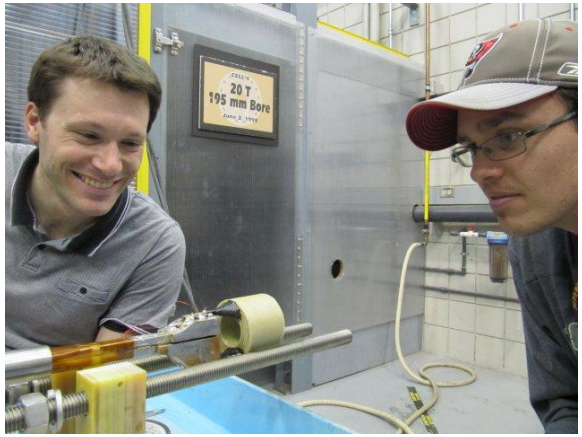

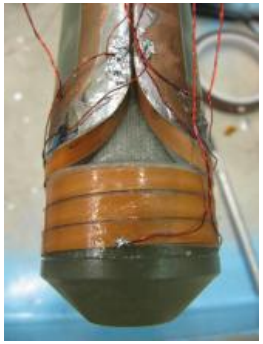

Postdoc Matthieu Dalban-Canassy and engineer David Myers inspect a new formerless and leak-free Bi-2212 coil after reaction. The coil reached 2 T in self field and 1 T in tests inside the 20 T large bore resistive magnet at the Magnet Lab. A 7 T coil set is planned.

Right: A small-diameter layer wound YBCO coil designed to reach record field values using a 31 T resistive magnet as background. Detail of a novel terminal concept shown in a small trial coil at the top.

The HTS conductors of Bi-2212 ($Bi_2Sr_2CaCu_2O_8$) and YBCO ($YBa_2Cu_3O_7$) are complex to make, to apply, and complex to use safely in the very high fields >30 T where these two very different conductor types now allow superconducting magnet technology to be developed. Their performance limits are being explored in an R&D program that is testing the stress, quench energy, fabrication, and performance limits.

Bi-2212 must be reacted at almost 900 ºC after winding to make it superconducting. Since this involves melting of the 2212 phase, leakage through the Ag sheath is a problem that is now being resolved by better processing.

YBCO tape grown on high strength alloy is supplied commercially, but as a single tape it is more susceptible to debilitating local defects than the multi-filamentary Bi-2212 round wire.

Project team includes Ulf Trociewitz, David Myers, Matthieu Dalban-Canassy, Jan Jaroszynski, Aixia Xu, Valeria Braccini, Jun Lu, David Hilton, Patrick Noyes, Huub Weijers, Eric Hellstrom and David Larbalestier