

Breaking the 30 T Superconducting Magnet Barrier

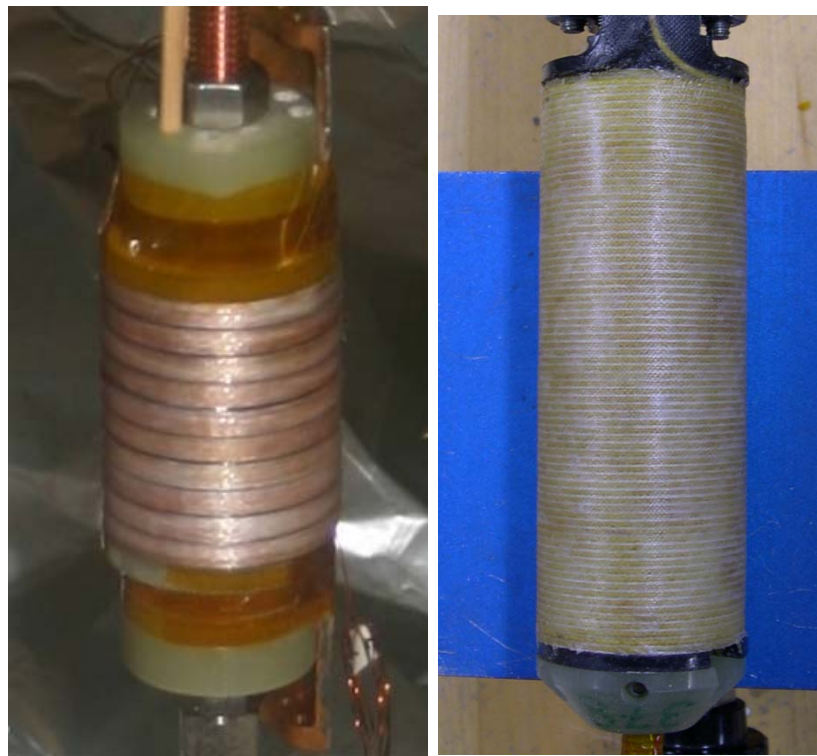
2009 NHMFL Science Highlight for NSF

DMR-Award 0654118

Applied Superconductivity Center and Magnet Science and Technology Division

Amongst the long term goals of COHMAG (the 2004 NRC Committee on High Magnetic Field Science) was the development of a 30 tesla all-superconducting NMR magnet. As a first step towards this goal, MagLab researchers have shown that small solenoids made from YBCO coated conductors can work at unprecedented high stress and winding current density in fields never before achieved by a superconducting magnet. The coil convinced us that we were ready to make the next major step in this technology: In January we submitted a proposal to build an all-superconducting 32 tesla magnet to enable NHMFL users to make high sensitivity, low noise experiments hitherto only possible in 20 T superconducting magnets. To provide flexibility for future applications of so-called high temperature superconducting magnets, we are developing two complementary technologies, one using tapes of YBCO^[1] and the second using round, multifilament wires of Bi-2212 [manuscript under preparation].

^[1] W.D. Markiewicz, H.W. Weijers, P.D. Noyes, U.P. Trociewitz, K.W. Pickard, W.R. Sheppard, J.J. Jaroszynski, A. Xu, D. Larbalestier, D.W. Hazelton, *Adv. In Cryogenics*, to appear.



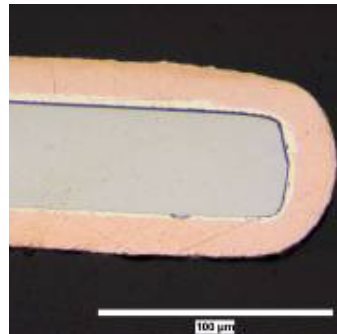
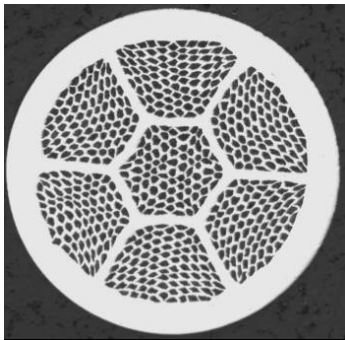
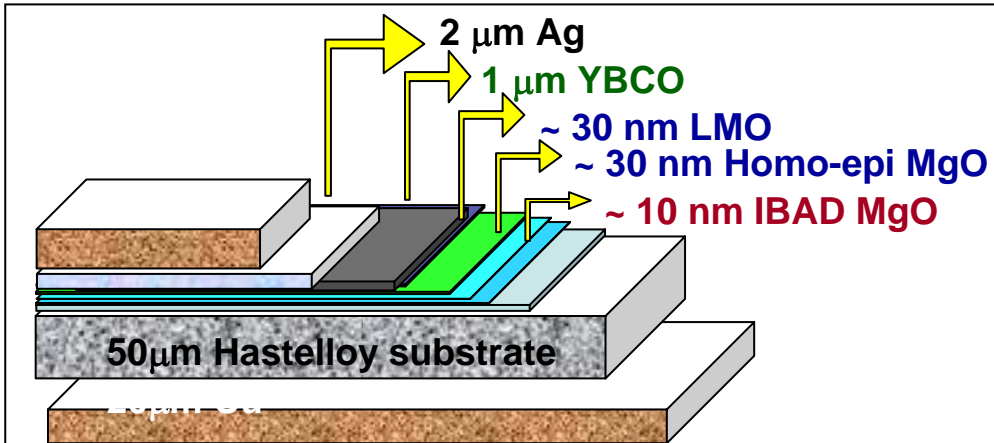
At left a solenoid wound from a coated conductor of YBCO superconductor that achieved 33.8 T when tested in the 31 T Bitter magnet at the NHMFL (W.D. Markiewicz et al.). At right is a solenoid wound from a second cuprate conductor using Bi-2212 as the active superconducting element. This coil achieved 32.1 T when tested under the same conditions (U.P. Trociewitz, et al.). The coils are ~38 mm in outer diameter.

Breaking the 30 T Superconducting Magnet Barrier

2009 NHMFL Science Highlight for NSF

DMR-Award 0654118

Applied Superconductivity Center and Magnet Science and Technology Division



At top is the conductor used for the YBCO coil. It is a complex multilayer tape about 0.1 mm thick (see real cross-section of one edge at lower right) made on a very strong Ni-alloy substrate. Bi-2212 is a round wire containing many hundred superconducting filaments embedded in a silver matrix. It is about 1 mm in diameter. Each form has particular advantages and disadvantages which the NHMFL team is evaluating closely at the present time.

Superconducting magnets have multiple broad impacts:

- First use of a YBCO magnet will be to enable a 60% increase in magnetic field for low noise, long signal averaging experiments by users presently limited to 20 tesla.

- The NHMFL DC user facility annually supports more than 400 users with 20 MW magnets that cost up to about \$2400 per hour to run. The new magnet will have power costs of less than \$10/hr, thus allowing significant reduction in power costs for some experiments.

- The YBCO coated conductor technology could liberate users of superconducting magnets from liquid helium use since YBCO can yield multi-tesla fields using conventional (electric) refrigerators. This would transform the accessibility of superconducting magnets.

- The US superconductor industry is the world's largest and most successful. These conductors are made in the USA and close collaborations with SuperPower Inc of Latham NY with Oxford Superconducting Technology of Carteret NJ were essential in developing the YBCO and the Bi-2212 coils, respectively.