



# Ceramic Insulation for High-Temperature Superconducting Wire

H.Kandel, J.Lu, J.Jiang, P.Chen, M.Matras, N.Craig, U.P.Trociewitz, E.E. Hellstrom and D.C. Larbalestier  
National High Magnetic Field Laboratory



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Insulation technology is critically important to magnet development. Insulation must be both electrically and mechanically reliable, but it must also be *as thin as possible* to not waste valuable space better filled with current-carrying conductor. Each new high-temperature superconductor poses many magnet-design challenges, including developing an optimized insulation. The MagLab has developed a  $TiO_2$ -based ceramic coating that has proven over several years to be an effective electrical insulation in superconducting magnets made of  $Bi_2Sr_2CaCu_2O_{8-x}$  (Bi-2212) superconducting round wire.

The coating has a base layer comprised of  $TiO_2$ , polyvinyl butyral (PVB) with a small amount of polysilicate and a top layer made of polyacrylic. The coating is applied on the conductor using a continuous reel-to-reel dip coating process. Arrows in Fig (a) show the path of the wire through the heaters (dashed lines) and twice into the dip vat (not shown, denoted by green arrows at bottom). The insulation shows very good adherence and flexibility suitable for magnet coil winding (Fig b). Small test coils were built with the coated Bi-2212 round-wires (Fig c) and were heat treated at 100 atm pressure. During a 900C heat treatment, the PVB and polyacrylic are evaporated and the polysilicate decomposes to  $SiO_2$  that serves as a sintering aid for  $TiO_2$ . After heat treatment, the insulation remains strongly adhered to the conductor, withstands 150V even though it is only 7 microns thick, and, most importantly, does not have a detrimental effect on the superconducting properties of Bi-2212 wire.

This development enables Bi-2212 wire to be used as a conductor in ultra-high field magnets, especially in high field NMR magnets. This technology is the subject of a US patent application.

**Facilities:** Magnet Science and Technology and Applied Superconductivity Center

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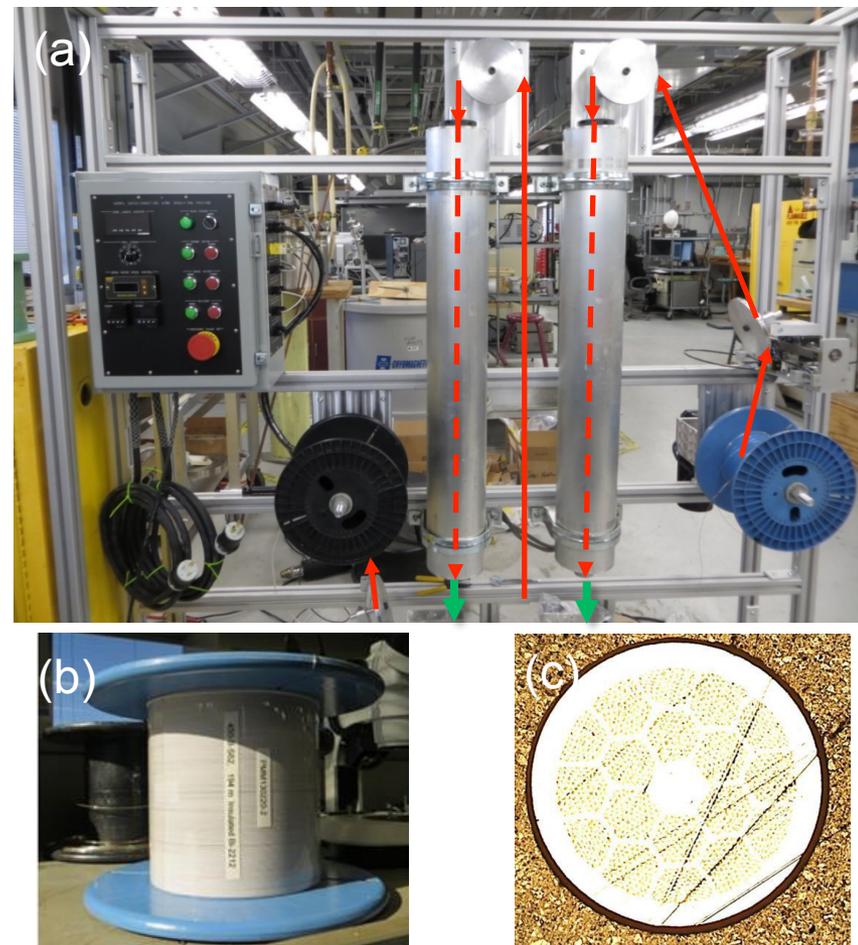


Figure (a) The Bi-2212 insulation system. (b) Insulated conductor on a spool. (c) Cross-section of the 0.8mm diameter Bi-2212 wire featuring a particularly thick layer of insulation.