New Bi-2212 ($Bi_2Sr_2CaCu_2O_8$) Powder Delivers Record Superconducting Critical Current Density in Bi-2212 Round Wire

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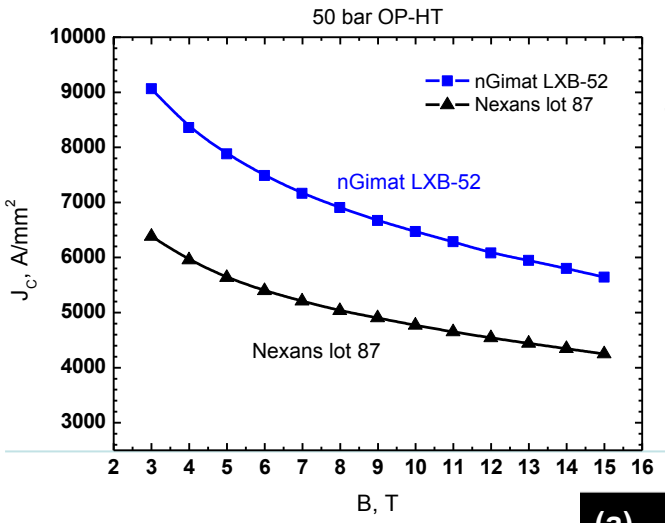
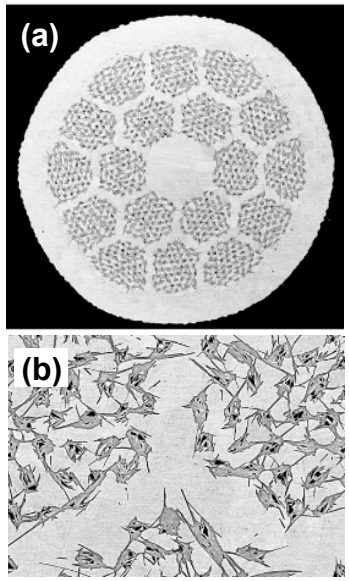
The critical current density (*Jc*) of a superconductor indicates the maximum electrical current density that can be transported by a superconductor, beyond which the superconductivity itself is destroyed. As such, a high *Jc* is of central importance to the development of high-performance superconducting magnets. A recent collaboration among researchers at the MagLab and two corporations has resulted in the *Jc* of Bi-2212 round wire being increased from 4200 A/mm^2 to 5600 A/mm^2 (measured at 4.2 K in a 15 T magnetic field). This increase of one third represents a huge technological leap forward and a new world record *Jc* for Bi-2212 round wire.

The next generation of all-superconducting magnets will generate magnetic fields that are beyond the capability of existing Nb-based superconductors. Achieving these magnetic fields will require magnet coils made from high-temperature superconductors. Bi-2212 ($Bi_2Sr_2CaCu_2O_8$) is a viable high-temperature superconductor for these magnets, particularly in light of these recent results.

Making superconducting Bi-2212 wire is a collaborative three-step process: (1) synthesizing Bi-2212 powder (done by nGimat); (2) fabricating a Ag-sheathed wire (done by BOST); and (3) heat treating the wire using overpressure processing to make the wire superconducting (done using the MagLab's unique overpressure furnace capabilities). nGimat recently modified part of their powder synthesis process, providing the powder that increased *Jc*. This higher *Jc* will enhance our capability to build Bi-2212 magnet coils for the next generation of all-superconducting high-field user magnets.



Jc as a function of applied magnetic field at 4.2 K for the new record wire (blue) made with nGimat powder. Also shown is J_c for the previous record wire (black), which was made with Nexans powder.



Microstructure of fully-processed record *Jc* wire made with nGimat powder. (a) Transverse cross section of the wire, which has a 55 x18 architecture (55 Bi-2212 filaments in each of 18 bundles). (b) Bi-2212 filaments at higher magnification. Silver is the light gray background, Bi-2212 is the medium gray dendritic filaments, and non-superconducting alkaline earth cuprate are black.

Facility: The MagLab's Applied Superconductivity Center