Experimental Report

15/02/2012

Proposal: **5-23-634** **Council:** 4/2011

Title: Quantitative Textures of Bi-2212 melt-cast processed superconductors

This proposal is a new proposal

Research Area: Materials

Main proposer: **CHATEIGNER Daniel**

Experimental Team: CHATEIGNER Daniel
DELLICOUR Aline

Local Contact: OULADDIAF Bachir

Samples: Bi2Sr2Ca1Cu2O8

Instrument	Req. Days	All. Days	From	To
D19	3	1	15/11/2011	16/11/2011

Abstract:

In Bi2212 high-temperature superconductors (HTS), it is recognized that significant supercurrent may flow in materials with rather weak texture. This behavior, which is observed both in melt-cast processed (MCP) bulk conductors and in oxide-powder in tube (OPIT) round-wire conductors, challenges the known models of current transfer in HTS [1]. Understanding this behavior requires fundamental studies of current transfer mechanisms in various polycrystalline forms of Bi2212. Together with further technological developments, this may lead to significant improvement in performance of practical conductors and their use in high-field magnets (Bi2212 round wires), fault current limiters, current leads and magnetic screens (Bi2212 bulks) [1-3].

Report for experiment 5-23-634

Quantitative Texture of Bi-2212 melt-cast processed superconductors

A. Dellicour[1], D. Chateigner[2], B. Vertruyen[3], M.O. Rikel[4], P. Vanderbemden[3]

[1] LCIS, University of Liège, Belgium
[2] CRISMAT-ENSICAEN, Université de Caen Basse-Normandie, UMR 6508 Caen, France
[3] SUPRATECS, University of Liège, Belgium
[4] Nexans Superconductors GmbH, Hürth, Germany

Research on $Bi_2Sr_2CaCu_2O_8$ high-temperature superconductors (HTS) produced by the melt casting process (MCP) reveal that high superconducting currents are able to flow through weakly textured materials (1). This performance challenges the known models of current transfer in HTS. A study of current transfer mechanisms on various samples (shape, synthesis parameters…) is needed to understand this unusual performance. This may lead to significant improvement in performance of practical conductors and their use in fault current limiters (2), current leads, magnetic screens and trapped-field magnets.

A better understanding of these materials clearly calls for the use of the "Combined Analysis" approach (3) in order to take into account factors such as particle size and shape, presence of secondary phases and texture at several scales and correlate them to the resulting macroscopic properties. This approach combines different complementary techniques in a way to characterize texture at various length scales: neutron diffraction (macroscopic), X-ray experiments (surface) and electron back-scattering diffraction (microscopic). With a higher penetration depth of neutrons, neutron diffraction is the best technique to obtain a statistical probe of the sample. A first ILL experiment allowed us to acquired data for 4 samples different in shape (tubes and rods) and synthesis parameters.

A study along the thickness of a tube-shaped sample clearly demonstrated a difference in grain orientation from the inner part to the outer part. Figure 1 shows a polarized image of a section made along the thickness of the sample. Bi2212 grains are colored in pink and light blue while secondary phases are colored in yellow and light purple (Figure 2). Several zones inherited from the melt cast sate can be distinguished: (i) the outer part of the sample where small grains are found, resulting from the rapid cooling at the mould walls (ii) a partially textured zone composed of bundles of Bi2212 grains (4) that very likely exhibits the highest critical current density, (iii) a black zone corresponding to a porous part of the sample (shrink hole) and (iv) a thin zone at the inner part which is less dense because of a shrinkage due to cooling during the process (5). In the already accomplished experiments, a sample was cut along its thickness in three parts –inner, center and outer - and each part was analyzed using the D19 diffractometer. Clearly the refined pole figures (Figure 3) noticeably differ for the three parts studied. This confirms that grain orientation varies along the thickness. Further studies with larger sampling are therefore very promising for better understanding the grain alignment issues in Bi2212 MCP bulk samples.

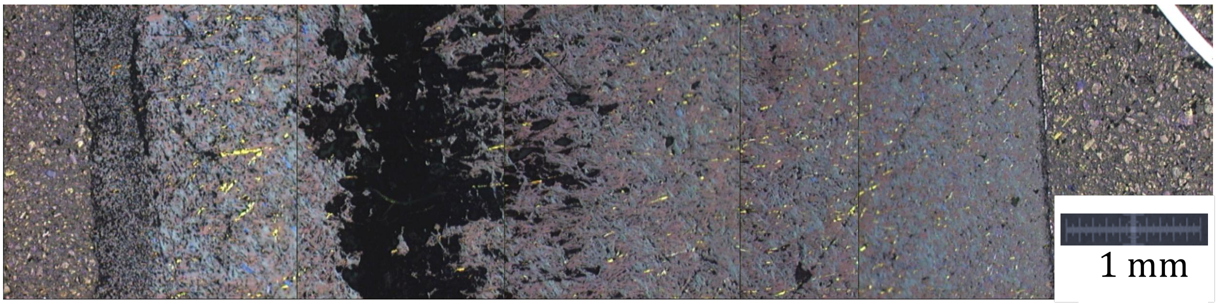

Figure 1- polarized image of a section made along the thickness of a Bi2212 tube-shaped sample (left: inner part of the tube; right: outer part of the tube)

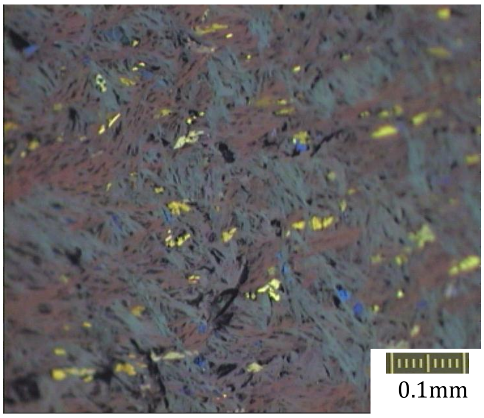

Figure 2- polarized image of a section made along the thickness of a Bi2212 tube-shaped sample (pink and light blue: Bi2212 grains; yellow and purple: secondary phases)

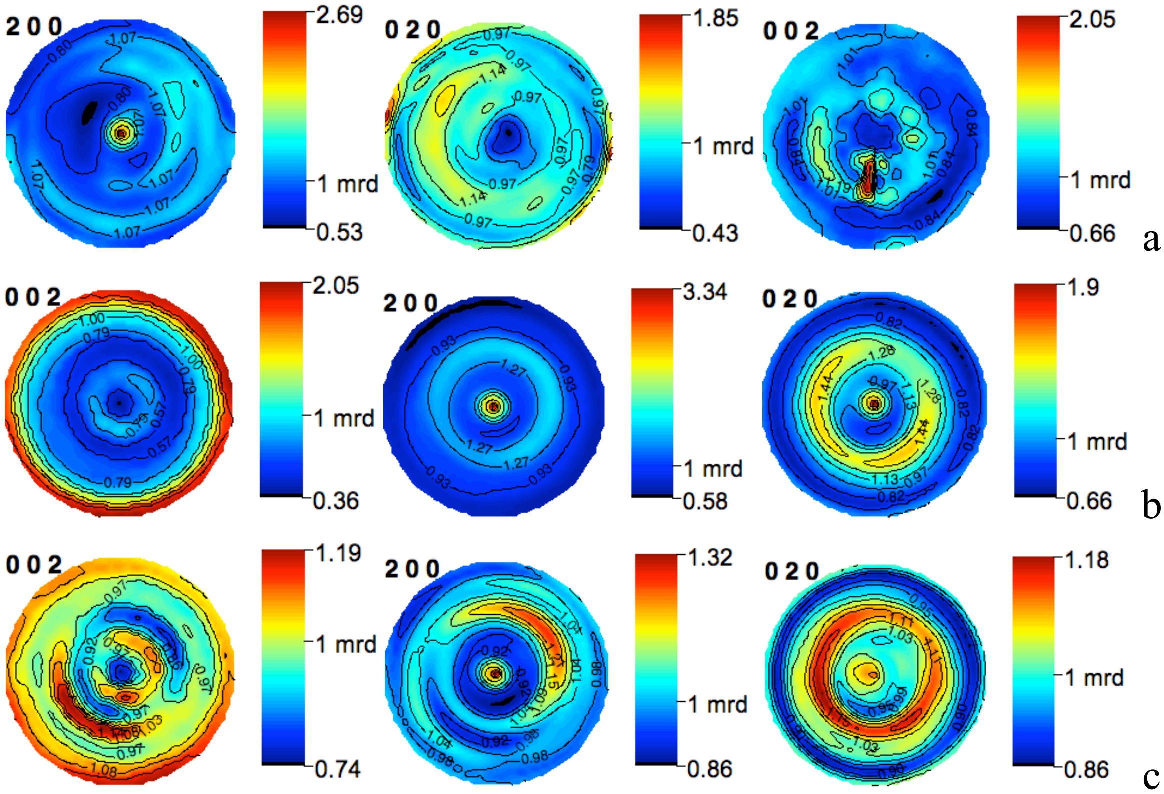

Figure 3-Reconstructed normalized pole figures for (a) Inner part, (b) Center part and (c) outer part of a Bi2212 tube-shaped sample

(1) J. Bock, R. Dommerque, S. Elschner, A. Hobl, M. O. Rikel. Melt-cast Bi-HTS for fault current limiting devices, presented at PARSEG' 10 (Washington 2010)

(2) J. Bock, M. Bludau, R. Dommerque, A. Hobl, S. Kraemer, M. O. Rikel and S. Elschner. , ASC2010 (4LB-01)

(3) D. Chateigner Ed. : Combined analysis, 2010, Wiley-ISTE, 496p.

(4) S Elschner, J. Bock, and H. Bestgen. Supercond. Sci. Technol., 6:413, 1993.

(5) J-F Fagnard, S. Elschner, J. Bock, M. Dirickx, B. Vanderheyden, and P. Vanderbemden, Supercond. Sci. Technol. **23** (2010) 095012