Global and micro texture analysis of Bi-2223 superconducting tapes using neutron diffraction and synchrotron radiation

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Strong influence of preferred orientations on critical current density (Jc) of high critical temperature superconductors has been documented many times in a recent past. In the so-called YBCO system the textural effect is particularly constraining in films (1) and bulk samples (2), while for Bi-2223 or Bi-2212 less Jc dependency has been revealed (3) whatever the sample preparation. In the case of Ag-sheated Bi-based tapes and multifilaments, geometrical and absorption problems made quantitative texture analysis practically impossible to operate using classical X-ray techniques. Recently we successfully carried out texture measurement using neutron diffraction and a PSD detector at ILL-Grenoble which showed stronger texture stabilization in multifilament than in monofilament tapes, and explained how current carrying is limited by texture in Ag-sheathed wires (4). Results indicated also fibre textures for the superconducting phases in all the analyzed samples, while the Ag sheaths presented various orientations, from classical rolling textures in cold deformed samples to the absence of preferred orientation in hot rolled tapes. Since neutrons probe the entire volume, it was however impossible using this technique to reveal possible texture variations across the tape section, as was suggested from local Jc measurements (5).

To solve this question we decided to measure local textures. Due to relatively poor crystalline state and high strain level of the superconducting phase of the ribbons, local measurements using EBSP techniques are unfortunately impossible. We had the opportunity to use the high brilliance synchrotron X-ray source from the insertion device of the Microfocus beamline at ESRF-Grenoble. We used a 30x30 μm2 square collimated beam in a reflection mode, and a bidimensional CCD detector in order to record the Debye-Scherrer rings from the Ag etched Bi-2223 samples for the optimized Bragg positions. The rings were then developped and the width at half maxima of the (00$\underline{1}$0) and (00$\underline{1}$4) reflections used for measuring the texture variations. From these measurements we verified the strongest texture of the multifilaments documented by neutron diffraction. Surprisingly, no texture variation was detected across the tape widths, whatever the overall texture strength of the monofilament. This observation shows that the inhomogeneous Jc distribution is not due to a variation of the degree of texturing with the distance from the tape center. An explanation could be found in the local variations of secondary phases.

This study demonstrates that the combined synchrotron and neutron measurements allow to determine the texture both at the global and micrometric scales.

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