

Performance of hot stacked-sinter forged Bi2223 ceramics

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Abstract

Dense Bi2223 superconductors have been successfully formed by hot stacking-forging process (HSF). Neutron diffraction measurements were used to investigate the bulk textures of HSF-Bi2223 samples. Angular dependence of transport critical current density, J_c values were measured at various temperatures and different applied magnetic fields. Several textured pieces were hot-stacked. This procedure leads to an increase of both the sample thickness and the nominal engineering critical current (I_c), favourable hints for use of textured-Bi2223 in power generation supplies.

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1. Introduction

Texturing of Bi2223 superconductors is essential to achieve high- J_c . For the power applications such as current leads or fault current limiters, high nominal I_c are required. The hot stacked-sinter forged method (HSF) offers the possibility of processing the large cross-section textured materials. The angular dependence of electrical J_c have been studied and correlated to the bulk textures of HSF-Bi2223 samples thanks to neutron diffraction investigations.

2. Experimental

As starting material, we used laboratory powders having the composition $\text{Bi}_{1.85}\text{Pb}_{0.35}\text{Sr}_2\text{Ca}_2\text{Cu}_{3.1}\text{O}_{10+\delta}$. The details of the preparation of the raw material and process of Bi2223 bulk textured samples by thermo-mechanical processing are reported elsewhere [1]. A

series of several samples has been elaborated by hot-stacking three single textured discs in the absence of soldering agents under various uniaxial pressures.

The texture was analysed using neutron diffraction measurements. The electrical properties were measured by standard four-point contacts method, applying a $1 \mu\text{V}/\text{cm}$ criteria for the critical current.

3. Results

The texture data (Fig. 1) show very strong intensity variations when the sample is tilted and rotated azimuthally relative to the neutron beam. These data are treated in a combined manner using an approach detailed previously [2], which is able to deconvolute signals from the two main superconducting and the parasitic phases. The orientation distribution function was refined using the WIMV formalism [3] implemented in MAUD [4], then used to recalculate the $\{00\ell\}$ pole figure of Bi2223 and Bi2212 (Fig. 2, top and bottom respectively). Both superconducting phases show c -axes aligned along the stress direction, with a maximum as high as 33 times and 27 times the random powder respectively. The texture development in this sample is larger than in

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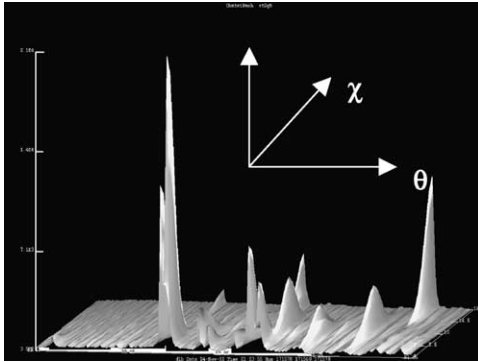


Fig. 1. Neutron diffraction diagrams measured in different tilt orientations of the stacked sample.

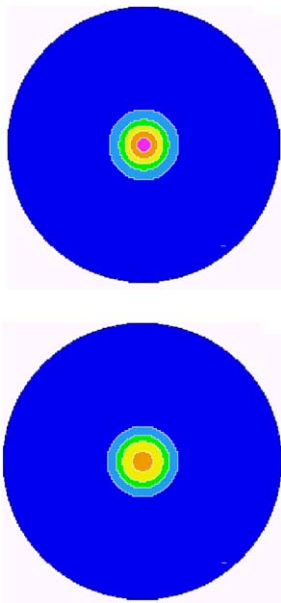


Fig. 2. $\{00\ell\}$ -Bi2223 (top) and $\{00\ell\}$ -Bi2212 pole figures recalculated from the orientation distribution function. Linear density values, maximum is 34 multiples of a random distribution.

multifilamentary tapes and very close to the ones observed on single discs, indicating that texture losses, if existing, are very reduced when stacking. This texture stabilization explains the (i) anisotropy (ii) the relatively good superconducting properties of the sample and (iii) the microstructure observations [5]. The inset of Fig. 3 shows the angular dependence of J_c in magnetic fields (H) up to 3 T. The angle θ is measured between the magnetic field and the mean ab -planes. We can clearly observe that J_c decreases with applied field and typically much more along the c -axis ($\theta = 90^\circ$). On the other hand (Fig. 3) J_c peaks at $\theta = 0^\circ$ when the field is parallel

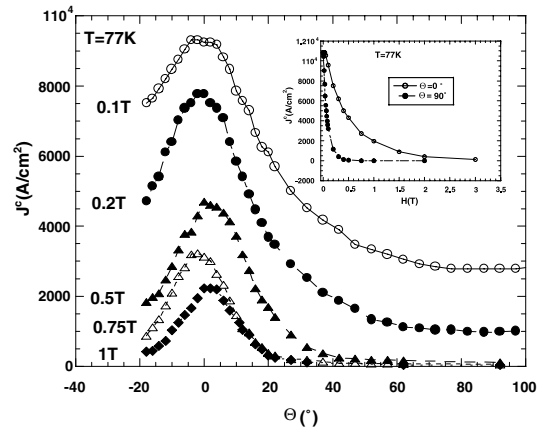


Fig. 3. Angular dependence of J_c under magnetic field. Inset: J_c deduced at $\theta = 0^\circ$ and 90° .

to the ab -planes due to intrinsic pinning. From the width at half-maximum of the $J_c(\theta)$ curves, we can have an estimation of the c -axes crystallites misalignment around 28° in low field (0.5 T).

This value is by around 6° larger than the one deduced from texture analysis, which represents the real crystallite dispersion. This difference should be assigned to other phenomena than orientations.

4. Conclusion

HSF-Bi2223 ceramics samples have been processed and performed. The bulk texture degree has been quantified by means of neutron diffraction measurements and correlated to the angular dependence of the transport current density, J_c .

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