Anisotropic Resistivity Tensor of melt-cast Bi2212 superconductors from QTA

Aline Dellicour[1,2], B. Vertruyen[1], M. Rikel[3], L. Lutterotti[4], A. Pautrat[2], D. Chateigner[2]
[1] GREEnMat/LCIS, Department of Chemistry, University of Liege, Belgium
[2] Laboratory CRISMAT UMR 6508 CNRS/University of Caen, France
[3] Nexans Superconductors, 50354 Hürth, Germany
[4] Department of Materials Engineering, Engineering Faculty, University of Trento, Italy

$Bi_2Sr_2CaCu_2O_{8+\delta}$ HTSC superconductor is characterized by a very strong normal-state resistivity anisotropy, with ρ_c/ρ_{ab} typically above 10^4. The aim of this study is to use Quantitative Texture Analysis from x-ray diffraction measurements to estimate the orientation effect on the anisotropic macroscopic resistivity in melt-cast bulk $Bi_2Sr_2CaCu_2O_{8+\delta}$ superconductors. Our approach uses the geometric mean [1] of the single crystal resistivity tensor weighted by the Orientation Distribution Function (ODF) to quantitatively estimate the macroscopic resistivity tensor of the samples. The ODF is obtained from x-ray Combined Analysis [2], using the E-WIMV algorithm of the MAUD software. The GMA applies to the rank-two resistivity tensor of the orthorhombic space group considered tetragonal due to the small difference of a- and b-axes of the phase, with only two independent tensor components. We relate a relatively good agreement between measured and calculated macroscopic anisotropic resistivity ratios.
Even with ρ_c/ρ_{ab} between 10^4 and 10^5 for Bi2212 at room temperature in single crystals [3], we experiment macroscopic ratio in our bulk samples of around only 2. This small ratio is explained by the weak planar- or fiber-like texture achieved in the melt-cast samples, characterized by maxima of orientation distributions not larger than 10 mrd. Calculated resistivities, based on homogeneous crystallites, perfect grain boundaries and no secondary phases, are 10 times larger than the observed ones. This suggests that the observed minor phases positively affect conductive pathways between grains. Calculated and measured anisotropic resistive ratios are coherent with one another, and Combined Analysis [3] gives good predictions of these former.

[1] S. Matthies and M. Humbert, J. Appl. Crystallogr. **28**, 254 (1995).
[2] D. Chateigner, Combined Analysis, ISTE-Wiley 2010
[3] T. Watanabe, T. Fujii, and A. Matsuda, Phys. Rev. Lett. **79**, 2113 (1997).