Combined texture-microstructure-structure analysis of polyphased Bi2223 superconducting and Co349 thermoelectric textured ceramics

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Texture analysis is more and more recognized as an important tool in the characterisation of many polycrystalline materials in order to understand how the microscopic intrinsic anisotropic properties are revealed at the macroscopic level in certain sample directions. The texture analysis wants to correlate physical properties, texture strength, microstructure aspects… and to establish, finally, a best understanding and design of textured materials. For examples, the development of texture in $Ca_3Co_4O_9$ (Co349) thermoelectric and $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10}$ (Bi2223) superconducting materials is required to increase respectively their electrical conductivity and critical current densities, and envisage the conception of power generation. However, a quantitative texture analysis of these materials is not a simple task. The modulated structure of layered cobaltites and the presence of several textured phases present in bismuth-based superconductors remain a handicap in the characterisation using diffraction techniques. The diffraction spectra are also very complex with many partially or fully overlapping diffraction peaks. The small number of quantitative texture studies on superconductors and the absence of any ones, to our knowledge, on cobaltites compounds, highlight the different problems encountered in these materials. Usually, textures are determined by extracting pole figures from single diffraction peaks but this is difficult if pole figures overlap. To overcome this problem, the combination of Rietveld, WIMV and Popa approaches, for instance as implemented in the MAUD software (Materials Analysis Using Diffraction) permits a comprehensive new approach to crystal structure-texture-microstructure analysis. In this study we report the first application of this method to the polyphased $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10}$ superconductor and the $Ca_3Co_4O_9$ thermoelectric compounds. Orientation distributions (OD) were determined from neutron and X-ray diffraction on curved position-sensitive detectors (D1B (ILL) & INEL CPS 120). Different processed materials were analysed to illustrate the efficiency and reliability of iterative combination of algorithms for structure determination (Rietveld), microstucture (Popa) and OD calculation (WIMV). Correlation between texture strengths and superconducting current densities and thermoelectric power are respectively illustrated.

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