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Improvement of thermoelectric performances of $Bi_2Sr_2Co_2O_x$ by controlling microstructure through bulk melt process

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Layered misfit cobaltites are considered as promising oxide materials for thermoelectric applications at high temperatures, the $Bi_2Sr_2Co_2O_x$ composition (abbreviated as BSC-222) being considered as one of the best thermoelectric materials among the layered cobaltites. The highest dimensionless figure of merit (ZT) value reported for this p-type oxide compound is 0.19 at 973 K [1]. For efficient energy-conversion thermoelectric systems, a significant improvement of ZT values of this oxide is required. BSC-222 exhibits a layered structure, where CoO_2 layers alternate with $Bi_2Sr_2O_4$ block layers along the c-axis. Increasing ZT values can be expected by lowering the electrical resistivity through optimization of grain alignment or lowering the thermal conductivity by phonon scattering. Considering this second strategy, composite materials, which contain nanoinclusions or nanodefects, are known possessing lower thermal conductivity compared with conventional bulk materials. In this study, for preparing such nanostructured materials, a bulk melt processing way was developed. Bi-Sr-Co-O oxide being a peritectic system, starting from a partial melted state where liquid and solid phases coexist (incongruent melting), peritectic reaction between these phases forms the main phase BSC-222. However, solid phases resulting from the incongruent melting can remain during the solidification process and allow preparing composite in the solidified materials. The control of the size and the pattern distribution of secondary phases can promote a decreasing of thermal conductivity thank to boundary scattering of phonons. This strategy should significantly improve the overall thermoelectric performance of BSC-222 materials.

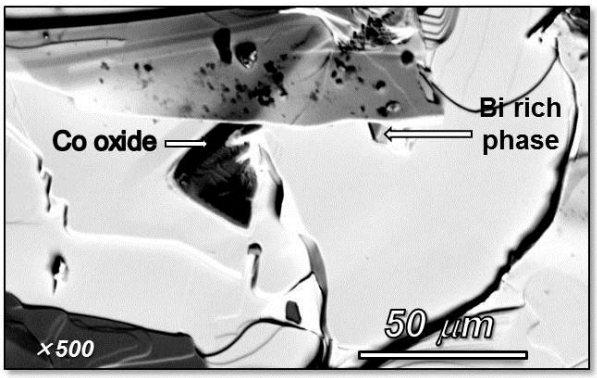

Figure: Scanning Electron Micrograph of a BSC-222 composite material prepared through bulk melt processing way. Co oxide and Bi rich secondary phases can be observed in the $Bi_2Sr_2Co_{1.5}O_x$ matrix, which exist as solid and liquid phases at high temperature, respectively.

[1] R. Funahashi, I. Matsubara , S. Sodeoka, Appl. Phys. Letters 76 [17] (2000) 2385