18a-A7-4

Decreased thermal conductivity in $Bi_2Sr_2Co_2O_9$ bulk materials prepared by partial melting processing way

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The cobaltite $Bi_2Sr_2Co_2O_9$ (named BSC-222 phase in this study) is a promising p-type material for high temperature thermoelectric applications in air. Due to the particular layered structure of this compound, where CoO_2 layers alternate with $Bi_2Sr_2O_4$ block layers along the c-axis with a misfit structure [1], phonon scattering at the interface between layers is expected with a benefit impact on thermal transport properties. BSC-222 single crystals exhibit a promising ZT value of 1.1 at 700ºC in air [2] but the maximal ZT value for BSC-222 polycrystalline samples is decreased to 0.19 in air at 700ºC [3]. ZT values of polycrystalline BSC-222 bulk materials are too low for widespread large-scale use of this material. Recently, we investigated the preparation of BSC-222 bulk materials by partial melting process [4]. The decreasing of electrical resistivity and thermal conductivity can be achieved in BSC-222 bulks possessing simultaneously large average grain size and appropriate bulk density. The correlation between the microstructure of partially melted BSC-222 samples and the observed decreased thermal conductivity appears complex to establish. Indeed, the nano/microstructure of partially melted BSC-222 samples reveals the presence of pores but also secondary phases and inclusions. In partial melting process, BSC-222 grains are recrystallized through a peritectic reaction from the slow cooling of incongruent melt. In such prepared bulk materials, the solid and liquid phases remain. Such remnant secondary phases might act as phonon scattering sites. In fact, lowering thermal conductivity of the phonon part has been observed in the partially melted sample (Fig. 1).

In this study, BSC-222 bulk materials have been prepared by different processing methods, i.e. partial melting or hot pressing, in order to prepare samples with different microstructures: grain size, grain alignment, presence of pores or nano inclusions. The evolution of the BSC-222 sample's microstructure with processing methods and their impact on the thermal properties are investigated and discussed.

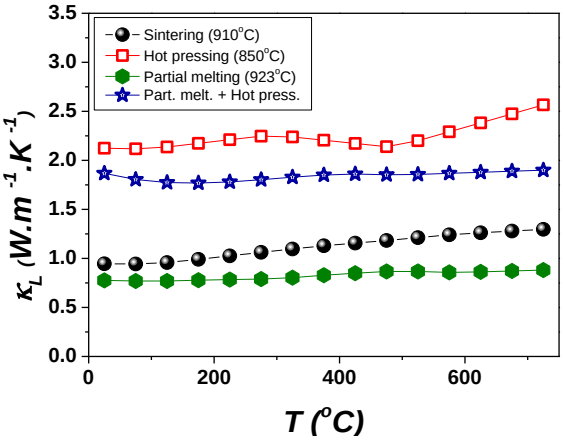

Figure 1: Temperature dependence of thermal conductivity of phonon part for $Bi_2Sr_2Co_2O_9$ bulk samples.

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