Improving thermoelectric performances of n-type Bi-Sb alloys by post treatment after pulse electric current sintering (SPS)

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Compounds based on the Bi-Sb solid-solution are considered as one of the most effective candidate materials for thermoelectric (TE) applications systems operating in temperature range below 200 K. Promising ZT values have been obtained for single crystals of Bi-Sb alloys [1]. The preparation of polycrystalline materials is however necessary for mass production of Bi-Sb TE elements in order to overcome the limit of single crystals (difficulty of processing, low mechanical strength, etc.). Several preparation technologies have been investigated for improving the TE performances of Bi-Sb polycrystalline materials [2,3]. Due to the layered crystal structure of Bi-Sb materials, the introduction of a preferential orientation of the grains in the consolidated material by using specific texturing processing way, like pulse electric current sintering (SPS), is efficient for decreasing the electrical resistivity. In this study, Bi-Sb bulk materials have been prepared by powder metallurgy (mechanical alloying) following by pulse electric current sintering (SPS). Improved TE properties have been obtained by microscopic modification resulting from a second SPS treatment including deformation performance during processing of a sintered Bi-Sb pellet. The ZT value at 200 K was improved by about a factor 1.5 by comparison with a Bi-Sb sample treated one time by SPS sintering. The improved ZT values result from a decreased electrical resistivity thank to texturing effect, whereas the lattice part of the thermal conductivity is also significantly decreased. Microsctructural modifications, presence of dislocations or twin boundaries, are observed in the deformed Bi-Sb sample after second SPS treatment.

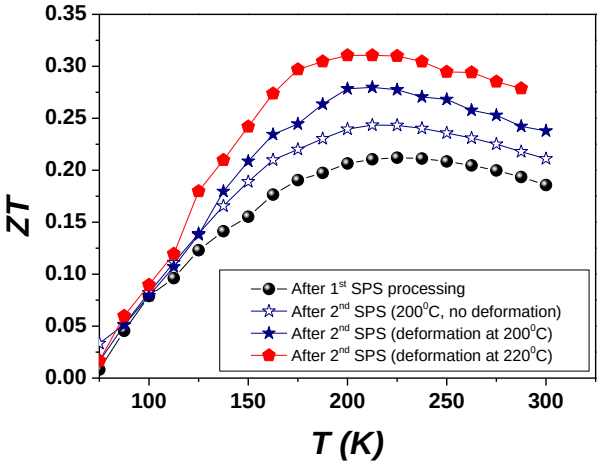

Figure: temperature dependence of ZT values of prepared Bi-Sb bulk materials

[1] W.M. Yim, A. Amith, Solid State Electron., 15 (1972), p. 1141

[2] R. Martin-Lopez, B. Lenoir, et al., Mater. Sci. Eng. A-Struct., 248 (1998), p. 147

[3] H.J. Liu, Ch.M. Song, et al., Cryogenics, 47, 1 (2007) p. 56