Accepted Manuscript

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PII: S0925-8388(17)32817-7

DOI: 10.1016/j.jallcom.2017.08.089

Reference: JALCOM 42846

To appear in: *Journal of Alloys and Compounds*

Received Date: 5 June 2017

Revised Date: 14 July 2017

Accepted Date: 10 August 2017

Please cite this article as: S.-S. Lim, B.K. Kim, S.K. Kim, H.-H. Park, D.-I. Kim, D.-B. Hyun, J.-S. Kim, S.-H. Baek, A two-step synthesis process of thermoelectric alloys for the separate control of carrier density and mobility, *Journal of Alloys and Compounds* (2017), doi: 10.1016/j.jallcom.2017.08.089.

A two-step synthesis process of thermoelectric alloys for the separate control of carrier density and mobility

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Abstract

It is challenging to improve the thermoelectric figure-of-merit as its constituent terms such as Seebeck coefficient, electrical conductivity, and thermal conductivity, are inter-related in the way that the enhancement of one term leads to the degradation of others. Therefore, it is highly desirable to design a new synthesis process that allows us to independently control these terms. Here, we report a simple, two-step process combining spark plasma sintering (SPS) and post-annealing (PA) to separately control the carrier density and mobility in the p-type $(Bi_{0.2}Sb_{0.8})_2Te_3$. High-temperature SPS enables enhancing the carrier mobility by reducing scattering sites such as grain boundaries. Then, the following PA at a lower temperature allows tailoring the carrier density without the degradation of mobility. Beyond bismuth telluride-based, room-temperature thermoelectric materials, we believe that our result will provide an insight for the performance enhancement of other thermoelectric materials such as oxide and skutterudite.

Key words: thermoelectric, bismuth antimony telluride, carrier density, carrier mobility