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

Sang-Soon Lim^{1,2}, Byung Kyu Kim³, Seong Keun Kim¹, Hyung-Ho Park², Dong-Ik Kim³, Dow-Bin Hyun¹, Jin-Sang Kim^{1*}, Seung-Hyub Baek^{1,4*}

¹Center for Electronic Materials, Korea Institute of Science and Technology, Seoul 02792, Republic of Korea

²Department of Materials Science and Engineering, Yonsei University, Seoul 03722, Republic of Korea

³High Temperature Energy Materials Research Center, Korea Institute of Science and Technology, Seoul 02792, Republic of Korea

⁴Division of Nano & Information Technology, KIST School, Korea University of Science and Technology, Seoul 02792, Republic of Korea

*Corresponding author: jskim@kist.re.kr, shbaek77@kist.re.kr

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 $(\text{Bi}_{0.2}\text{Sb}_{0.8})_2\text{Te}_3$. 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

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