Optimization of spark plasma sintering conditions for antimony-doped bismuth telluride

Han, Li; Van Nong, Ngo; Le, Thanh Hung; Pham, Hoang Ngan; Hegelund Spangsdorf, Steeven ; Roch, Aljoscha ; Stepien, Lukas ; Pryds, Nini

Published in:
Book of Abstracts - 34th Annual International Conference on Thermoelectrics (ICT 2015) and 13th European conference on Thermoelectrics (ECT 2015)

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

BOOK OF ABSTRACT

34TH ANNUAL INTERNATIONAL CONFERENCE ON THERMOELECTRICS (ICT 2015)

AND

13TH EUROPEAN CONFERENCE ON THERMOELECTRICS (ECT 2015)

JUNE 28TH – JULY 2ND, 2015 DRESDEN, GERMANY

WWW.CPFS.MPG.DE/ICT2015

8A.3

Optimization of spark plasma sintering conditions for antimony-doped bismuth telluride

Li Han[1*], Ngo Van Nong[1], Le Thanh Hung[1], Hoang Ngan Pham[1], Steeven Hegelund Spangsdorf[1], Aljoscha Roch[2], Lukas Stepien[2], and Nini Pryds[1]

[1] *Department of Energy Conversion and Storage, Technical University of Denmark, DTU Risø Campus, Frederiksborgvej 399, 4000 Roskilde, Denmark.*
[2] *Fraunhofer Institute for Material and Beam Technology (IWS), Winterbergstrasse 28, 01277 Dresden, Germany.*
[*] *e-mail of presenting author: ihan@dtu.dk*

Antimony-doped bismuth telluride (Sb-doped Bi_2Te_3) is one of the best and most-used p-type thermoelectric materials for near-room-temperature application [1, 2, 3]. It has a stacked two-dimensional (2D) layered crystal structure, and exhibits the anisotropic thermoelectric properties [4]. In this work, we investigated the correlations between spark plasma sintering (SPS) conditions and the thermoelectric properties of Sb-doped Bi_2Te_3 samples. After sintered using SPS, the Sb-doped Bi_2Te_3 samples showed distinctive density, microstructure, and crystalline preferential orientation as the sintering conditions (temperature, pressure, and ramping rates) changed. Accordingly, different thermoelectric properties were also observed by these samples. An optimized sintering condition was found and an in-plane figure of merit *ZT* up to 1.3 at 298 K was achieved. Such high *ZT* was supported by the excellent in-plane electrical transport properties, which was mainly resulted from a high degree of c-plane orientation. A high in-plane power factor of 4.79 $\times 10^{-3}$ W m^{-1} K^{-2} was shown compared with the out-of-plane value of only 2.76 $\times 10^{-3}$ W m^{-1} K^{-2}. On the other hand, the micron-scaled grains along the in-plane directions were resulted from SPS sintering; these grains are very effective to scatter acoustic phonons while giving minor harm to electrical transport. This work gives an insight for manipulating the spark plasma sintering conditions and anisotropic thermoelectric properties of Sb-doped Bi_2Te_3.

References:

[1] H. J. Goldsmid, R. W. Douglas, Thermoelectric. Br. *J. Appl. Phys*.1954, 5, 458.
[2] D. A. Wright, *Nature* 1958, 181, 834.
[3] W. Xie, J. He, H. J. Kang, X. Tang, S. Zhu, M. Laver, S. Wang, J. R. D. Copley, C. M. Brown, Q. Zhang, and T. M. Tritt, *Nano Lett*. 2010, 10, 3283.
[4] D. Teweldebrhan, V. Goyal, and A. A. Balandin, *Nano Lett*. 2010, 10, 1209.