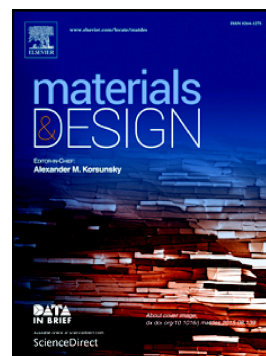


Accepted Manuscript

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PII: S0264-1275(18)30650-6
DOI: doi:[10.1016/j.matdes.2018.08.035](https://doi.org/10.1016/j.matdes.2018.08.035)
Reference: JMADE 7333
To appear in: *Materials & Design*
Received date: 1 June 2018
Revised date: 13 August 2018
Accepted date: 19 August 2018

Please cite this article as: Anil K. Bohra, Ranu Bhatt, Ajay Singh, Shovit Bhattacharya, Ranita Basu, K.N. Meshram, Shaibal K. Sarkar, Pramod Bhatt, P.K. Patro, D.K. Aswal, K.P. Muthe, S.C. Gadkari, Transition from n- to p-type conduction concomitant with enhancement of figure-of-merit in Pb doped bismuth telluride: Material to device development. Jmade (2018), doi:[10.1016/j.matdes.2018.08.035](https://doi.org/10.1016/j.matdes.2018.08.035)

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Transition from n- to p-type conduction concomitant with enhancement of figure-of-merit in Pb doped bismuth telluride: material to device development

Anil K. Bohra¹, Ranu Bhatt¹, Ajay Singh^{1*}, Shovit Bhattacharya¹, Ranita Basu¹, K. N. Meshram¹, Shaibal K. Sarkar⁴, Pramod Bhatt², P. K. Patro⁵, D. K. Aswal^{1,3}, K. P. Muthe¹, S. C. Gadkari¹

¹Technical Physics Division, Bhabha Atomic Research Center, Mumbai-400085, India

²Solid State Physics Division, Bhabha Atomic Research Center, Mumbai-400085, India

³National Physical Laboratory, New Delhi -110011, India

⁴Dept. of Energy Science and Engineering, IIT Bombay, Powai, Mumbai-400076, India

⁵Powder Metallurgy Division, Bhabha Atomic Research Center, Mumbai-400085, India

*Corresponding author email: ajay@barc.gov.in (Ajay Singh)

Abstract

The majority of industrial, automobile processes, electrical appliances emit waste heat in the low-temperature range (< 573 K), hence efficient thermoelectric materials operating in this range are highly needed. Bismuth telluride (Bi_2Te_3) based alloys are conventional thermoelectric material for the low-temperature application. The pure Bi_2Te_3 sample synthesized in this work exhibits n-type conduction. We demonstrate that by small doping of Pb at Bi site a transition in electrical transport from n- to p-type is observed. The figure-of-merit (ZT) of n-type Bi_2Te_3 is ~ 0.47 and optimized $\text{Bi}_{1.95}\text{Pb}_{0.05}\text{Te}_3$ exhibit p-type conduction with enhanced ZT of ~ 0.63 at 386 K. The conversion efficiency of $\text{Bi}_{1.95}\text{Pb}_{0.05}\text{Te}_3$ based single thermoelement with hot pressed Ni/Ag electrical contacts was found to be $\sim 4.9\%$ for a temperature difference (ΔT) of 200 K. The efficiency was further enhanced to $\sim 12\%$ (at $\Delta T \sim 494\text{K}$) in the segmented thermoelement consisting of $\text{Bi}_{1.95}\text{Pb}_{0.05}\text{Te}_3$ and $(\text{AgSbTe}_2)_{0.15}(\text{GeTe})_{0.85}$ (i.e. TAGS-85).

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