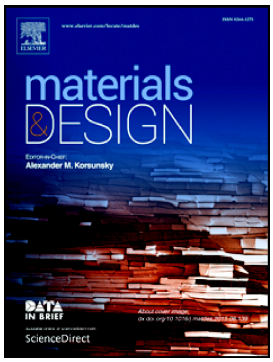

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Transition from n- to p-type conduction concomitant with enhancement of figure-of-merit in Pb doped bismuth telluride: material to device development

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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 form n- to p-type is observed. The figure-of-merit (ZT) of n-type Bi_2Te_3 is ~ 0.47 and optimized $Bi_{1.95}Pb_{0.05}Te_3$ exhibit p-type conduction with enhanced ZT of ~ 0.63 at 386 K. The conversion efficiency of $Bi_{1.95}Pb_{0.05}Te_3$ based single thermoelement with hot pressed Ni/Ag electrical contacts was found to be ~4.9% for a temperature difference (ΔT) of 200 K. The efficiency was further enhanced to ~ 12% (at ΔT ~494K) in the segmented thermoelement consisting of $Bi_{1.95}Pb_{0.05}Te_3$ and $(AgSbTe_2)_{0.15}(GeTe)_{0.85}$ (i.e. TAGS-85).