Transport Properties of Sn and SbI_3 Doped Single Crystal p-Bi_2Te_3

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Traditionally impurity energy states fall in the band gap, which leads to statistical distribution of free carriers, contributing to spatial inhomogeneity, and small high-field Shubnikov-de Haas (SdH) oscillations[1] in solid solutions of $Bi_2Te_3 - Sb_2Te3$, the most common room temperature thermoelectrics. However, in these solid solutions with Sn impurity, the Sn states pin the Fermi level and tremendously improve the spatial homogeneity of carriers. This results in observation of high-amplitude SdH oscillations in lower magnetic field[2]. The Fermi level was estimated to be at the top of the second valence band (heavy holes). However, the additional doping has not been studied. We chose Bi_2Te_3 doped with Sn and I impurities to shift the Fermi level and investigate the model that best fits the Sn states. The introduction of similar levels of concentration for the two dopants preserves the Sn impurity states but affects the filling factor. Our results of SdH effect show different frequencies around 4.2 K for samples with 0.05 % and 0.1 % of I and no feature in specific heat at low temperature. This indicates that the model for one-electron states in Bi_2Te_3 doped with Sn is that of two impurity bands with the Fermi level pinned in-between.

[1]Kulbachinskii *et al*, Physics of the Solid State, 48(5), p.p.833-840 (2006)
[2]Laiho *et al*, Semiconductors, 41(5), p.p.546-549 (2007).