Abstract

Motivated by the energy applications of thermoelectrics (TE) such as power generation and refrigeration, my research goal is to develop new PbTe based material system with high power factor ($\alpha^2\sigma$, where α is the Seebeck coefficient and σ is the electrical conductivity) for the enhancement of its thermoelectric figure of merit ZT ($=\alpha^2\sigma T/k$, where k is the thermal conductivity and T is the absolute temperature).

For the measurements of Seebeck coefficient and electrical resistivity two instruments have been designed and fabricated for the two temperature regimes, viz., 100 – 300 K and 300 – 600 K.

For the enhancement of power factor the value of α must be increased with a simultaneous increment in σ. However, it is challenging to tailor the crystal and band structure of the materials to enhance the value of α without the reduction in the value of σ. In my research work, I have grown single crystalline bulk PbTe for the evaluation of its thermoelectric performance.

PbTe nanocomposites have been prepared by compaction of solution-phase-synthesized PbTe nanocrystals under high pressure and temperature. The introduction of the large number of interfaces within the system has been found to enhance the power factor with the highest value of 18.72×10^{-4} $Wm^{-1}K^{-2}$ at temperature 500 K for the sample with room temperature thermal conductivity of 1.69 $Wm^{-1}K^{-1}$.

To study the effect of embedded Ag nanodots within the grains, PbTe:Ag nanocomposites have been prepared by hot pressing Ag doped PbTe nanocrystals synthesized by chemical route. The presence of Ag nanodots in PbTe:Ag nanocomposite is found to produce higher Seebeck coefficient through preferential scattering of charge carriers, however, due to reduced carrier mobility its electrical conductivity is found to be lower. The highest value of power factor for PbTe:Ag nanocomposite is observed to be 18.78×10^{-4} $Wm^{-1}K^{-2}$ at 500 K.

To avoid the reduction in the value of σ with the enhancement in the value of α of PbTe the concept of local enhancement of density of states (DOS) has been implemented in Cr doped PbTe. The highest power factor of PbTe:Cr sample has been found to be

38.49×10^{-4} $Wm^{-1}K^{-2}$ at 300 K which is almost double than that obtained for pure bulk PbTe.