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# IV-VI Semiconductor Nanocomposites for Thermoelectric Energy Converters

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## Abstract

Efficient thermoelectric power generators and Peltier refrigerators require new materials with thermoelectric figure of merit parameter ZT improved over currently used materials with ZT=0.5-1. One of new ideas for thermoelectrics concerns materials prepared in the form of bulk crystalline nanocomposites engineered to suppress the conduction of heat while preserving good electrical conductivity. This practical realization of electron crystal - phonon glass concept of optimal thermoelectric has been recently tested for various thermoelectric alloys and nanocomposites based on IV-VI narrow gap semiconductors. In n- and p-type doped PbTe-CdTe, PbTe-PbS, PbTe-SrTe, PbTe-GeTe, and PbTe-MnTe materials systems the enhanced density of states at the Fermi level results in the increased thermoelectric power. Spontaneous formation of two-phase crystalline nanostructures observed in PbTe-CdTe and PbTe-PbS semiconductor systems permits the growth of composite thermoelectrics with nanosize precipitates embedded in the PbTe thermoelectric matrix. These nanostructures are known to exhibit reduced lattice thermal conductivity and improved ZT parameter with laboratory results reporting ZT=1.5-2 at high temperatures T=900 K. We report on manufacturing of materials as well as experimental and theoretical studies of electronic structure and thermoelectric properties of bulk crystals and epitaxial multilayers of PbTe with Mn or Cd heavily doped n-type with Bi and p-type with Na. The band gap of PbMnTe and PbCdTe increases with increasing Mn or Cd content whereas the energy separation between the light hole and the heavy hole valence bands decreases. It results in improved thermoelectric parameters of these materials with the experimentally found ZT=0.7-0.9 at T=700 K. We also assembled and tested the performance of PbMnTe and PbCdTe thermoelectric p-n couples observing the effective device ZT parameter up to 0.5.

***Keywords: Thermoelectricity, IV-VI semiconductors, Nanocomposites***

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