Pierre F. P. Poudeu et al., J Material Sci Eng 2012, 1:3
http://dx.doi.org/10.4172/2169-0022.S1.002

OMICS Group Conferences
Accelerating Scientific Discovery

International Conference and Expo on
Materials Science & Engineering

October 22-24, 2012 DoubleTree by Hilton Chicago-North Shore, USA

Electronic and phonon transport in bulk quantum dot engineered semiconductors

Pierre F. P. Poudeu, Julien P. A. Makongo, Pranati Sahoo, Liu Yuanfeng, Xiaoyuan Zhou and Ctirad Uher
University of Michigan, USA

One of the major roadblocks to large enhancements in the thermoelectric figures of merit (ZT) of leading candidate thermoelectric materials such as the Bi_2Te_3, PbTe, $CoSb_3$ and half-Heusler (HH) based systems remains the difficulty in making meaningful simultaneous improvements in both the electrical conductivity (σ) and thermopower (S) of these materials through doping and/or substitutional chemistry. In conventional semiconductors, both materials parameters (S and σ) are fundamentally coupled adversely through the concentration, n, of charge carriers. Therefore, the maximization of one parameter by tuning n via doping and/or substitution inevitably results in the minimization of the other. Here, we show that by coherently embedding sub-ten nanometer scale inclusions within a semiconducting HH matrix, large enhancements of S and the mobility (μ) can be achieved simultaneously in both n-type and p-type nanocomposites. The enhancement in thermopower originates from large reductions in the effective carrier density (n) coupled with an increase in the carrier effective mass (m*). The surprising enhancement in the mobility is attributed to an increase in the mean-free time (τ) between scattering events (phonon-electron, ionized-impurity, and electron – electron). Using X-ray powder diffraction, electron microscopy, and electronic transports data, we will discussed the mechanism of phase formation at the sub-ten nanometer scale, in bulk HH matrix and the mechanism by which the embedded nanostructures regulate electronic charge transport within the semiconducting HH matrix to achieve unprecedented combinations of physical properties such as, large enhancements in μ, S and σ simultaneously with drastic decrease in thermal conductivity (κ) at high temperatures.

Biography

Pierre Ferdinand Poudeu is an Assistant Professor of Materials Science and Engineering at the University of Michigan. He studied Chemistry at the University of Yaounde-I (Cameroon) and obtained his Ph.D. in Inorganic Chemistry from the Dresden University of Technology (Germany) in 2004. He was research associate at Michigan State University (2004-2006) and at Northwestern University (2006–2007), and served as an Assistant Professor of Chemistry at the University of New Orleans (2007-2011). Dr. Poudeu has published over 50 papers on inorganic multifunctional materials for thermoelectrics and spintronics. He is an Associate Editor of "Reviews in Advanced Sciences and Engineering" (RASE).

ppoudeup@umich.edu