Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Length scale dependent of thermal conductivity of Si-Ge alloys
LONG CHEN, S. JOSEPH POON, BRIAN DONOVAN, JOHN T. GASKINS, PATRICK HOPKINS, University of Virginia — A crucial aspect of the optimization of the thermoelectric figure of merit involves manipulation of the lattice thermal conductivity without significantly effecting electronic mobility. In order to fully understand the contributions to the lattice thermal conductivity, we present a calculations based on a phonon frequency-dependent model. This model, derived using the effective medium method, predicts the lattice thermal conductivity reduction due to the presence of nanoinclusions in a matrix. We further extend our work to study fully nanostructured materials. By using this method, the dependence of lattice thermal conductivity on various length scale is determined. We validate these models with experiment results obtained via time-domain thermoreflectance. By varying the modulation frequency of this pump-probe technique, we are able to measure the thermal conductivity of Si and Si-Ge systems over a variety of thermal penetration depths. We use this combination of modeling and experimental findings to gain insight into the relationship between phonon mean free path and the lattice thermal conductivity.

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Date submitted: 17 Nov 2014 Electronic form version 1.4