Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Reduction of thermal conductivity in silicon phononic metamaterials WILLIAM JONES, AXEL SCHERER, SLOBODAN MITROVIC, Cal Inst of Tech (Caltech) — We explore the limits of thermal conductivity reduction through phononic design of single crystal silicon membranes by direct measurement via thermal bridge method. Phononic metamaterials with nanoscale critical dimensions can modify the dispersion for heat carrying phonons via Brillouin-zone folding. In monolithic crystalline thin films, thermal conductivity can be further reduced by employing a superstructure of these patterned regions. We hypothesize that this approach can reduce the thermal conductivity due to phonon reflection. We also discuss the potential of these structures to enable a true phonon-glass, electron-crystal material and push the limits of thermoelectric cooling/heat conversion efficiency. We predict that the high electrical conductivity of doped single crystal silicon will endow this phononic metamaterial with a high ZT characteristic.

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Date submitted: 15 Nov 2013 Electronic form version 1.4