Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Low temperature phonon boundary scattering in slightly rough Silicon nanowires MARC GHOSSOUB, KRISHNA VALAVALA, MYUNGHOON SEONG, BRUNO AZEREDO, JYOTHI S. SADHU, SANJIV SINHA, Department of Mechanical Science and Engineering - University of Illinois at Urbana-Champaign — Nanostructured materials [1-3] have lower thermal conductivities than the bulk and are promising candidates for thermoelectric applications. In particular, measurements on single silicon nanowires show a reduction in thermal conductivity below the Casimir limit. This reduction increases with surface roughness [4] but the trend and its connection to phonon boundary scattering are still elusive. Here, we measure the thermal conductivity of single silicon nanowires fabricated using metal-assisted chemical etching. High resolution TEM imaging shows crystalline wires with slightly rough surfaces. Their statistical correlation lengths (5-15 nm) and RMS heights (0.8-1.5 nm) are in a range where perturbation-based wave scattering theory is still applicable. We use the thermal conductivity data to extract the frequency dependence of phonon boundary scattering at low temperatures (10-40 K) and show agreement with multiple scattering theory. This work provides insight into enhancing the thermoelectric performance of nanostructures. 1-A. I. Hochbaum et al, Nature Lett. 451, 163-167 (2008). 2-A. J. Minnich et al, Energy Environ. Sci. 2, 466-479 (2009). 3-L. Shi, Nanoscale Microscale Thermophys. Eng. 16, 79–116 (2012). 4-J. Lim et al, Nano Lett. 12, 2475−2482 (2012).

Marc G. Ghossoub
University of Illinois at Urbana-Champaign

Date submitted: 09 Nov 2012 Electronic form version 1.4