Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Probing Large-Wavevector Phonons in Silicon Nanomembranes using X-ray Thermal Diffuse Scattering GOKUL GOPALAKRISHNAN, University of Wisconsin - Madison, MARTIN HOLT, Argonne National Laboratory, KYLE MCELHINNY, University of Wisconsin - Madison, DAVID CZAPLEWSKI, Argonne National Laboratory, PAUL EVANS, University of Wisconsin - Madison — Phonons play a critical role in determining physical properties of crystalline materials. Phonon dispersions can be modified via nanoscale engineering, by introducing boundaries separated by distances comparable to phonon wavelengths. In free-standing nanowires and sheets, theoretical and experimental investigations have been largely restricted to studying small-wavevector phonons lying within the central 1% of the Brillouin Zone. Large-wavevector phonons, important for transport in nanostructures, cannot be modeled using continuum physics, and are difficult to probe using conventional optical techniques. Synchrotron x-ray thermal diffuse scattering (TDS) collects information from the scattering of x-rays by phonons with wavevectors spanning the entire Brillouin zone. We adopt this technique to probe the dispersion of large-wavevector acoustic phonons in the nanoscale regime. TDS measurements were performed on silicon nanomembranes, from 315 nm thick sheets exhibiting bulk Si dispersions, to membranes as thin as 6 nm, where deviations from bulk-like behavior are observed. Systematic examinations of the variation of scattered intensity with crystallographic orientation, wavevector, and membrane thickness will be presented.

Gokul Gopalakrishnan
University of Wisconsin - Madison

Date submitted: 09 Nov 2012 Electronic form version 1.4