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Mapping Phonons Across the Brillouin Zone of a Silicon Nanomembrane using X-ray Thermal Diffuse Scattering GOKUL GOPALAKRISHNAN, University of Wisconsin - Platteville, KYLE MCELHINNY, University of Wisconsin - Madison, MARTIN HOLT, DAVID CZAPLEWSKI, Argonne National Laboratory, PAUL EVANS, University of Wisconsin - Madison — Advances in the fabrication of ultrathin semiconductor membranes provide an opportunity to create novel vibrational phenomena that will ultimately yield controllable thermal and electronic phenomena not observed in bulk systems. Theoretical studies predict an order-of-magnitude reduction in thermal conductivity in silicon quantum wells relative to bulk values. The increasingly important contributions of large-wavevector phonons at the nanoscale have not been observed due to fundamental limitations of conventional probes. As a result, predictions for the behavior of confined phonons have only been experimentally investigated for small-wavevector modes near the zone center. Synchrotron x-ray thermal diffuse scattering (TDS) allows large-wavevector phonons to be probed with high momentum resolution. TDS measurements performed at the Advanced Photon Source at Argonne National Laboratory, were used to probe the entire Brillouin zone by varying the orientation of the sample relative to the incident beam and detector. Doing so yields populations of acoustic phonons in silicon nanomembranes from throughout the Brillouin zone. Results of this experiment reveal deviations from bulk-like phonon dispersions arising from confinement due to the closely separated surfaces of the nanomembrane.

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