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Probing Large-Wavevector Phonons in Strain-Relief Patterned Silicon/Silicon Germanium Heterostructure Nanomembranes KYLE MCELHINNY, Univ of Wisconsin, Madison, GOKUL GOPALAKRISHNAN, Univ of Wisconsin, Platteville, DON SAVAGE, MAX LAGALLY, Univ of Wisconsin, Madison, MARTIN HOLT, Center for Nanoscale Materials, Argonne National Laboratory, PAUL EVANS, Univ of Wisconsin, Madison — Freestanding Si/SiGe nanomembranes have promising thermal properties as a result of the ability to decouple the electronic and thermal transport. Challenges in fabrication of freestanding Si/SiGe nanomembranes arise due to buckling in reaction to stresses generated by the lattice mismatch between the Si and SiGe layers. This results in an equilibrium state where the elastic energy is minimized through a buckling distortion. We demonstrate that the strain and curvature of these membranes is reduced by nearly an order of magnitude through the strain-relief patterning of the buckled membrane. X-ray thermal diffuse scattering (TDS) studies of these membranes evaluate the effect of confinement on the phonon dispersion of the Si/SiGe heterostructure by probing the populations of acoustic phonons at wavevectors spanning the Brillouin zone. A comparison between the x-ray TDS intensity distributions of Si and Si/SiGe heterostructure nanomembranes demonstrates the importance of fabricating SiGe nanostructures with reduced strain and curvature. Results of these experiments show deviations in TDS intensity compared to bulk and Si nanomembranes. In Si nanomembranes these deviations have previously indicated a softening of 1-2 meV at large wavevectors.

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