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Measurement of the phonon mean free path spectra and the universality in the high temperature limit KEITH REGNER, JUSTIN FREEDMAN, Carnegie Mellon University, ZLATKO SITAR, North Carolina State University, JACOB LEACH, Kyma Technologies, ROBERT DAVIS, JONATHAN MALEN, Carnegie Mellon University — Here, we use broadband frequency domain thermoreflectance (BB-FDTR) to measure thermal conductivity accumulation functions (k_{accum}) of Si, GaAs, GaN, AlN, and SiC at temperatures of 80 K, 150 K, 300 K, and 400 K and show that they collapse to a universal accumulation function (k_{univ}) in the high temperature limit. BB-FDTR is a novel technique developed to measure the spectral contributions of phonons to bulk thermal conductivity as a function of phonon MFP i.e., k_{accum}. BB-FDTR uses a heterodyne approach allowing for continuous resolution of the phonon MFP spectrum spanning two orders of magnitude (0.3 - 8 μm in Si at $T = 300$ K). Results in Si and GaAs compare favorably to numerical predictions (Esfarjani, et al., PRB, 2011) (Luo et al., arXiv, 2012) and show that phonons with long MFPs (>1 μm) contribute significantly to the bulk thermal conductivity at $T = 300$ K. Next, we present a method to predict k_{accum} as the temperature of the material approaches its Debye temperature. Using the measured spectra at $T = 400$ K and assuming Umklapp scattering as the dominant scattering mechanism, k_{univ} was found to exist in GaAs, GaN, and Si after normalizing the phonon MFP. The existence of k_{univ} suggests that the phonon MFP spectrum is a universal feature of matter in the high temperature limit, and can be used to predict k_{accum} for any crystalline semiconductor near its Debye temperature.

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