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Thermal Conductivity Minima in Superlattices and Localization-like Phenomena[1] RAMA VENKATASUBRAMANIAN, RTI International — It is becoming clear in many 2-dimensional superlattice (SL) material systems that there exists a minimum lattice thermal conductivity for an optimal SL period. These have been first observed and reported in the Bi_2Te_3/Sb_2Te_3, PbTe/PbTeSe and Si/Ge SL systems by us in RTI. These minima become evident when the electronic thermal conductivity, using Lorentz parameter, is subtracted from the total thermal conductivity to monitor the lattice thermal conductivity as a function of SL period. The basis for the numerical value of Lorentz parameter, observed from many facets of material and device characteristics, will be presented. Such a lattice thermal conductivity minimum has also been recently observed in other SL material systems. Recently, a similar behavior has also been observed in the thermal conductivity of superlattices embedded with an ordered array of nanoparticles. We will explore the commonality of these results in terms of a localization-like behavior for phonons. The arguments for the complex relationship between the SL period and the low-frequency cut-off wavelength, traceable to a cut-off frequency originating from diffusive transport of a temperature wave, will be presented. The physics behind what triggers the localization-like phenomena of phonons in such nanostructures will be discussed.

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