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Phonon impedance matching: minimizing interfacial thermal resistance of thin films[1] CARLOS POLANCO, JINGJIE ZHANG, AVIK GHOSH, University of Virginia — The challenge to minimize interfacial thermal resistance is to allow a broad band spectrum of phonons, with non-linear dispersion and well defined translational and rotational symmetries, to cross the interface. We explain how to minimize this resistance using a frequency dependent broadening matrix that generalizes the notion of acoustic impedance to the whole phonon spectrum including symmetries. We show how to "match" two given materials by joining them with a single atomic layer, with a multilayer material and with a graded superlattice. Atomic layer "matching" requires a layer with a mass close to the arithmetic mean (or spring constant close to the harmonic mean) to favor high frequency phonon transmission. For multilayer "matching," we want a material with a broadening close to the geometric mean to maximize transmission peaks. For graded superlattices, a continuous sequence of geometric means translates to an exponentially varying broadening that generates a wide-band antireflection coating for both the coherent and incoherent limits. Our results are supported by "first principles" calculations of thermal conductance for $GaAs/Ga_xAl_{1-x}As/AlAs$ thin films using the Non-Equilibrium Greens Function formalism coupled with Density Functional Perturbation Theory.

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