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Thermal conductivity reduction in self-assembled lamellar materials with randomly oriented grains CHRIS DAMES, FAN YANG, UC Riverside, Mechanical Engineering — Bulk-scale thermoelectric materials with nanometer-scale lamellae (e.g. PbTe / Sb2Te3) can be prepared by rapid solidification [Ikeda et al., Chem. Mater. 19, 763 (2007)]. These materials contain numerous randomly oriented grains, each of which contains multiple lamellar periods and therefore can be modeled as a small superlattice. We develop a frequency-dependent Boltzmann Transport Equation (BTE) to calculate the anisotropic thermal conductivity tensor of a single grain. Then the effective isotropic thermal conductivity of the macroscopic material is obtained using an analytical averaging rule that is verified by finite element methods. The results reveal that the macroscopic thermal conductivity is best understood as dominated by the physics of heat conduction in parallel (rather than series), and that further efforts to reduce the effective conductivity should focus on reducing the in-plane (rather than cross-plane) component of the superlattice thermal conductivity tensor within each grain.

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