Talk

Strategies for Engineering Complex Thermoelectric Materials

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Strategies for Engineering Complex Thermoelectric MaterialsThermoelectric (TE) energy conversion is widely studied for its potential to produce electricity from waste heat or provide cooling without the use of harmful refrigerants. There are a number of common strategies used to engineer higher thermoelectric figure of merit, zT, in complex materials. Because the properties that make up zT are all interrelated, the improvement of thermoelectric materials is best guided by the thermoelectric Quality Factor B, proportional to the weighted mobility, μW, and lattice thermal conductivity, κL, as $B \sim \mu W/\kappa L$. The weighted mobility is a better measure of the relevant electronic properties than the power factor because it is a constant material property. Strategies to reduce κL, must not significantly reduce μW for there to be a net improvement in B and therefore zT.The weighted mobility, μW, is related to the mobility measured by the Hall effect and density of electronic states measured by the Seebeck effective mass m^*. This can be used to identify high band degeneracy and band convergence which is known to lead to high B and zT with examples of $zT > 1$ found in PbTe, GeTe, and MgSb.In this context, we review the common strategies of nanostructuring, band engineering, doping and alloying, using the more recently specified strategies of full spectrum phonon scattering and phonon softening, increasing band convergence and reducing inertial effective mass; while at the same time, phase boundary mapping to engineer dopants and avoiding excessive grain boundary electrical resistance. Finally the method to easily calculate device ZT will be introduced to accurately compare the maximum efficiency of a new material with others in a thermoelectric device.

Tuesday, April 12, 2022 11:00am - 12:00pm

Big Seminar Room B - Sunstone Building

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