Thermoelectric Transport in Nanocomposites

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Energy transport in nanostructures differs significantly from that in macrostructures because of classical and quantum size effects on energy carriers. Nanostructure-based materials such as superlattices have shown significant increases in thermoelectric figure-of-merit ZT compared to their bulk counterparts, mainly due to the reduced phonon thermal conductivity of these structures. Materials with a large ZT can be used to develop efficient solid-state devices that convert waste heat into electricity. Superlattices grown by thin-film deposition techniques, however, are not suitable for large scale applications. Nanocomposites represent one approach that can lead to high ZT through both thermal conductivity reduction and possibly low energy electron filtering. This paper presents theoretical studies on thermoelectric properties (thermal conductivity, the Seebeck coefficient, and electrical conductivity) in semiconducting nanocomposites, aiming at developing high efficiency thermoelectric energy conversion materials. The modeling results are compared to recent progress in experimental data.