Recent Advances in High Performance Thermoelectrics based on Indium Filled Skutterudites

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Abstract

Synthesis and thermoelectric properties of indium filled M_4Sb_{12} (M = Co, Rh) skutterudites are reported. The location of the indium atoms in the oversized void-sites was verified by their unusually large thermal displacement parameters resulted from rattling motion. The indium solubility limit in the M_4Sb_{12} cages was found to be close to 0.2. Indium-filled Co skutterudites are *n*-type and showed thermoelectric figure of merit, ZT > 1 at 600K. $In_xRh_4Sb_{12}$ samples exhibited semiconducting behavior and produced a striking sign change in the Seebeck coefficients around 400K. The ZTs of Indium filled Rh skutterudites are not as competitive as the isostructural $In_xCo_4Sb_{12}$ due to relatively high thermal conductivities and fairly low Seebeck coefficients in the presence of two types of charge carriers.

We also report on the synthesis and thermoelectric properties of bulk thermoelectric nanocomposites produced from polycrystalline void-site filled $In_xCo_4Sb_{12}$ skutterudites. The bulk nanocomposites exhibit marked reduction in thermal conductivity compared to nanoinclusion-free $In_xCo_4Sb_{12}$. We provide unequivocal evidence demonstrating that the InSb nanoinclusions are seeded by indium atoms diffusing *from* the icosahedral void-site. This discovery clarifies the source of the InSb nanoinclusions in high ZT double and triple-filled indium based antimonide skutterudites, and is expected to produce exceptional ZT's when applied to optimally doped indium-filled skutterudites.