Structure and transport properties of nanostructured alloys of the novel thermoelectric material SnSe

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Abstract

Single crystals of the orthorhombic semiconductor SnSe, was identified in 2014 as a mid-temperature thermoelectric material with record high figure of merit with high power factor and surprisingly low thermal conductivity. We have studied polycrystals of various alloys of SnSe prepared by arc-melting, a rapid synthesis that results in strongly nanostructured samples with low thermal conductivity – advantageous for thermoelectricity. The nanostructuring appears on various length scales: the sample consists of tens-of-nm thick crystalline platelets, and these in turn show structural inhomogeneities down to the ~2nm scale. The thermal conductivity reaches the amorphous limit, with values around 0.3-0.5 W/mK. The Seebeck coefficient of some Ge-alloyed SnSe is record high, reaching 1000 µV/K. The electrical conductivity of pure SnSe and alloys with Ge, Sb, In or Pb is rather low, but alloying with transition metals such as Cu, Ag, Nb or Au provides a means to optimize the power factor.


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