"Nanocomposites and nanomaterials"

Thermoelectric of composites on the base of PbTe with nanoinclusions

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Lead telluride is promising semiconductor material for thermoelectric energy conversion in medium temperature range (500–850) K.

The efficiency of thermoelectric materials is determined by dimensionless figure of merit $ZT = S^2\sigma T/\chi$ (S – Seebeck efficient, σ – specific electrical conductivity, χ – efficient of heat conductivity, T – temperature).

Thus, prerequisite to improve the efficiency of thermoelectric materials is modification of features that will change the phonon and electronic structures to lower of thermal conductivity (χ) and increase both of the Seebeck coefficient (S), and specific conductivity (σ).

Now, in thermoelectric material science use two methods to improve the thermoelectric figure of merit Z: (1) transition to materials with low dimensionality (2D-, 1D-and 0D-structure) [1], or (2) creation of new composite materials [2].

The method is proposed of increasing the value of electrical conductivity (σ) through formation on the surface of composite grains nanoinclusions formed from silver nanoparticles. This technique improves the contact between individual polycrystalline particles, which reduces the electrical resistance and, consequently, to an increase in the electrical conductivity (σ). The phonon scattering, which is carried through the entire volume of the structure (composite), leads to an additional reduction of scattering and thermal conductivity (χ).

Synthesis of solid solutions was performed by allowing in quartz ampoule evacuated to pressure of $2\cdot10^{-4}$ Pa. The initial components used purified Pb and Te. Preparation of thermoelectric composite process involves grinding the ingot pre-synthesized material into separate factions.

Colloidal silver nanoparticles were received by method of photo-stimulated reduction of Argentum ions with form of decahedral shape of nanoparticles stabilized by poly-acrylic acid [3]. And, the photochemical effect was carried out at wavelength of 470 nm, which corresponds to the transverse plasmon resonance of the particles of decahedral shape. As result of TEM showed that the obtained nanomaterials are decahedral flat structures with transverse diameter of 50 nm and height of 30-40 nm.

In prepared PbTe powder was added 1 (or 2) ml of the colloidal solution of silver nanodecahedres [Ag] - 0,4 mg/ml before pressing. And, after adding of the suspension of colloidal silver the sample homogenized by ultrasound and dried with periodically homogenizing using ultrasound up to constant mass. The resulting materials compact by pressing followed by annealing.

For such material the Seebeck coefficient increase for the region of strong degeneracy due to carrier selection for energy barriers both within the crystallite core matrix and nanoinclusions, or on grain boundaries, which is especially effective for composite material. The influence on middle-length wave phonons exist after varying the technology for colloidal silver, as well as technology of the composite formation, which leads to increase the thermoelectric figure of merit.

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