Thermoelectric properties of the nanotextured semiconductor $Bi_{1-x}Sb_x$ foils and wires

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In this work structural characteristics, thermoelectric properties of nanotextured semiconductor $Bi_{1-x}Sb_x$ foils [1] and single- crystal wires are investigated. The comprehensive investigation of the temperature dependences of the thermoelectric power $\alpha(T)$, the resistivity $\rho(T)$, and the thermal conductivity $\chi(T)$ of nano-, micro- textured foils and single-crystalline wires different diameters (from 100 nm) on the basis of semiconductor $Bi_{1-x}Sb_x$ alloys was carried out. It was found that the thermal conductivity on the semiconductor Bi–16at%Sb foils is on one order of magnitude lower than in bulk samples of a similar composition. This is related to an increase in the scattering of phonons at the surface and grain boundaries and leads to an increase in the thermoelectric efficiency in the temperature region of 100–200 K.
It is established that the band gap in thin Bi–17at%Sb (d = 200 nm) semiconductor wires grows due to manifestation of the quantum- size effect in the region of 300-100 K and a decrease in the resistivity (at 100-4.2 K) is detected due to manifestation of the topological insulator properties. That proves by the Shubnikov de Haas oscillations in transverse and longitudinal magnetic field. It is shown that a decrease in the wire diameter d of the $Bi_{1-x}Sb_x$ semiconductor alloys leads to an increase in the power factor at 100-200K.

[1] A. V. Demidchik and V. G. Shepelevich, Inorg. Mater. 40, 391 (2004).

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