# Shubnikov- de Haas effect and thermoelectric properties layer and wires

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Thermoelectric devices have been attracting attention because of their ability to convert to electricity.
The most widely used commercial thermoelectric material is bulk $Bi_2Te_3$ and its alloys with Sb, Se, and so on, which have $ZT=S^2T/\rho k\approx 1$, where S, ρ, k and T are the Seebeck coefficient, electrical resistivity, thermal conductivity and absolute temperature, respectively. It is difficult to scale bulk $Bi_2Te_3$ to large-scale energy conversion, but fabricating synthetic nanostructures for his purpose is even more difficult and expensive.
The advent of the topological insulator and the emerging micro- and nanotechnology open a new way to design high- performance thermoelectric device [1, 2].
Here we present the investigations the thermoelectric properties and Shubnikov de Haas oscillations in longitudinal and transverse magnetic field of the $Bi_2Te_3$ wires and layers on temperature range 2.1-300 K. $Bi_2Te_3$ microwires in glass coating were prepared by the Ulitovsky-Teilor method [3]. X-ray studies showed that the plane of the layers was perpendicular to the $C_3$ trigonal axis. Single crystal of $Bi_2Te_3$ layers were fabricated using the mechanical exfoliate method by cleaving thin (10-20 μm) layer from bulk monocrystaline $Bi_2Te_3$ samples.
We observed the Shubnikov- de Haas oscillations arising from the surface states in wires and layers of $Bi_2Te_3$ n- and p- type. The quantum mobilities ($\mu_Q$= 20 000 $cm^2$ per volt second) determined from Shubnikov de Haas oscillations in longitudinal magnetic field in n- type layers is substantially higher than in the bulk crystals [ ].
The temperature dependences of the electrical resistivity ρ(T) and Seebeck coefficient α(T) of the $Bi_2Te_3$ micro wires and layers were measured at temperature range 4.2- 300 K.
An analysis of the experimental data on the thermoelectric efficiency $ZT = \alpha^2\sigma(T)\chi$ taking into account the fact that the thermal conductivity χ in bulk $Bi_2Te_3$ samples is $1*10^{-2}$ W/K*$cm^2$, and in the 0.7 $*10^{-2}$ W/K*$cm^2$ layers it is possible to estimate the thermoelectric efficiency ZT≈1.2 at 300 K for p-type wires, which is at the level of the maximum values of the power factor for the most advanced bulk n-type single crystals. According to [4], a decrease in the thickness of $Bi_2Te_3$ layers and wires diameters should lead to a more significant decrease in thermal conductivity, so we should expect an increase in ZT in $Bi_2Te_3$ layers and wires at thicknesses less than 1 μm.
The obtained results shed light on heat conduction in low- dimensional materials and may open up applications in thermal management of nanoelectronics [1, 5].

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