QUANTUM ELECTRICAL TRANSPORT PROPERTIES OF TOPOLOGICAL INSULATOR $Bi_{0.83}Sb_{0.17}$ NANOWIRES

Leonid KONOPKO[1], Albina NIKOLAEVA[1], Tito HUBER[2], Krzysztof ROGACKI[3]

[1]*Ghitu Institute of Electronic Engineering and Nanotechnologies, Chisinau, Moldova*
[2]*Howard University, 500 College St. N.W., Washington, DC 20059, USA*
[3]*Institute of Low Temperature and Structure Research, Academy of Sciences, Wroclaw, Poland*

*Corresponding author: Leonid Konopko, l.konopko@nano.asm.md

Recently a new class of insulator, namely, topological insulator (TI) [1], was proposed. A TI is a material with a bulk electronic excitation gap generated by the spin-orbit interaction, which is topologically distinct from an ordinary insulator. The strong topological insulator is predicted to have surface states whose Fermi surface encloses an odd number of Dirac points. This defines a topological metal surface phase, which is predicted to have novel electronic properties. The semiconducting alloy $Bi_{1-x}Sb_x$ is a strong topological insulator due to the inversion symmetry of bulk crystalline Bi and Sb . The transport properties of TI $Bi_{0.83}Sb_{0.17}$ nanowires were investigated earlier [2].

Here we report the observation of quantum oscillations of magnetoresistance arising from the surface states in topological insulator $Bi_{0.83}Sb_{0.17}$ nanowires. Single-crystal nanowire samples with diameters ranging from 75 nm to 1.1 μm are prepared by high-frequency liquid phase casting in a glass capillary. $Bi_{0.83}Sb_{0.17}$ is a narrow-gap semiconductor with an energy gap at the L point of the Brillouin zone, ΔE = 21 meV**.**

We study the magnetoresistance (MR) of $Bi_{0.83}Sb_{0.17}$ nanowires at various magnetic field orientations. Shubnikov-de Haas (SdH) oscillations are observed in nanowires with diameter d = 200 nm at T = 1.5 K and 3 K; this fact indicates the existence of high-mobility ($\mu_S \approx 30000$ $cm^2V^{-1}s^{-1}$) two-dimensional (2D) carriers in the surface areas of the nanowires, which are nearly perpendicular to the C_3 axis. In thin nanowires ($d \leq 100$ nm) at low temperatures (1.5 K $\leq T <$ 5 K), we discovered the Aharonov–Bohm (AB) [3,4] oscillations of longitudinal MR with two periods, namely one flux quantum, Φ_0 and half of flux quantum, $\Phi_0/2$, ($\Delta B_1 = \Phi_0/S$, $\Delta B_2 = \Phi_0/2S$, where S is the cross-sectional area of the nanowire).

The periods ΔB of AB oscillations depend on slope α of the magnetic field direction according to the law $\Delta B = \Delta B_{parallel}/\cos\alpha$. This law is preserved up to angles of about 60^o. The nonmonotonic changes of magnetoresistance, which are equidistant in a direct magnetic field, were observed in transverse magnetic fields under conditions where the magnetic flux through the cylinder Φ = 0. Possible causes of this behaviour by analogy with thin bismuth nanowires are discussed.

Keywords: *topological insulator, Bi-Sb, quantum size effect, Shubnikov-de Haas oscillation, Aharonov-Bohm effect.*

References

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