physica status solidi a — applications and materials science

2014, Volume 211, Number 6, pag. 1325-1328

Temperature and magnetic dependence of the resistance and thermopower in the topological insulator Bi1−xSbx nanowires

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https://doi.org/10.1002/pssa.201300189

Abstract

We report on the electrical transport and thermoelectric properties of Bi1−xSbx nanowires in the semiconductor region made of Bi1−xSbx. Such alloys are classified as topological insulators. The individual Bi−17 at\%Sb wires in a glass capillary with diameters ranging from 100 to 1000 nm were prepared by high-frequency liquid-phase casting in an argon atmosphere. They were cylindrical single crystals with (1011) orientation along the wire axis. For large-diameter wires we observed that the temperature-dependent resistance, R(T), displays the temperature-activated dependence that is expected of semiconductors. We also found that small-diameter wires at low temperatures show a sharp deviation from the behavior of the resistance R(T), characteristic of semiconductors. The contrasting behavior of wires of different diameters can be interpreted in terms of the conductance of the surface states in BiSb where the surface states arise through a spin-orbital Rashba interaction in the surface of BiSb. The thermopower remains negative over the entire temperature range, but it is strongly temperature dependent. The longitudinal magnetoresistance R(H) at low temperature shows quantum Shubnikov–de Haas oscillations only in thin (d < 200 nm) Bi−17 at\%Sb nanowires. Only high-mobility carriers display SdH oscillations. Since we expect the electronic transport in the 200-nm semiconducting Bi1−xSbx

nanowires to be dominated by the surface, this indicates that the surface states have sufficiently high mobility to display SdH.

Keywords: nanowires, topological insulators, glass capillars, cylindrical single crystals

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