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Semimetal-Semiconductor Transitions in Semimetal Bismuth-Antimony Nanowires Induced by Size Quantization, Strain, and Magnetic Field

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Abstract

In this work, we study glass-coated single-crystal Bi98Sb02 wires obtained by liquid phase casting.

Semimetal Bi98Sb02 nanowires exhibited a “semiconductor” behavior of the temperature dependence R(T) for wire diameters <400 nm, which is significantly higher than the critical diameter (70 nm) for similar dependences R(T) of pure bismuth nanowires. The thermopower sign reversal in the temperature dependence α(T) was found to depend on the wire diameter d. The effect is interpreted in terms of manifestation of the quantum size effect, based on the appearance a new scattering channel stimulated by fluctuations in the diameter d.

The effect of negative magnetoresistance in a perpendicular magnetic field was observed for the first time both at H || C3 and H || C2 in magnetic fields of 1 T.

It is shown that a semimetal-semiconductor transition can be controlled using an elastic strain and a strong magnetic field, which lead to a significant shift of the band boundaries of the energy extrema in the bands.

Keywords: glass-coated single-crystals wires, liquid phase casting, semimetal nanowires, bismuth nanowires, magnetic fields

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