MIPT Conference & International School

“Superconducting hybrid nanostructures: physics and application”

September 19-26

МФТИ

Argonne NATIONAL LABORATORY

РНФ Российский научный фонд

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SPECS™

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General Information

The Conference will cover a broad spectrum of topics in nanodevices, nanostructured materials and hybrid structures and will be held at the moscow Institute of Physics and Technology, Dolgoprudny.

The Scientific program will last from September 19 till September 23.

The School for young scientists will be held from September 24 to 26.

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Quantum size phenomena in bismuth nanostructures

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Size-dependent quantization of energy spectrum of conducting electrons in solids leads to oscillating dependence of electronic properties on corresponding dimension(s) [1]. In conventional metals with typical energy Fermi E_F~1 eV and the charge carrier's effective masses m* of the order of free electron mass m_0, the quantum size phenomena provide noticeable impact only at nanometer scales. Here we experimentally demonstrate that in single-crystalline semimetal bismuth nanostructures the electronic conductivity non-monotonously decreases with reduction of the effective diameter (Fig.1). In samples grown along the particular crystallographic orientation the electronic conductivity abruptly increases at scales of about 50 nm due to metal-to-insulator transition mediated by the quantum confinement effect. The experimental findings are in reasonable agreement with theory predictions. The quantum-size phenomena should be taken into consideration to optimize operation of the next generation of ultra-small quantum nanoelectronic circuits.

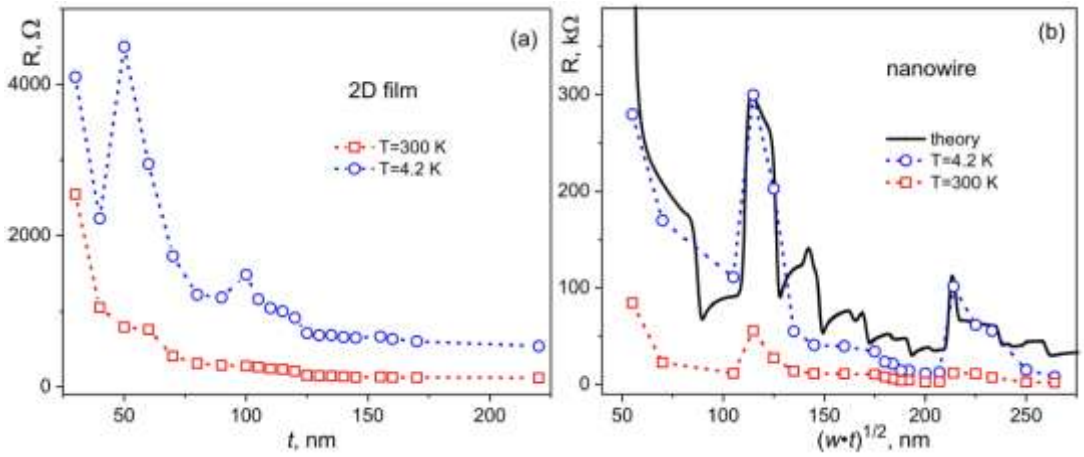

Fig. 1: (a) Typical dependence of co-deposited wide 2D bismuth film resistance *R* on thickness *t*; (b) Dependence of *L*=600 nm bismuth nanowire resistance *R* on effective diameter $d_{eff}=(w\cdot t)^{1/2}$. Theory fit (solid line) assumes trigonal axis C3 being perpendicular to the sample plane and ~3 degree misorientation angle between the sample axis and the crystallographic bisectrix axis C2.

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[1] Tringides, M. C., Jatochowski, M., and Bauer, E. ***Phys. Today***, 60, 50 (2007).