MAGNETOTRANSPORT PROPERTIES OF BISMUTH WIRES BELOW 25 K

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In this paper we report on magnetotransport measurements of single crystalline bismuth wires at high magnetic fields and low temperatures. These investigations are motivated in part by the unusual electronic properties of the semimetal bismuth that reflect its unique location in an intermediate position between good metals and semiconductors and present the fundamental and practical interest.

Measurements of the magnetoresistance (MR) and magnetothermopower (Seebeck coefficient) in the range of magnetic field up o 20 T reveal a various behavior of quantum oscillations for the different values of temperatures that persist from 4.2 to 25 K. Observed Shubnikov-de Haas oscillations exhibit anomalies in their amplitude up to 15 T which deviates from the conventional Lifshitz-Kosevich behavior below the magnetic ordering temperature and around 20 K. The latter, which has so far not been observed, suggests a field- and temperature-induced electronic structure transition.

Thermopower (S) of the 1.1 μm wire with high resistance residual ratio (R(300K)/R(4.2K) = 30) exhibits a non-linear temperature dependence with $\partial S/\partial T < 0$ at B = 0 (Figure 1(b)). In standard low-temperature measurements of bulk Bi crystals such behaviour is associated with the phonon drag effect that dominates the total thermopower of being the sum of diffusion (Sd) and phonon drag term (Sg) at liquid helium temperature. The phonon-drag effect ($S \propto 1/T$) has been observed in the set of Bi wires a higher crystalline perfection as compared with submicron nanowires with low resistance residual ratio (Figure 1(a)).

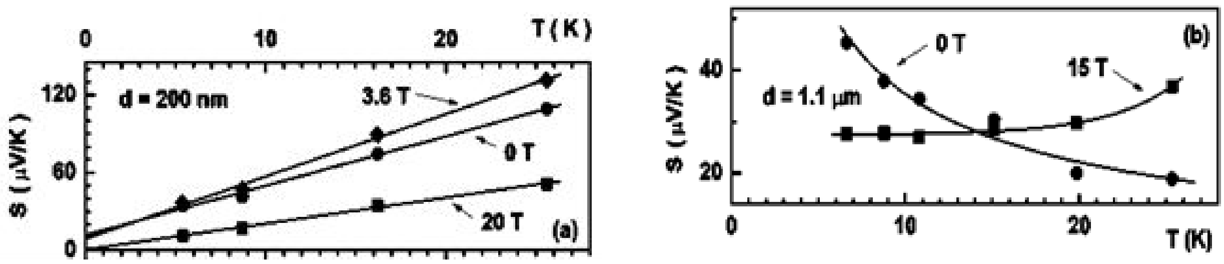

Figure 1. Dependence of the thermopower with temperature at various values of longitudinal magnetic field for the submicron nanowire (200 nm) (a) and 1.1 μm wire (b).

As shown in figure 1(b), the curves of temperature dependence S(T) have different shapes at magnetic field of B = 0 and 15 T. The observed change from $\partial S/\partial T < 0$ to $\partial S/\partial T > 0$ suggests that increasing the magnetic field enhances the relative contribution of the diffusion TEP and decreases the phonon drag contribution.

We provide a thorough analysis of the different samples, highlighting the importance of sample quality for elucidating details in the transport behavior.

ACKNOWLEDGMENTS: The study was supported by the Project "Nanostructures and advanced materials for implementation in spintronics, thermoelectricity and optoelectronics" no. 020201.