Electronic transport and optical properties of WTe_2 single crystal

V.V. Marchenkov,[1,2] A.N. Domozhirova,[1] S.V. Naumov,[1] A.A. Makhnev,[1] E.I. Shreder,[1] S.M. Podgornykh,[1] E.B. Marchenkova,[1] V.V. Chistyakov,[1] and J.C.A. Huang[3]

[1]*M.N. Mikheev Institute of Metal Physics, UB RAS, 620108 Ekaterinburg, Russia*

[2]*Ural Federal University, 620002 Ekaterinburg, Russia*

[3]*National Cheng Kung University, 70101 Tainan, Taiwan*

Layered transition metal dichalcogenides (TMDs) attract a lot of attention due to their diverse properties and are considered to be promising materials for optoelectronics, nanoelectronics, and spintronics. TMD WTe_2 is known to be a type-II topological Weyl semimetal. Non-trivial topology of the electronic band structure of these materials causes intriguing electronic properties such as non-saturating extremely large magnetoresistance, ultrahigh current carrier mobility, etc. The purpose of this work is a comprehensive study of the electronic transport and optical properties of WTe_2. WTe_2 single crystals were grown by the chemical vapour transport method. Electrical resistivity, magnetoresistivity, and Hall Effect were measured in the temperature range from 2 K to 300 K in magnetic fields of up to 9 T. Since WTe_2 has a layered structure, the electronic transport properties are anisotropic. Therefore, the measurements were carried out when an electric current flowed in the $(00l)$ plane of the sample, and then perpendicular to it; a magnetic field was directed perpendicular to it. The optical properties were measured by the Beattie method in the spectral range of 0.2–5.0 eV at room temperature. The temperature dependence of the electrical resistivity has a “metallic” type. Whereas the applied magnetic field causes a “turn on” effect at low temperatures, that is a minimum in the temperature dependence of the resistivity, the temperature of which rises in higher fields. At this minimum, it is assumed that the mean free path l is equal to the Larmor radius r_H. This allows us to estimate the value of l. The magnetoresistivity is observed to increase with a magnetic field according to the quadratic law, which is caused by the compensation of charge carriers in WTe_2. Their concentration and mobility were determined from Hall Effect measurements. Optical studies did not reveal features characteristic of metals. The optical conductivity spectrum is found to be a broad band, formed by interband transitions. The presence of peaks in the infrared region indicates the formation of low-energy gaps in the band spectrum of WTe_2. The optical characteristics are in good agreement with the data on electronic transport at room temperature.

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