Charge Transfer in Thallium Monosulfide Single Crystals

Solmaz Mustafaeva [C, S]
Institute of Physics, National Academy of Sciences, Baku, Azerbaijan

Thallium monosulfide TlS is a III–VI semiconductor compound. It crystallizes in various structures, in particular, in a tetragonal structure of the TlSe type and a monoclinic structure (structural analog of TlGaSe2) [1]. In [2], the electrical and dielectric properties of layered monoclinic TlS single crystals were measured in the vicinity of high-temperature phase transitions. However, no data are available on their low-temperature conduction. The aim of this work is to study the charge transfer in layered monoclinic TlS single crystals at low temperatures and to establish the conduction mechanism. TlS single crystals were grown, using the slow cooling method, from a melt with excess sulfur (4 at. %) with respect to the stoichiometric compound [2]. The grown TlS single crystals have a monoclinic structure (space group C62h) and the following lattice parameters: a = 10.90, b = 10.94, c = 15.18 Å. It is revealed that TlS single crystals exhibit a variable range hopping conduction along a normal to their natural layers at temperatures $T \leq 230$ K in a dc electric field and nonactivated hopping conduction at low temperatures in strong electric fields. Estimates are made for the density of states near the Fermi level and their energy spread (W = 0.02 eV), the localization radius (a = 33 Å), the average jump distance in the region of activated (Rav(T) = 40 Å) and nonactivated (Rav(F) = 78 Å) hopping conduction, and also the drop in the charge carrier potential energy along the jump distance in an electric field F: eFR = 0.006 - 0.009 eV .

[1]. S.Kashida and K.Nakamura. J.Solid State Chem. 110, 264 (1994)
[2]. V.P.Aliev, Sh.G.Gasimov, T.G.Mammadov, Phys. Solid State 48(12), 2233 (2006)