# Space Charge Limited Currents in $TlInS_2$ Single Crystal at Different Temperatures

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Current injection was studied in a high-resistive layer $TlInS_2$ single crystal at a temperature interval (293-381) K. $TlInS_2$ samples formed flat capacitors whose plane was perpendicular to the crystalline C-axis. The capacitor plate area was $(4\text{-}6)\cdot10^{-2}cm^2$. Ohmic contacts of samples are made by Ag paste.

The current-voltage characteristics of the Ag – $TlInS_2$ – Ag system at different temperatures from 293 to 381 K involve linear portions ($I\sim V$) that transform into quadratic portions ($I\sim V^2$). At 293 K the current-voltage characteristic is characterized with superlinear portion ($I\sim V^{6.5}$) after the quadratic portion. The experimental results obtained in this study were interpreted within the Lampert theory for an electric current limited by space charge. An important feature of current limited by space charge is that the electric charge in this case cannot exceed the quantity $C_gV$, where $C_g$ is the geometric capacitance of the sample and V is the voltage imposed across the sample. For the samples studied in the present work, the geometric capacitance was estimated at $\sim10^{-12}$ F. The maximum voltage across the sample amounted to 150 Volts. This means that the greatest possible charge Q accumulated in the system Ag – $TlInS_2$ – Ag is equal to $1.5\cdot10^{-10}$ C. The charge per unit area $Q_{max}$ allowed to be transported by space charge limitations is $3.75\cdot10^{-9}$ C/cm$^2$.

From obtained experimental results on study of current injection, the following parameters of the $TlInS_2$ single crystal were determined: equilibrium concentration of charge carriers in allowed zone ($p_0$), concentration of traps ($N_t$), capture factor ($\theta$), mobility of charge carriers ($\mu$), and the depth of trap level responsible for injection current ($E_t$). For example, at $T = 293$ K, $p_0 = 1.67\cdot10^{10}$ cm$^{-3}$; $N_t = 10^{12}$ cm$^{-3}$, $\theta = 0.17$, $\mu = 3.3\cdot10^{-3}$ cm$^2$/V·s, and $E_t = 0.44$ eV. The level with activation energy ~ 0.4 eV was estimated also from the temperature dependence of Ohmic conductivity and from photocurrent spectra of the $TlInS_2$ single crystal.