Magnetic, kinetic, optical properties and band parameters of crystals $Cu_2ZnSnSe_2Te_2$

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Investigation magnetic properties of $Cu_2ZnSnSe_2Te_2$ crystals performed by method Faraday method Faraday in the temperature range T = 290 - 330 K and magnetic field H = 0.25 - 4 kOe. Samples crystals $Cu_2ZnSnTe_4$ - diamagnetic: $\chi \approx (-0{,}2) \times 10^{-6}$ cm^3/g.

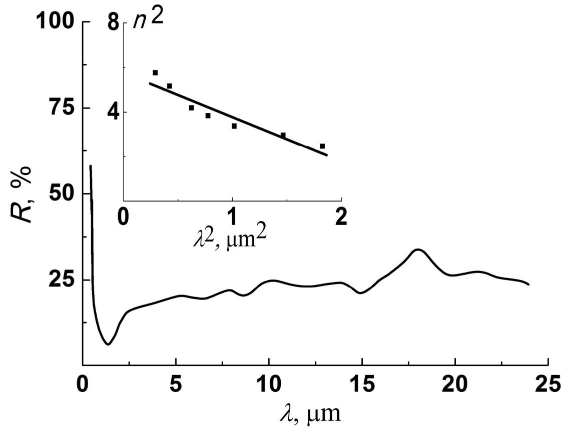
Crystals $Cu_2ZnSnSe_2Te_2$ have n-type conductivity, Hall coefficient (R_H) of the crystals is essentially temperature independent, which points to electron gas degeneracy, electron mobility decreases with increasing temperature, indicating predominance of charge carriers in thermal vibrations of the crystal lattice. In Table. 1 shows some kinetic parameters and concentration of electrons for samples $Cu_2ZnSnSe_2Te_2$.

$Cu_2ZnSnSe_2Te_2$	n, cm $^{-3}$	σ, S/cm	μ, cm^2/(V· s)	α, μV/K
T = 290 K	$4{,}5{\cdot}10^{19}$	610	85	-7,5
T = 320 K	$4{,}5{\cdot}10^{19}$	580	80	-
T = 340 K	$4{,}5{\cdot}10^{19}$	560	78	-

Taking into account the degeneracy of the electron gas in the $Cu_2ZnSnSe_2Te_2$ crystals (T = 300 K), the spherical symmetry of the constant energy surface for charge carriers, and the nonparabolic dispersion relation and using the values of σ, R_H, α(0), and Δα (determined from the averaged experimental dependences σ = $f(T)$, R_H = $f(T)$, α(0) = $f(T)$, and $\Delta\alpha = \alpha(H) - \alpha(0) = f(T)$, where $\alpha(0)$ and $\alpha(H)$, α_∞, R_∞ are the ther mopower coefficients in magnetic fields of H = 0 and 5 kOe) we calculated the electron effective masses at the Fermi level m^*_ξ, the room temperature 300 K by the relation (1), (2).

$$m^*_\xi = \frac{e\cdot\hbar^2}{k_Б^2 T}\cdot\frac{3}{\pi}\cdot\frac{1}{e\cdot R_\infty}\cdot\alpha_\infty \quad (1); \qquad m^*_\xi = \frac{\alpha(0)\cdot(3\cdot\pi^2\cdot n)^{2/3}\cdot e\cdot\hbar^2}{T\cdot(1+\gamma_r)\cdot k_Б^2\cdot\pi^2} \quad (2).$$

Electrons and holes form plasma in the semiconductor crystal. One of the plasma properties is its tendency to conserve the electroneutrality at each point of the crystal. If the electroneutrality is broken, the charged particles start to oscillate with a certain characteristic plasma frequency (ω). The natural plasma oscillations caused the absorption of electromagnetic radiation irrespective of the mechanism of free charge carrier scattering. This is manifested through a decrease in the reflection coefficient in the vicinity of the plasma frequency (the plasma minimum) (Fig. 1), which makes it possible to construct the spectral dependence of the refractive index (Fig. 1 inset). Using the relation (3) we can determine the effective mass of the electrons at the Fermi level:



$$m^*_\xi = \frac{e^2 N}{4\pi^2 c^2 \varepsilon_0}\cdot\frac{\lambda^2_{\min}}{\varepsilon_\infty - 1 + 4R_{\min}} \quad (3)$$

	Relation 1	Relation 2	Relation 3
m^*_ξ/m_0	0,028	0,035	0,015

In Table 2 shows the values of the effective masses of electrons at the Fermi level by different methods.