THE OPTICAL STUDY OF InSb–In_2GeTe SOLID SOLUTIONS

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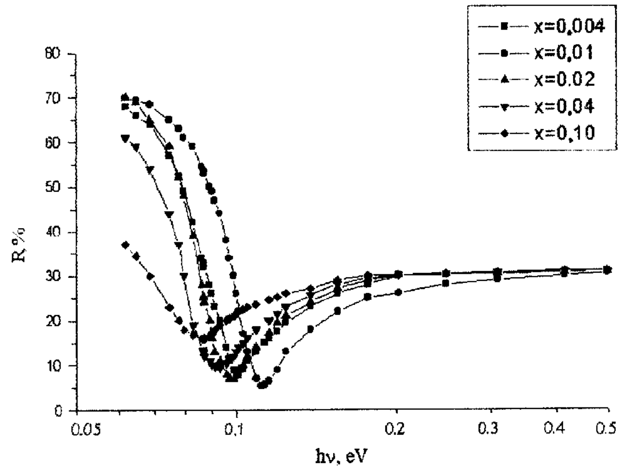
The optical reflection and absorption spectra are studied in the $(2InSb)_{1-x}(In_2GeTe)_x$ system. It is revealed that the dispersion law of electrons corresponds to the Keyn's model. The additional absorption and the peak which are observed in the absorption spectra are connected with the existence of a located level caused by the impurity of tellurium that is placed above the bottom of the conduction band.

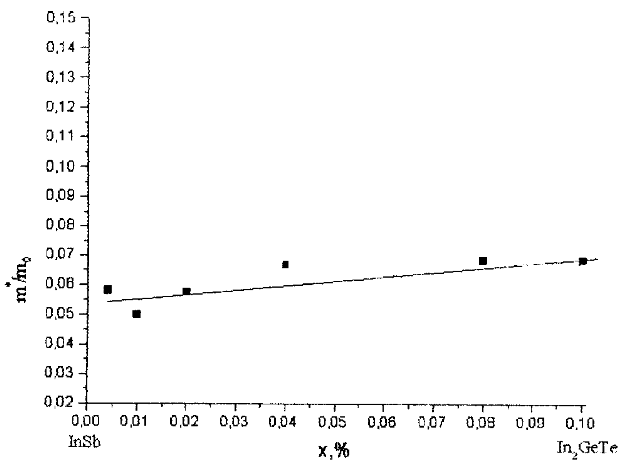
The physical chemical investigations of the $(2InSb)_{1-x}(In_2GeTe)_x$ system have shown that the hypothetical 'ternary compounds“ of In_2GeTe are dissolved up to $x = 0.1$ in InSb and solid solutions are formed. In these systems, the second metastable phase is observed at $x \geq 0.12$ and it passes to a stable state at 1125 K with dissipation of heat [1]. The investigations of galvanomagnetic and electrical properties of these alloys have shown that the quasi-local levels are formed and they are placed above the bottom of the conduction band (0.21–0.19 eV) [2]. The existence of such a level can be confirmed by study of optical properties [3–6].

The optical investigations were carried out on $(2InSb)_{1-x}(In_2GeTe)_x$ polycrystalline specimens got by quenching from the melt and then annealed. The alloys have electron concentrations from $3 \cdot 10^{18}$ to $7 \cdot 10^{18}\ cm^{-3}$.

For reflectivity measurements, one of the parallel-plane surfaces of the alloys was polished by 2μm, 1μm diamond pastes and 0.5 μm alumina and taken on the mirror form. The specimens, after reflectivity measurements, were set on the NaCl parallel-plane crystals and were ground down and polished up to the thickness of $30 \div 40$ μm, then the NaCl crystals were dissolved in water. The thickness and plane-parallelism of the specimens were controlled by a MIM-8 microscope with an accuracy of 0.5 μm. The reflectivity and transmission measurements were carried out by a UR-20 spectrophotometer in the spectral range of $400 \div 4000\ cm^{-1}$ ($2 \div 25$ μm). In

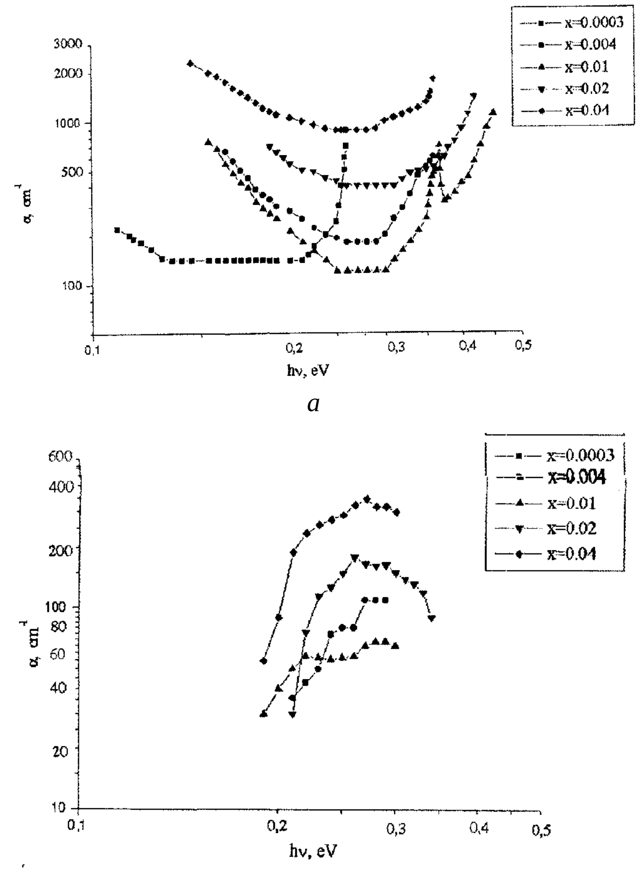


a



b

Fig. 1. *a* – reflection spectra of $(2InSb)_{1-x}(In_2GeTe)_x$, *b* – content dependence of the electron effective mass of $(2InSb)_{1-x}(In_2GeTe)_x$



a

b

Fig. 2. Optical (*a*) and additional absorption spectra (*b*) of $(2InSb)_{1-x}(In_2GeTe)_x$

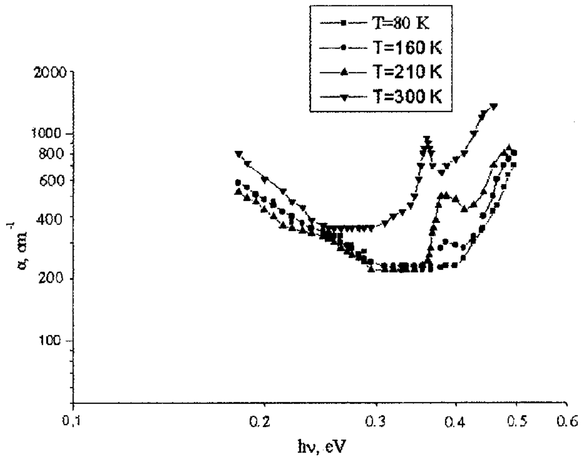


Fig. 3. Optical absorption spectra of $(2InSb)_{1-x}(In_2GeTe)_x$ ($x = 0.012$) at various temperatures

order to determine the relative reflectivity, LOMO firm (St. Peterburg) aluminized mirror glasses (0.975 reflectivity) were used. The transmission measurements at low temperatures were made by a Specord-75 IR spectrophotometer. The measurements were carried out with the gap spectral width of $1 \div 2\ cm^{-1}$.

In the optical reflection spectra of $(2InSb)_{1-x}(In_2GeTe)_x$ ($x = 0.005$; 0.01; 0.02; 0.04; 0.08; 0.1) (Fig. 1,*a*), the plasma minima were observed, which were displaced to the short-wave range with increase of electron concentrations. The high frequency dielectric constant was obtained and the effective mass of electrons was calculated from the reflection spectra. In order to watch the change of the dependence of the effective mass on the content of alloys, it is necessary to consider them at the same energy level. Therefore, the values of the effective mass of electrons were given for concentration $n = 5 \cdot 10^{18}\ cm^{-3}$, and it was assumed that the dispersion law of electrons corresponds to Keyn's model [2, 7, 8]. The effective mass of electrons was not changed essentially with the increasing contents of In_2GeTe, as seen from Fig. 1,*b*.

The optical absorption spectra of $(2InSb)_{1-x}(In_2GeTe)_x$ at room temperature are shown in Fig. 2,*a*. The values of the optical energy gap were determined as extrapolated linear sites on the curve $K(h\nu)^2 = h\nu$. The change of the fundamental absorption front versus the content of alloys is established, which is connected with the electron concentration (i.e., is due to the Burstein effect) [9].

We note that the additional absorption in the wave length range from the side of fundamental absorption was appeared. The absorption value grows with increase of the In_2GeTe content in InSb. In addition, the sharp peak at an energy of 0.36 eV is observed against the background of the fundamental absorption for alloys at $x = 0.01$ and $x = 0.012$. In compounds with $x > 0.012$, the peak is not observed. Probably, it disappears on the great absorption background. However, there are distortions in the absorption spectra.

In Fig. 3, the absorption spectra have been shown at 80, 210, 300 K for $(2InSb)_{1-x}(In_2GeTe)_x$ ($x = 0.012$) specimens. We assume that the appeared peak and additional absorption (Fig. 2 and Fig. 3) are connected with the existence of a level caused by the impurity of tellurium. The high value of impurity absorption is due to that the transitions of the level-zone are direct and allowed. The impurity absorption spectra have a sharp red boundary (Fig. 2,*b*). The depth of the impurity bedding takes value from 0.21 eV up to 0.19 eV with increase of the content of the second component. The depth of impurity bedding is also displaced to the energy gap with rise of temperature.

Thus, the study of optical properties in $(2InSb_{1-x}(In_2GeTe)_x$ system has been shown that the level located above the bottom of the conduction band is formed.

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