FAR-INFRARED REFLECTIVITY OF $CdAs_2$-$ZnAs_2$ SOLID SOLUTION

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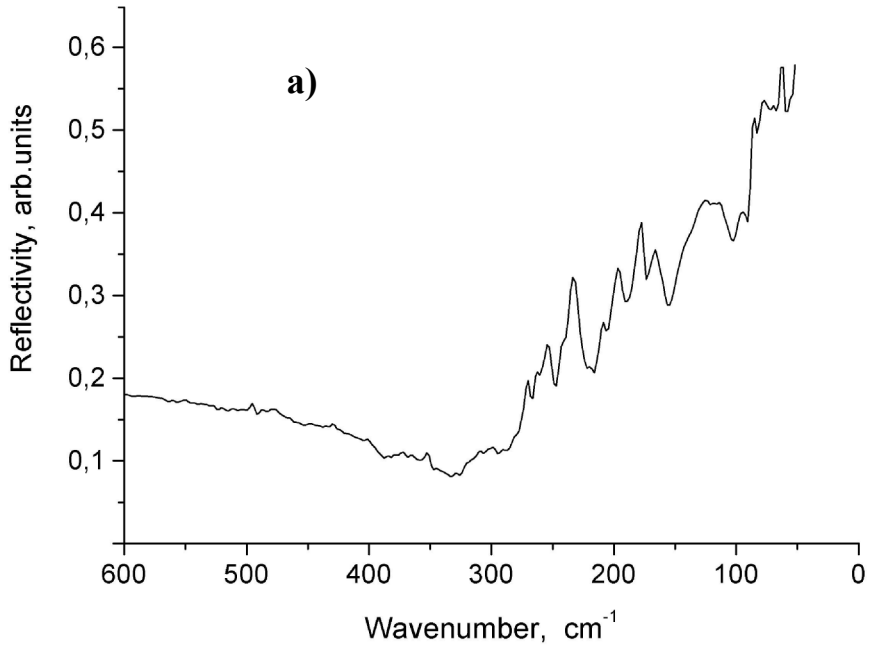
Recently, there is an increased interest in the compound semiconductors having high opticity and high anisotropy of physical properties. Among these substances are cadmium and zinc diarsenide – compound semiconductors of the $A^{II}B^{V}$ group [1]. The feature of the structures of compounds is the availability of the metal-arsenic links on level with the links between arsenic atoms which form line-by-line chain structures defining the considerable anisotropy of electrical and optical properties [2]. Discovered opticity of cadmium diarsenide is twice or three times more than opticity of known gyrotropic crystals. Moreover, this substance has considerable birefringence in the wave-length band 1.3-20 μm [3]. Zinc diarsenide can be used for creation of solid-state laser (induced emission is obtained on wave-length 1.235 μm) [4]. Properties of cadmium diarsenide and zinc diarsenide are studied sufficiently detailed. Methods of the growing of structurally principal single crystals and amorphous films of stoichiometric composition on the different substrates are worked up. Optical properties are investigated in detail. Parameters of the band structure are determined. Considerable anisotropy of the thermo-electromotive force is studied. The group-theoretical analysis of the dynamics of oscillation of crystal lattice is done [5-8]. At the same time, the solid solutions of cadmium diarsenide and zinc diarsenide are studied insufficiently. There is no information about their optical properties in the infra-red spectrum.



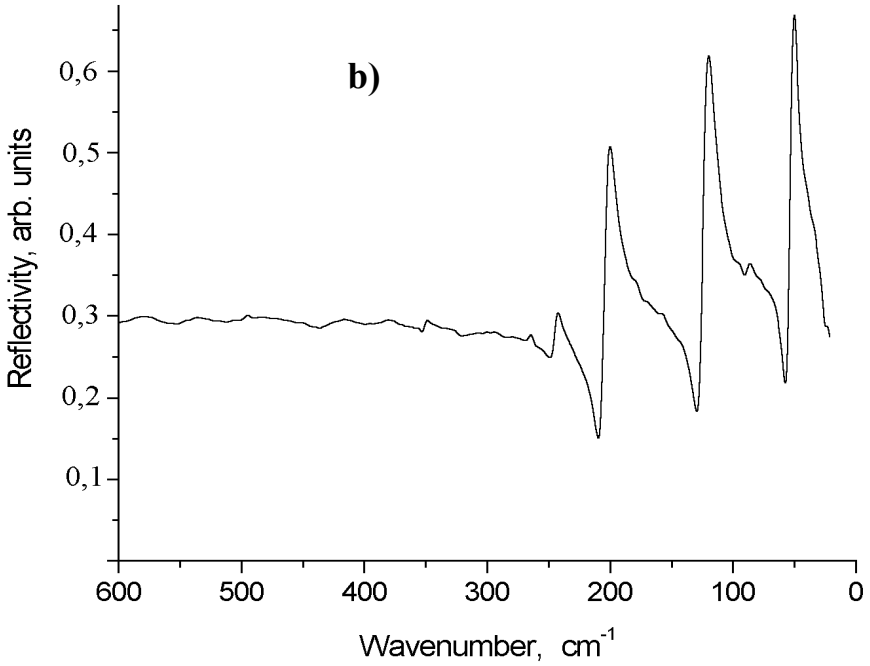


Figure 1. Spectra of reflectivity of solid solutions $Zn_{1-x}Cd_xAs_2$ of the composition: a) x = 0, b) x= 0.94, measured at room temperature in the nonpolarized light.

Solid solutions $Zn_{1-x}Cd_xAs_2$ exist in restricted range of the compositions: as $ZnAs_2$ at $0<x<0.13$ (monoclinic syngony), and as $CdAs_2$ at $0.9<x<1$ (tetragonal syngony). [9]

Measurements of nonpolarized spectra of the infra-red reflectivity for the samples of compositions x=0; 0.06; 0.94; 1 growing by means of Bridgman method in the direction [001] were done at room temperature by means of Fourier spectrometer *Bruker-113s*. Two of them are represented in figure 1. As shown in [6] for $CdAs_2$ the reflectance spectrum from the bound (001) in nonpolarized light coincides with the reflectance spectrum from the bound (110) in polarization $E \perp c$.

For the samples of the composition x=0; 0.06 spectra have the same type, and they are distorted because of the hashing of the plasma frequency onto the region of oscillations of crystal lattice that were not exactly measured. Although, the determination of the parameters of phonons in that situation is possible [10], but it is concerned with the considerable complication of the handling procedure and considerable extension of the calculation error. It is more suitable for the lowering of plasma frequency to decrease the temperature at which the measurements are done.

Spectra of the samples of the composition x= 0.94; 1 detect accurate structure that is appropriate to the oscillation of crystal lattice. Handling of the findings was done by means of the classical oscillating model describing the complex dielectric function of the substance as

$$\hat{\varepsilon}(\omega) = \varepsilon_\infty \cdot \prod_j \frac{\omega_{LOj}^2 - \omega^2 + i \cdot \omega \cdot \gamma_{LOj}}{\omega_{TOj}^2 - \omega^2 + i \cdot \omega \cdot \gamma_{TOj}},$$

where ε_∞ is high-frequency dielectric constant, ω_{TOj}, γ_{TOj} are frequency and attenuation constant of j transversal optical phonon, correspondingly, ω_{LOj}, γ_{LOj} are the same for the

longitudinal phonon, that is, every phonon is associated with four parameters which are thus selected that curves R(ω), calculated by means of formulas:

$$k(\omega)=\frac{1}{\sqrt{2}}\sqrt{\sqrt{\varepsilon_1^2(\omega)+\varepsilon_2^2(\omega)}-\varepsilon_1(\omega)}$$

$$n(\omega)=\frac{1}{\sqrt{2}}\sqrt{\sqrt{\varepsilon_1^2(\omega)+\varepsilon_2^2(\omega)}+\varepsilon_1(\omega)}$$

$$R(\omega)=\frac{(n(\omega)-1)^2+(k(\omega))^2}{(n(\omega)+1)^2+(k(\omega))^2};$$

where $\varepsilon_1(\omega)$ is real, $\varepsilon_2(\omega)$ are imaginary parts of dielectric function, $n(\omega)$ is refractive index, $k(\omega)$ is absorption coefficient, as much as possible approached to the measured ones. The program worked up by us was used during the search procedure of the phonons parameters. This program is based on the genetic algorithm [11], which successfully made a good showing during the handling of more complex spectra (for instance zinc phosphide) in comparison with nonlinear simplex method, gradient methods and step-by-step approach. Due to this algorithm it was possible to determine the revising of the frequencies of phonons while the revising of the composition from x=1 to x=0.94 (for different phonons from 0.075 to 2.6 cm^{-1}). The values of static ($CdAs_2$ – 17,0; $Zn_{0.06}Cd_{0.94}As_2$ – 18.6) and high-frequency ($CdAs_2$-11.5; $Zn_{0.06}Cd_{0.94}As_2$ – 10.9) dielectric constant were determined. Basic optical functions in the measured range were calculated.

Obtained values of the parameters of phonons will be used for the checkout procedure of the model's adequacy of homogeneous parallaxes which takes into account the character of the dispersion of optical mode of pure crystals [12] for the explanation of the concentration dependence of frequencies of the optical oscillations in the investigated solid solution.

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