

# Optical anisotropy in optoelectronics

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**Abstract**—In the paper is presented an overview on the optical anisotropy of  $\text{ZnP}_2$ ,  $\text{CdCa}_2\text{S}_4$  crystals manifested by strong gyration effects, birefringence, dichroism, rotation of the polarization plane, etc. These effects can be used to manufacture narrowband "Band-pass" and "Band-Elimination" filters for optoelectronics and communication systems, optoelectronic devices, which can change the photo current sign depending on light polarization – null indicators of polarized light.

**Index Terms**—anisotropy, birefringence, optical filters, current sign inverter.

## I. INTRODUCTION

Optical anisotropy (optical activity) is the phenomenon characterized by the difference of optical properties of a medium, associated with the dependence of the light waves speed on the direction of propagation in matter and their polarization. Optical activity is manifested in birefringence, dichroism, *rotation of the polarization plane (gyrotropy)*, as well as in depolarization in case of light scattering in a medium, in polarized photoconductivity, luminescence, etc. In a transparent optically anisotropic medium, the light wave in general is a superposition of two orthogonally polarized waves having different propagation velocities.

The optical anisotropy is distinguished between natural and induced optical activity. The natural optical activity of crystals is due to the non-similarity of forces towards different directions of the field, which bonds the lattice atoms. The natural optical activity of matters, which manifest it in any aggregate state, is associated with the asymmetry of the individual molecules' structure and the difference between the interaction of these molecules with the radiation at various polarizations, as well as the particularities of excited states of electrons.

Gyrotropy of the medium is a set of medium's optical properties, having at least one direction, not being equivalent to the inverse one, associated with the manifestation of the spatial dispersion effects of first order. The most important of them are the elliptical birefringence and elliptical dichroism (a special case is the rotation of the polarization plane). The phenomenon of gyrotropy was discovered by D.F. Arago in 1811 in experiments with crystal quartz plates cut out perpendicularly to the optical axis.

For the appearance of gyrotropy it is necessary:

- a noticeable change of the light wave phase at the characteristic distance  $\mathfrak{R}$  of molecular

interaction, that creates spatial dispersion (parameter  $\mathfrak{R}$  can be the dimensions of molecules, intermolecular distances, the lattice constant, the length of free path of electrons, excitons, etc.);

- presence of a certain dissymmetry for the considered object (chirality) - first of all the absence of symmetry center.

Gyrotropy can be natural and induced, induced by any fields (electric, magnetic) or deformation, and also nonlinear optical activity is possible in strong light (laser) fields. The phenomenon of optical activity is used to manufacture various devices like optical polarizer, narrow-band optical filters for optical communications, etc.

## II. EXPERIMENTAL RESULTS AND DISCUSSIONS

When light waves propagate along the C axis in  $\text{ZnP}_2$  crystals of  $D_4^8$  symmetry, the optical activity – rotation of the polarization plane of light waves occurs. It is absent towards the perpendicular directions to the optical axis - C. The crystal has a linear birefringence for these directions. Figure 1, B shows the dispersion curves of the rotational capacity of  $\text{ZnP}_2$  crystals. The magnitude of the rotational power for the crystals with left and right rotations of the light polarization plane increases near the edge of the fundamental absorption. The characteristics of the optical activity practically coincide for the left- and right-rotating  $\text{ZnP}_2$  crystals (Fig. 1, A, B).

The spectral dependences of the refractive index difference  $\Delta n = n^a - n^b$ ,  $\Delta n = n^c - n^a$ ,  $\Delta n = n^c - n^b$  in  $\text{ZnP}_2$  crystals are presented in fig. 1, A, where  $n_a$ ,  $n_b$ ,  $n_c$  are the refractive indices for E||a, E||b, E||c polarizations, respectively.

The spectral dependence of the difference of refractive index in the short-wavelength region  $\lambda < \lambda_0$  (612nm) and in the long-wave region  $\lambda > \lambda_0$  (612nm) is different. The refractive indices for the E||a and E||b polarizations intersect at a wavelength of 612 nm. The transmittance maximum is observed in the transmittance spectra at this wavelength for crossed polarizers (Fig. 1, A). The  $\lambda_0$  wavelength is shifted towards short-wavelength region at a temperature of 9 K, in accordance with the temperature displacement coefficient of the absorption edges for E $\perp$ c and E||c polarizations. The differences of refractive indices  $\Delta n = n^a - n^b$ ,  $\Delta n = n^c - n^a$ ,  $\Delta n = n^c - n^b$  are positive values for the short-wave region part of  $\lambda_0$ . These differences are negative for the long-wave region part of  $\lambda_0$  (Fig. 1, A). Such crystal represents a phase plate, in which two light waves with different velocities propagate.

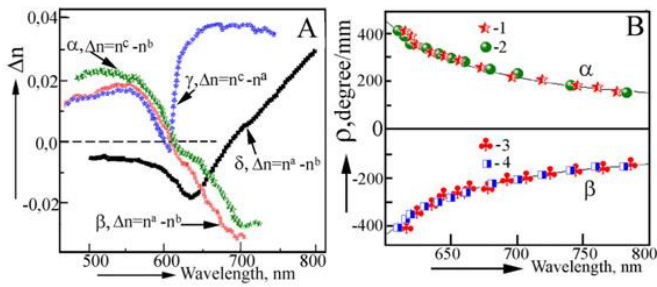


Fig. 1. A – Spectral dependencies of the differences of refractive indices  $\Delta n=n^a-n^b$ ,  $\Delta n=n^c-n^a$  and  $\Delta n=n^c-n^b$  for  $\text{ZnP}_2$  crystals, where  $n^a$ ,  $n^b$ ,  $n^c$  are the refractive indices for E|a, E|b, E|c polarizations, respectively ( $\alpha$ ,  $\beta$ ,  $\gamma$  – undoped crystals,  $\delta$  – alloyed with 1.5% Sb), B – spectral characteristics of the rotational power of four undoped  $\text{ZnP}_2$  crystals obtained under different technological conditions.

The  $\text{CdCa}_2\text{S}_4$  crystals of theogolates group have a pronounced natural optical activity. The symmetry of  $\text{CdCa}_2\text{S}_4$  crystal (spatial group S4) is characterized by the absence of an optical activity along the C axis and manifests itself only towards the directions perpendicular to this axis, where it is weak in comparison with linear birefringence. For this reason, it is possible to observe the gyrotropy of  $\text{CdCa}_2\text{S}_4$  crystals in pure form.

The estimated value of the specific rotation of the polarization plane towards the light propagation direction [100] in the vicinity of  $\lambda_0 = 4909 \text{ \AA}$  is 16.87 deg/mm [3, 4]. The wavelength at which the refractive indices for different polarizations are equal is called the *isotropic wavelength*. The linear birefringence appears and optical activity manifests as elliptical birefringence at wavelengths  $\lambda > \lambda_0 < \lambda$  (away from  $\lambda_0$ ). The phase difference between two elliptically polarized components, acquired on a unit path, is:

$$\Delta\varphi = \frac{2\pi}{\lambda} \left[ (\Delta n)^2 + \left( \frac{g_{11}}{n} \right)^2 \right]^{1/2} \quad (1)$$

where  $\Delta n = n_e - n_o$  – birefringence of  $\text{CdCa}_2\text{S}_4$  crystals,  $\lambda$  – wavelength,  $g_{11}$  – the nonzero component of the gyration tensor for the propagating light towards the [100] direction of  $\text{CdCa}_2\text{S}_4$  crystals,  $n$  – average refractive index [4]. As a result, the linearly polarized light passing through the crystal is elliptically polarized. The orientation of the ellipse, with respect to the optical axis of the crystal and its ellipticity, depends on the incident light wavelength. The change of light intensity during the passage through the  $\text{CdCa}_2\text{S}_4$  crystal, in case of crossed polarizers outside the  $\lambda_0$  spectral region, is described by an expression obtained from the analysis of interference phenomena, taking into account the gyrotropy of the crystal:

$$I = I_0 \rho^2 \frac{\sin^2 \left\{ \left[ \rho^2 + (\pi \Delta n / \lambda)^2 \right]^{1/2} d \right\}}{\rho^2 + (\pi \Delta n / \lambda)^2} \quad (2)$$

The maxima of the inference picture take place if:

$$\left[ \rho^2 + (\pi \Delta n / \lambda)^2 \right]^{1/2} d = (m + 1/2)\pi, \quad M = 0, 1, 2, \dots \quad (3)$$

and minima if:

$$\left[ \rho^2 + (\pi \Delta n / \lambda)^2 \right]^{1/2} d = m\pi, \quad M = 0, 1, 2, \dots \quad (4)$$

It follows from conditions (3) and (4) that when crystal thickness varies, the spectral position of wavelengths for the

maxima and minima of the interference pattern is observed on either side of the anomalous transmittance band.

The transmittance spectra  $T$  of  $\text{CdCa}_2\text{S}_4$  crystals, in case of parallel beams of crossed polarizers, when the C axis is parallel to the polarization direction of one polarizer, is characterized by the presence of a narrow pass band localized at  $\lambda = 485.7 \text{ nm}$  wavelength (Fig. 2, A). In the case of unidirectional oriented polarizers, a narrow absorption line at the same wavelength is observed. Interference is observed in the transmittance spectra of  $\text{CdCa}_2\text{S}_4$  crystals, if placed between crossed polarizers in converging beams at 300K, (Fig. 2, A). Choosing the thickness of the crystals, it is possible to reduce the number of spin-off maxima and to basically isolate the maximum at  $\lambda_0$  wavelength. Figure 2, B shows the temperature dependence of  $\lambda_0$  (curve- $\alpha$ ) for different cases. The light that passed through the crystal in  $\lambda_0$  the region remains linearly polarized, and therefore, there occurs an interaction between two waves circularly polarized in opposite directions, which, after passing through the crystal, acquired a phase difference determined by the specific rotation  $\rho$  of the crystal. This leads to the appearance of interference. The peaks a1-a11 and b1-b17 of the interference fringes are detected at a crystal thickness  $d = 4.8 \text{ mm}$ . Taking into account the position of the maxima (minima), the spectral dependence  $\Delta n = n_o - n_e$  was calculated (Fig. 2, A, B).

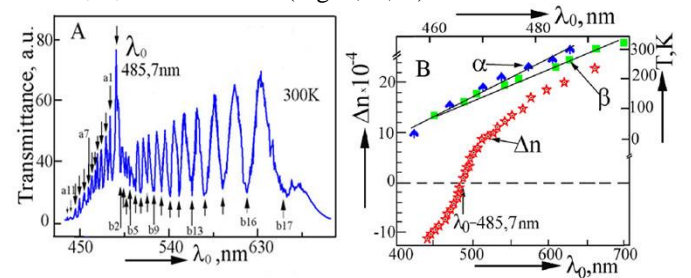


Fig. 2. A – Interference of transmittance spectra for  $\text{CdCa}_2\text{S}_4$  crystals placed between crossed polarizers at 300K temperature; B –  $\lambda_0$  dependence on temperature and the spectral dependence  $\Delta n = n_o - n_e$  calculated from interference fringes a1-a11 and b1-b17 (crystal thickness  $d = 4.8 \text{ mm}$ ).

The dispersion of the refractive indices  $n_o$ ,  $n_e$  and  $\Delta n = n_o - n_e$  in the region of the absorption edge of cadmium thiogallate ( $\text{CdCa}_2\text{S}_4$ ) is related to the features of the band structure. The rules for selecting electronic transitions determine the nature (allowed, forbidden) of these transitions. The magnitude of the absorption and dielectric constant for the corresponding polarizations depend on this, and hence also the sign of the birefringence. These features lead to a rapid growth of one of the refractive indices as they approach the edge of fundamental absorption. This determines the anisotropy of the boundary interband absorption of the crystal for the corresponding polarizations. The intersection of dispersion curves (isotropic point - IP) is observed from the long-wave side of the absorption edge for cadmium thiogallate crystals. The experimental study of the spectral dependence of light absorption coefficients at different polarizations (E|c and E⊥c) propagating through  $\text{CdCa}_2\text{S}_4$  crystals shows that close to IP,  $\alpha_{||}$  and  $\alpha_{\perp}$  (a – absorption coefficient) become closer by magnitude. A singularity as an absorption line is observed at E⊥c polarization, while at the E|c polarization as a pass band [1-3]. The isotropic wavelength for  $\text{CdCa}_2\text{S}_4$  crystals is

observed at  $\lambda_0 = 4909\text{\AA}$ . The birefringence changes its sign if passing through  $\lambda_0 = 4909\text{\AA}$  wavelength, i.e. the crystal becomes optically negative in the region  $\lambda > \lambda_0$  from an optically positive crystal in the spectral region  $\lambda < \lambda_0$ .

The absorption is small and is determined by several mechanisms in the transparency region of the crystal – by the natural optical activity or by polarized local absorption bands of impurities, defects, etc. The existence of two types of waves, the ordinary and extraordinary one, for which there are two refractive indices  $n_o$  and  $n_e$ , is determined by the dielectric constant tensor of the crystal  $\varepsilon(\omega, K)$ , which depends both on the frequency  $\omega$  and on the wave vector  $K$ . Spatial dispersion, i.e. the dependence of the dielectric constant on the wave vector  $K$  causes the appearance of the non-diagonal element  $\varepsilon_{zz}$  of the dielectric permittivity tensor. The refractive index  $n_o$  is greater than  $n_e$  in many anisotropic crystals, in the region of edge absorption, but in the transparency region  $n_o$  is lower than  $n_e$ . An inverse relationship is also possible. Mutually perpendicular light waves with refractive indices  $n_o$  and  $n_e$  interfere in the crystal.

The transmittance spectra  $T$  of  $\text{Cu}_2\text{ZnSiSe}_4$  crystals placed between crossed polarizers, in case if the  $C$  axis is parallel to the polarization direction of one polarizer, are characterized by a series of narrow interference fringes. Interference bands at 300K and 10K temperature values thicken as the energy increases. At room temperature the interference spectra are separated by a maximum of weak intensity  $\lambda_0$  (622nm) into two groups marked from -1 to -6 in the long-wave region and 1-9 bands located in the short-wave region from  $\lambda_0$ . At a temperature of 10 K, the bands system is shifted toward higher energies. Seven maxima (minima) are observed from the long-wavelength region of this singularity  $\lambda_0$ , which is marked with negative numbers. One observes twenty-one maxima (minimum) 1-21 in the high-energy region from  $\lambda_0$  at 10 K temperature (Fig. 3, A). An interval is calculated from transmittance spectra of crystals in case of crossed polarizers, in which the absorption coefficient and its spectral dependence change. It is evident from the figure that the absorption coefficient of these crystals, in case of crossed polarizers, varies by two orders of magnitude from 10 up to  $10^3 \text{ cm}^{-1}$ . The  $\lambda_0$  wavelength is the isotropic wavelength for  $\text{Cu}_2\text{ZnSiSe}_4$  crystals. At these wavelengths the crystal cannot distinguish the polarized light waves. The light transmitted by the crystal in crossed polarizers in the region  $\lambda_0$  remains linearly polarized. The light transmitted by the crystal, in case of crossed polarizers and  $\lambda_0$  region, remains linearly polarized. Consequently, the interaction between two waves circularly polarized in opposite directions occurs, which acquired a phase difference after passing through the crystal. This is determined by the specific rotation  $\rho$  of the crystal and leads to interference effects.

Figure 3, B shows the temperature dependence of  $\lambda_0$  for  $\text{Cu}_2\text{ZnSiSe}_4$  crystals. The spectral dependence of  $\Delta n = n_o - n_e$  for different temperatures is calculated from interference bands (-1) – (-6) and 1- 21 at a crystal thickness  $d = 0.33\text{mm}$ . The curves  $\Delta n = n_o - n_e$  cross the energy axis at  $\lambda_0$

wavelength for the whole temperature range 10-300 K. The isotropic wavelength  $\lambda_0$  shifts towards higher energies with temperature decrease from 300K to 10K (Fig. 3, B), i.e. short wavelengths from 622nm down to 605nm.

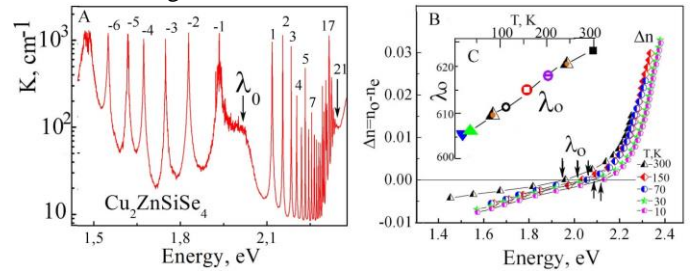


Fig.3 A – the spectral dependence of the absorption change for  $\text{Cu}_2\text{ZnSiSe}_4$  crystals with 0.330mm thickness placed between crossed polarizers at 10 K; B – the spectral dependence  $\Delta n = n_o - n_e$  calculated from the interference fringes and the dependence of the spectral position of  $\lambda_0$  on temperature.

The sign of  $\Delta n$  changes from positive to negative in  $\text{Cu}_2\text{ZnSiSe}_4$  crystals, when passing through  $\lambda_0$  wavelength from the short-wave region of the spectrum to the long-wavelength region (Fig. 3, B).

The interference of absorption spectra shown in Fig. 3, A for  $\text{Cu}_2\text{ZnSiSe}_4$  crystals, in case of crossed polarizers at 10 K, were obtained measuring crystals with 0.33mm thickness. The Fabry-Perot interference is not manifested for such crystals and the observed spectra are due to the interference of birefringence. This is due to the fact, that at  $\lambda_0$  wavelength the phase difference  $\Delta\Phi(\lambda_0)$  between two mutually perpendicularly polarized modes propagating through the crystal is always zero. Therefore, in the interference spectrum of birefringence at  $\lambda_0$  wavelength, either the total maximum (in case of parallel polarizers) or a zero minimum (in case of crossed polarizers) is always observed, regardless of the thickness of the crystal. The order of these extrema corresponds to  $\kappa=0$ . The ordinal number  $\kappa$  of interference spectra is described by the expression  $\Delta n(\lambda)d = \kappa\lambda$ , where  $d$  is the thickness of the crystal. The determination of the  $\kappa=0$  band in interference spectra is very important and is possible when investigating the dispersion  $\Delta n(\lambda)$  of crystals possessing the isotropic point. With this in mind, one can create narrowband "Band-pass" and "Band-Elimation" filters. Narrowband filters are needed in various fields of optics, optoelectronics, optical communication, etc. Crystals (materials) having an isotropic wavelength  $\lambda_0$ , which coincides to the emission wavelengths of existing lasers are needed to manufacture narrowband filters in Raman spectroscopy and in other areas of optical spectroscopy. The dependence of the isotropic wavelength  $\lambda_0$  (the center of the pass band) on the parameter  $X$ , of a filter manufactured based on  $\text{CuGa}_x\text{Al}_{1-x}\text{S}_2$ , is shown in Fig. 4. The same figure shows the emission wavelengths of  $\text{Ar}^+$  and He-Ne lasers and the necessary compositions of solid solutions, that will have an isotropic wavelength  $\lambda_0$  corresponding to the wavelengths of the lasers. A solid solution in the vicinity of the  $\text{CuGa}_{0.95}\text{Al}_{0.5}\text{S}_2$  composition can be used for a wavelength of 632.8nm. The thickness of the crystalline plates is determined from the experimental results of birefringence and optical activity. The thickness and composition were chosen so that the filter would have a

transmittance maximum corresponding to the emission of the laser. Filters for narrowing the emission bands of the Ar<sup>+</sup> laser can be made from the compositions with X = 0.35-0.53.

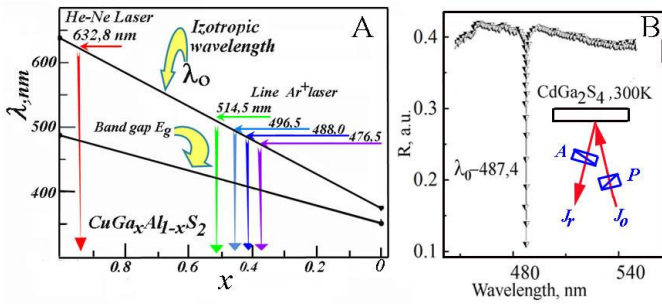


Fig.4. A – the dependence of  $\lambda_0$  and  $E_g$  on the parameter X in  $\text{CuGa}_x\text{Al}_{1-x}\text{S}_2$  solid solutions; B – band of a filter based on  $\text{CdGa}_2\text{S}_4$  crystals, in the reflection spectra in case of crossed polarizers.

These filters will allow Raman scattering measurements near the emission lines and use a single monochromator for Raman spectroscopy instead of a double or triple spectrometer. Such filters are extremely important when used in Raman spectroscopy as excitation sources for high-power semiconductor lasers that have a broad emission band. It was possible to obtain a filter band of a  $\approx 5\text{-}7\text{\AA}$  order in the reflection spectra of  $\text{CdGa}_2\text{S}_4$  crystals and crossed polarizers, (Fig. 4, B).

The phenomena of optical activity (gyration) affect the spectral characteristics of photoelectronic devices. Figure 5 shows the spectral distribution of the photoresponse  $J_{ph}$  in case of unpolarized light of ITO-n-p- $\text{CdP}_2$ -Au diodes and the structure of the photodiode (Indium Tin Oxide – ITO). The photodiodes are based on  $\text{CdP}_2$  crystals with n-p or p-n structure. In the photoelectric spectra of the structures presented in Fig. 5 there is an intense maximum of the photoresponse at a wavelength of 654nm and a more flat maximum at 570-600nm (curve  $J_{ph}$ ), in case of unpolarized light. These maxima correspond to the isotropic wavelength  $\lambda_0$  and  $\lambda_{01}$  for  $\text{CdP}_2$  crystals. The  $J_{ph}^*$  curve at E||a polarization also contains two maxima at approximately the same wavelengths, but the negative photoresponse value is greater than the one for the  $J_{ph}$  characteristic.

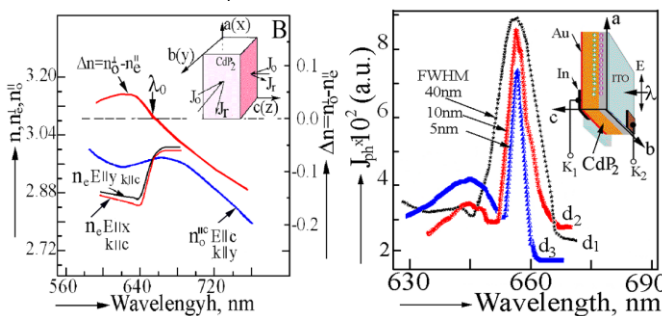


Fig. 5. The spectral dependence of the  $J_{ph}$  photoresponse, in case of unpolarized light;  $J_{ph}^*$  at E||a polarization for ITO-n-p- $\text{CdP}_2$ -Au photodiodes and the photodiode construction.

The presence of high photosensitivity at the isotropic wavelength  $\lambda_0$  means that the most effective mode interaction in the crystal occurs at this wavelength. In the neighborhood of the isotropic point ( $\lambda_0$ ) of the crystal, energy is exchanged between orthogonally polarized waves. In order to carry out

the transfer of energy from one orthogonally polarized mode to another, it is necessary and sufficient that the following conditions would be satisfied: 1) phase matching; 2) the presence of a coupling element.

The transmittance spectra of  $\text{ZnP}_2$  ( $D_4^8$ ) crystals have a different transmittance coefficient in the wavelength region  $\lambda > 650\text{nm}$  for E||a and E||b polarizations, crossing at the  $\approx 640\text{nm}$  wavelength value, (Fig. 6, A). p-n junctions are formed on the surface of the crystals and the light wave polarization influence the photosensitivity. The photosensitivity has the opposite sign when the polarization changes from E||a to E||b, with a sensitivity maximum in the region 500-800nm. The polarization change from E||a to E||b leads to a significant change of the photosignal, (Fig. 6, B) due to the absorption of light in the upper or lower active layer. The photoresponse has opposite signs of the upper and lower photodiodes. At  $\lambda = 640\text{nm}$  wavelength, a change in the sign of the photosensitivity occurs after the polarizations change. Such a structure, placed between crossed polarizers, has a narrow photosensitivity maximum at  $\lambda_0 = 640\text{nm}$  wavelength, (Fig. 6, C).

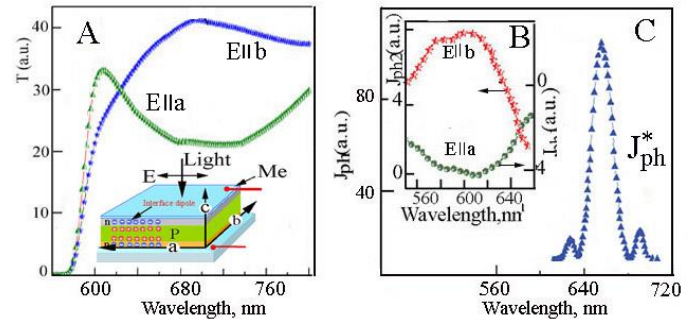


Fig. 6. A – the transmittance spectra of  $\text{ZnP}_2$  ( $D_4^8$ ) crystals at E||a and E||b polarizations; B – the spectral distribution of the photoconductivity of Me- $\text{ZnP}_2$  ( $D_4^8$ ) structure at E||a and E||b polarizations; C – the spectral distribution of the photoconductivity ( $J_{ph}^*$ ).

In  $\text{ZnP}_2\text{-C}_{2h}^5$  crystals (monoclinic modification), the minimum interband interval is formed by direct allowed transitions from the upper valence band  $V_1$  with  $\Gamma_2$  symmetry to the conduction band  $C_1$  with  $\Gamma_1$  symmetry. These transitions cause the edge absorption in the region of 880 nm (Fig. 7, A). The direct transitions are allowed from the valence band  $V_2$  with  $\Gamma_1$  symmetry to the conduction band  $C_1$  with  $\Gamma_1$  symmetry, at E $\perp$ c polarization. Zone  $V_2$  is split from  $V_1$  by the crystal field of a low-symmetric crystal structure  $C_{2h}^5$ . The transitions at E $\perp$ c polarization form the edge absorption in the region of 830-800 nm. The experimental absorption and transmittance spectra at E||c and E $\perp$ c polarizations begin to change at different wavelengths, for 300K temperature. The transmittance spectra at wavelengths 880-870nm vary from 45% to 0% at E||c polarization, and the changes occur at 840-820nm wavelengths in the range 40-0%, at E $\perp$ c polarization. In the 880- 800 nm wavelength range, the change of polarization from E||c to E $\perp$ c for each wave length leads to a 30-40% change in transmittance spectra.

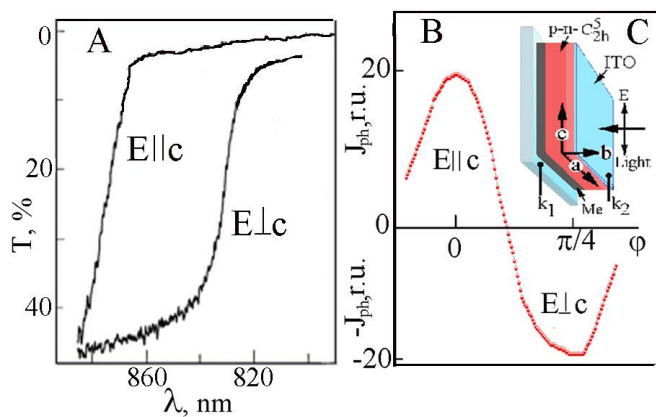


Fig. 7. A – the edge absorption of ZnP<sub>2</sub>-C<sub>2h</sub><sup>5</sup>; B – the Me-p-n-ZnP<sub>2</sub>-C<sub>2h</sub><sup>5</sup> photodiode; C – the dependence of detector photosensitivity on the orientation of the lightwave vector E.

A strong difference of the transmittance coefficients for both polarizations in the region of the beginning of fundamental absorption makes it possible to create photodetectors with various designs sensitive to the polarization change (null indicators of polarized light). The current sign changes from positive to negative if the lightwave polarizations change from E||c to E⊥c (Fig. 7).

ZnP<sub>2</sub>(D<sub>4</sub><sup>8</sup>)-ZnP<sub>2</sub>(C<sub>2h</sub><sup>5</sup>) heterojunctions have unusual characteristics, including the photoelectric ones. These are heterojunctions of the same compound, differing in the symmetry of the crystal lattice (the contact between the two modifications), being obtained from gas phase. Structures with most ideal constructions had been selected for measuring the photoelectric characteristic of the obtained. We have selected structures having plane surface with monoclinic modifications grown along (001) plane of the tetragonal modifications of zinc diphosphide. We have obtained ZnP<sub>2</sub>(C<sub>2h</sub><sup>5</sup>) layers of monoclinic modification with different thicknesses, but selected the thinnest ones for measurements (≈100-200μm). The crystal with tetragonal modification was chipped for obtaining the needed thickness (≈200-250μm). On the surface of the crystals there were applied metal semitransparent contacts on both sides.

The incident light was parallel to the C axis of the crystal while illuminating the heterojunction from the part of the wide-band ZnP<sub>2</sub>(D<sub>4</sub><sup>8</sup>) crystal. The polarization of light waves was changing from E||a to E||b, while photoconductivity was observed in the wavelength region 800-900 nm. The polarization change was significantly influencing the photo signal in the long-wave region, since the E||b polarization for ZnP<sub>2</sub>-D<sub>4</sub><sup>8</sup> crystals corresponds to E||c for the monoclinic ZnP<sub>2</sub>-C<sub>2h</sub><sup>5</sup> crystal. Interference in the photosensitivity spectra was observed for some structures at E||a polarization, for which the thickness of the monoclinic layer was small. The photosensitivity in the 800-900nm spectral region is formed in

the spatial charge region of the ZnP<sub>2</sub>(C<sub>2h</sub><sup>5</sup>) monoclinic modification, and in the short-wave region in case of ZnP<sub>2</sub>-D<sub>4</sub><sup>8</sup>.

### III. CONCLUSIONS

The optical activity can be manifested in birefringence, dichroism, rotation of the polarization plane (gyrotropy), as well as in depolarization in case of light scattering in a medium, in polarized photoconductivity, luminescence, etc.

The spectral dependence of the difference of refractive index in the short-wavelength region  $\lambda < \lambda_0$  (612nm) and in the long-wave region  $\lambda > \lambda_0$  (612nm) is different and occurs at the so called *isotropic wavelength*.

The determination of the  $\kappa=0$  band in interference spectra of anisotropic crystals gives the possibility to create narrowband "Band-pass" and "Band-Elimination" filters. Narrowband filters are needed in various fields of optics, optoelectronics, optical communication, etc. Crystals (materials) having an isotropic wavelength  $\lambda_0$ , which coincides to the emission wavelengths of existing lasers can be used to manufacture narrowband filters in Raman spectroscopy and in other areas of optical spectroscopy.

A strong difference of the transmittance coefficients for E||c and E⊥c polarizations makes it possible to create photodetectors with various designs, sensitive to the polarization change - *null indicators of polarized light*.

### ACKNOWLEDGMENT

This paper is written in the memory of *Professor Valerian Dorogan* (3.01.1955 – 5.10.2017), a remarkable scientist and specialist in physics, optoelectronics and engineering of semiconductors and dielectrics, a supporter for joining the science and culture, promoter of developing informational society based on knowledge in Republic of Moldova.

### REFERENCES

- [1] Pochi Yeh. Zero crossing birefringent filters. *Optics Communications*, Volume 35, Issue 1, October 1980, pp. 15-19. (doi:10.1016/0030-4018(80)90351-X).
- [2] Lotspeich, J. F., Stephens R. R., Henderson D. M. Electrooptic tunable filters for infrared wavelengths. *IEEE Journal of Quantum Electronics*, vol. QE-18, Aug. 1982, p. 1253-1258. (doi:10.1109/JQE.1982.1071700).
- [3] Hiromichi Horinaka, Kazushi Tomii, Hajimu Sonomura, Takeshi Miyauchi. A New Method for Measuring Optical Activity in Crystals and Its Application to Quartz. *Japanese Journal of Applied Physics*, Volume 24, Part 1, Number 6 (1985), p.755. (doi:10.1143/JJAP.24.755).
- [4] H. Horinaka, N. Yamamoto, H. Hamaguchi. A New Approach to Highly Efficient Raman Spectroscopy Using a Laser Diode and AgGaSe<sub>2</sub> Crystal Filter. *Applied Spectroscopy*, Volume: 46 issue: 2 (1992), pp. 379-381, (doi:10.1366/0003702924125681).