From the values of α_{max} we determined the effective constants K_{eff} of the electromechanical coupling. In the calculations we used the surface-wave velocities $v_p = (1.72 \pm 0.02) \times 10^5$ cm/sec and $v_{SSW} = (1.80 \pm 0.02) \times 10^5$ cm/sec, which were determined from measurements of the synchronism frequency and the lattice period. $K_{eff} = 0.19 \simeq K_{15} = 0.188$ [6], for Rayleigh waves, and $K_{eff} = 0.29$ for SSW. This agrees with the theoretical estimate [1], which shows that for SSW the value of K_{eff} is of the order of K_{15}.

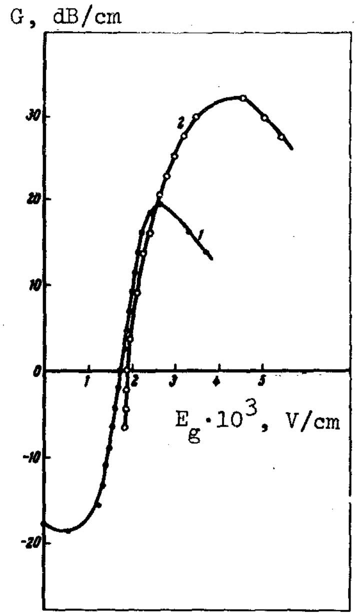

Fig. 2. Gain of the SSW vs. the drift field: 1) f = 10.9 MHz, 2) f = 19.5 MHz.

Figure 2 shows plots of the gain G of the SSW against the drift field E_g. The obtained gain reached 32 dB/cm at 19.5 MHz and 24 dB/cm at 10.9 MHz, and was larger by 5 - 6 dB/cm than for Rayleigh waves.

The electromagnetic-coupling constant determined from the gain of the SSW, $K_{eff} = 0.17$, is also close to K_{15}.

Thus, an investigation of the acousto-electric interaction for the waves of the new type in CdS has shown that the magnitude of this interaction is somewhat larger than for Rayleigh waves. This, together with the greater depth of penetration, makes the use of such waves promising for high-frequency acousto-electronic devices.

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PHOTOCURRENT INSTABILITY AND MULTIPHOTON PROCESSES IN $CdSnP_2$

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1. We wish to point out here several peculiarities of multiphoton absorption of light and of the relaxation of nonequilibrium carriers in a semiconductor having a complicated band structure, such as the recently obtained and thoroughly investigated compound $CdSnP_2$.

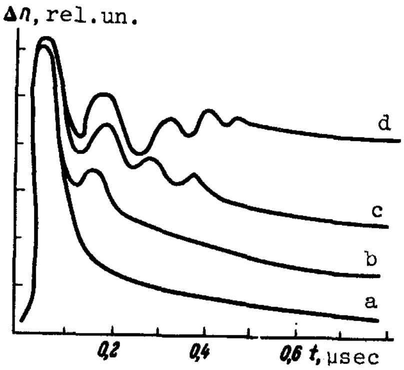

Fig. 1. Oscillations of the photocurrent in $CdSnP_2$ at different temperatures (sweep 0.1 μsec/cm): a) 300°K, b) 240°K,) 170°K, d) 90°K.

2. We investigated homogeneous samples measuring ~0.2 × 0.05 × 0.02 cm, provided with ohmic contacts and protected against direct exposure to light. The samples had a resistivity 10^2 - 10^4 ohm-cm at 300°K and 10^7 - 10^8 ohm-cm at 80°K. To increase the photosensitivity, the $CdSnP_2$ crystals were doped during the course of their preparation with Sb and Cu impurities (jointly) and with other impurities. The resistivity ratio of crystals prepared in this manner amounted to ~10^7 at an exciting-light intensity ~10^{25} $cm^{-2}sec^{-1}$.

The exciting-light source was a Q-switched Nd laser (output energy 0.5 J, pulse duration 35 nsec). The sample was placed in an optical cryostat whose temperature was adjustable in the interval 80 - 300°K, and was connected to a photoconductivity-measuring circuit with parameters $R_S \gg R_L$, E = 10 - 10^3 V/cm, time resolution 10^{-8} sec (R_S - dark resistance of sample, R_L - load resistance, E - constant electric field applied to sample). The photoconductivity signal was registered with a long-persistence oscilloscope.

3. Figure 1 shows the kinetics of the nonequilibrium-carrier relaxation at different sample temperatures. Appreciable oscillations of the photocurrent are seen, and their number and amplitude increase with decreasing temperature. This oscillogram was obtained by applying to the sample an electric field E = 80 V/cm and exposing it to Nd-laser light with intensity $I = 2 \times 10^{26}$ $cm^{-2}sec^{-1}$. The appearance of the oscillations is not connected with any threshold value of the electric field applied to the sample. We note that the amplitude of the oscillations is proportional to both the electric field E and the light intensity I, and the number of oscillations also increases with increasing I and E. The oscillation frequency is independent of I and E, and amounts to (8 - 12) × 10^6 Hz for the series of 30 investigated samples.

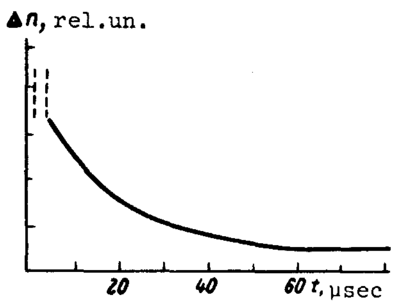

Fig. 2. Kinetics of nonequilibrium-carrier relaxation in $CdSnP_2$ at 80°K. The dashed lines mark the section in which instability of the photocurrent is observed.

Figures 1 and 2 make it possible to estimate the characteristic times of relaxation of the nonequilibrium current τ, viz., $\tau = 8 \times 10^{-8}$ sec at 300°K and $\tau = 2 \times 10^{-5}$ at 80°K. On Fig. 2 is marked the section on which oscillations of the photocurrent are observed.

Figure 3 shows plots of the nonequilibrium-carrier densities Δn against the intensity I of the exciting light. If the condition $t \ll \tau$ is satisfied (see Figs. 1 and 2), this plot takes the form $\Delta n \sim I^{\alpha}$, where α is the number of photons participating in the elementary light-absorption act (here t is the duration of the laser pulse). At T = 80°K the width of the forbidden band E_g exceeds the quantum energy ħω, and α = 2 (curve a of Fig. 3), corresponding to two-photon absorption of light in the $CdSnP_2$ [1]. Unlike in [1], however, the dependence obtained for a number of samples is $\Delta n \sim I^3$ (curve b of Fig. 3), corresponding to three-photon absorption of light.

4. The high-frequency current oscillations, the occurrence of which is not connected with the exceeding of some threshold value of the dc electric field applied to the sample, were apparently observed here for the first time. Obviously, the observed phenomenon is not connected with the classical Gunn effect or with generation of an acoustoelectric domain in piezoelectric crystals, and has no close analogy with the $CdSnP_2$ photocurrent oscillations described in [2]. As a possible cause of the photocurrent instability, we point to the so-called gradient instability [3] and to generation of acousto-optical domains in the field of a powerful light wave [4]. Appreciable gradients of the nonequilibrium carriers in the sample are quite possible in our experiment, and evidence favoring the latter mechanism is afforded by an estimate of the mean electron velocity $|V_e|$ in the field of the light wave: $\varepsilon = \varepsilon_0 \exp(-i\omega t)$. Indeed, when $I = 2 \times 10^{26}$ $cm^{-2}sec^{-1}$ and $m^* = 0.04m_0$, the electron velocity is $|V_e| = e\varepsilon_0/m^*\omega\sqrt{2} \simeq 10^6$ cm/sec. The value of $|V_e|$ exceeds the speed of sound and the Cerenkov emission of phonons by electrons apparently takes place. It is known that Cerenkov emission is not the only cause of phonon emission in the field of a powerful light wave. We note that it is impossible to indicate the specific cause of the instability at the present stage of the experiment.

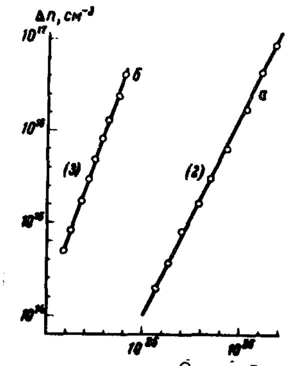

Fig. 3. Nonequilibrium carrier density Δn vs. intensity I of the exciting light (logarithmic scale): a) $\Delta n \sim I^2$; b) $\Delta n \sim I^3$. The slopes of the lines are indicated in parentheses).

The results of the experiment favor the assumption that both two-photon [1] and three-photon light-absorption processes are possible in $CdSnP_2$ (Fig. 3). The minimum gap E_g between the upper valence band and the lower conduction band in $CdSnP_2$ is 1.21 eV (80°K), and the Nd-laser photon energy is $\hbar\omega = 1.17$ eV. The difference between $2\hbar\omega$ and E_g is quite large, whereas an analysis of the band structure of $CdSnP_2$ [5] shows that at some points of K-space the quantity $(3\hbar\omega - \Delta E) > 0$ is quite close to resonance (here ΔE is the energy gap between bands). It is known that in the theory of multiphoton transitions, developed by Kovarskii [6], the expressions for the probability of a multiphoton transition are very sensitive to the ratio of the photon energy to the optical-transition energy; in addition, the parameter ρ_{cv} of the multiphoton theory contains matrix elements, and consequently also the oscillator strengths of the corresponding optical transitions. The probability of three-photon absorption in semiconductors with complicated band structures can apparently exceed the probability of the two-photon process. We note that similar anomalies were observed recently in gallium phosphide [7]. A detailed comparison of the theory and experiment is made difficult by the lack of information on the oscillator strengths of the corresponding optical transitions and on the contribution of the impurity states to the probability of the multiphoton transition.

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CONCERNING THE $\bar{\nu}e$ SCATTERING PROCESS

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At the present time, the theoretical analysis of the $\bar{\nu}e$ scattering process is based on the following models: (a) the model of diagonal interaction [1], (b) the model with a neutrino having a magnetic moment [2], and (c) the usual V - A interaction model [4].

In connection with the planned experiments [5, 6] with antineutrinos from a powerful reactor, it is proposed in [3] to determine the model of $\bar{\nu}e$ scattering from the spectrum of the recoil electrons. We deem it more promising to determine the $\bar{\nu}e$-scattering model by using a ferromagnetic target [7]. The strong dependence of the total cross section on the polarization of the initial electrons in the V - A theory had been pointed out earlier [7, 8]. It turns out that characteristic spin dependences are obtained also for the other models. The differential cross sections for the different model, in the rest system of the initial electron, are given by

$$\text{a)}\ d\sigma^{d} = d\sigma_0^{d}(1-\zeta), \tag{1}$$

$$\text{b)}\ d\sigma^{m} = d\sigma_0^{m}, \tag{2}$$

$$\text{c)}\ d\sigma^{V-A} = d\sigma_0^{V-A}\left[\left(1+\zeta+\zeta\frac{m}{E\left(1+\frac{E}{m-\omega}\right)}\right)\right], \tag{3}$$

where

$$d\sigma_0^{d} = \frac{m^5 d\omega}{\pi\lambda^4(m^2+rmE-\mu^2)^2}, \qquad \lambda,\ \mu \text{ - parameters of model}$$

$$d\sigma_0^{m} = \frac{4\pi\alpha f^2(E+m-\omega)\,d\omega}{E(\omega-m)}, \qquad \alpha = e^2,\ f \text{ - magnetic moment of neutrino}$$

$$d\sigma_0^{V-A} = \frac{2G^2m(E+m-\omega)^2 d\omega}{\pi E^2}, \qquad G = 10^{-5}M_N^2$$