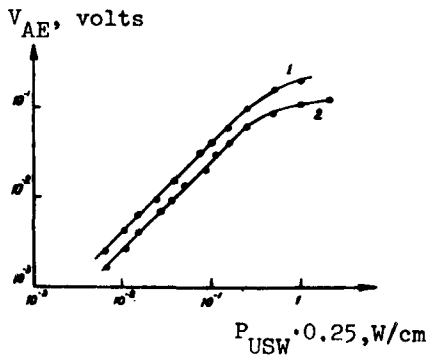

Fig. 2. Dependence of the acoustic emf on the power of the Rayleigh ultrasonic wave: 1 - $\sigma = 2.7 \times 10^{-4}$, 2 - $\sigma = 1.8 \times 10^{-3}$ $ohm^{-1}cm^{-1}$.

These results agree with the conclusions of the theory of the AE effect [3]. The expression for κ, which enters in formula (1), is complicated [3]. In addition, the properties of the surface layers of the crystal are considerably altered by the processing. It is therefore meaningful to regard κ as a phenomenological parameter. The numerical value of κ can be easily determined from the slope of the straight line in the dependence of the acoustic emf on the sound power. By determining κ is this manner, we can compare the measured value of the acoustic emf with that calculated by formula (1). The agreement between theory and experiment turns out to be satisfactory.

In a number of crystals, illumination changed the type of conductivity, as a result of excitation by the light of the holes from the impurity centers in the silicon possessing initially an n-type conductivity. In this case, the change of the type of conductivity was accompanied by a change in the sign of the acoustic emf. At low values of the conductivity, the change of the sign of the acoustic emf was observed also upon application of a constant drift field, when the drift velocity of the carriers exceeded the velocity of the surface USW in the sound guide. However, at large conductivities, the measurements were made difficult by the thermal heating of the crystals.

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ABSORPTION AND AMPLIFICATION OF ULTRASOUND IN A TWO-LAYER SYSTEM CONSISTING OF A PIEZOELECTRIC CERAMIC WITH LARGE DIELECTRIC CONSTANT AND A SEMICONDUCTOR

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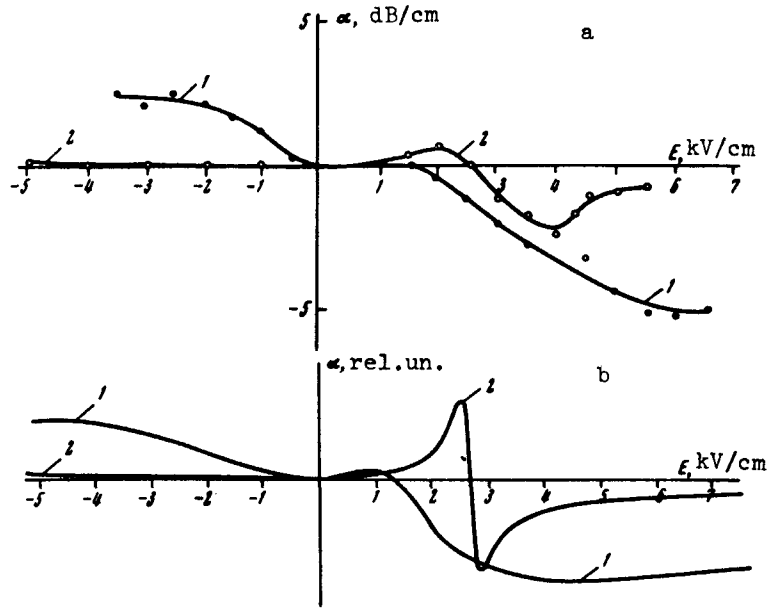
The purpose of this investigation was to observe experimentally the absorption and amplification of ultrasound as the result of electron-phonon interaction proportional to the applied electric field [1]. A layer of the semiconductor CdSe, of thickness $(1 - 2) \times 10^{-3}$ cm, was deposited on ceramic $BaTiO_3$ plates doped with oxides of cesium or of antimony and bismuth. The plate thickness was 0.2 cm; the dielectric constant ε was of the order of 4000; there was no dielectric hysteresis up to fields 8×10^3 V/cm, and no coefficient of electromechanical coupling was observed without an external electric field. The data pertain to a working temperature T = 26 - 28°C (the



Additional absorption of ultrasound in a two-layer system consisting of $BaTiO_3$ (with CsO_3) and CdSe, relative to the absorption in $BaTiO_3$ (with CsO_3): a - experimental plots, b - theoretical curve; 1 - μ = 200 cm^2/V-sec, n = 1 × 10^{15} cm^{-3}; 2 - μ = 100 cm^2/V-sec, n = 2 × 10^{14} cm^{-3}.

ceramic is in the paraelectric phase).

The semiconductor film was polycrystalline, not oriented, and the carrier density n and the mobility μ varied in it as functions of the intensity of light from an incandescent lamp. A filter absorbing the infrared light was used. The current contacts were made of indium.

Transverse acoustic waves of frequency f = 20 MHz, with displacements perpendicular to the plate surface, were introduced through the end of the plate. A pulsed electric field E (pulse duration 3 μsec, repetition frequency 40 Hz) was applied simultaneously to the semiconducting film (to produce carrier drift) and to the ceramic (to ensure the mechanism of interaction in accord with [1]). The Joule heating of the system did not exceed 1°C.

The ceramic with cesium oxide without the superconducting film, and also the two-layer system in darkness, have an ultrasound absorption coefficient that increases significantly with E. A similar effect in other substances is described in [2]. On the other hand, when conductivity with n on the order of 10^{14} - 10^{15} cm^{-3} was produced in the semiconductor film by illumination (μ in this case was of the order of 100 - 300 cm^2/V-sec), additional ultrasound absorption α was observed when the external electric field was applied. At the same illumination of the sample, but in the absence of the external electric field, no additional absorption was observed in the system. Figure a shows plots of the coefficient of additional absorption of the ultrasound in the system against the external electric field at two different conductivities.

Figure b shows the corresponding theoretical curves, calculated at the same values of the parameters by means of the formula

$$\alpha = AE^2 \frac{r_k}{r} \frac{\left(\frac{\mu E}{s} - 1\right)\omega r_k}{1 + \left(\frac{\mu E}{s} - 1\right)^2 \omega^2 r_k^2}, \qquad (1)$$

where

$$\frac{1}{\tau_k} = \frac{1}{\tau} + k^2 D; \quad \frac{1}{\tau} = \frac{4\pi\sigma h k}{\epsilon}.$$

Here $\omega = 2\pi f$, $\sigma = e\mu n$, $s = 2.6 \times 10^5$ cm/sec is the speed of sound determined by us from the delay time of the pulse in the sample, k is the wave vector of the sound, D is the coefficient of carrier diffusion in the semiconductor, and h is the thickness of the layer in the CdSe. The coefficient A depends significantly on the type of the acoustic wave (surface, volume, etc.) and was not calculated in this paper. The curves in Fig. b are therefore shown in arbitrary units.

We see that there is a similarity between the experimental and the theoretical curves. In both cases α reverses sign (the absorption changes into amplification) at a carrier drift velocity $\mu E \approx s$. When $E < 0$ we always have $\alpha > 0$. The shapes of the theoretical and experimental curves change in similar fashion with changing μ and n. All this favors the assumption that α is due to an electron-phonon interaction proportional to the applied electric field. Were the absorption connected with the usual piezoelectric interaction [3], then the $\alpha(E)$ would be centrally symmetrical with respect to the point $E = s/\mu$; at $E = 0$ we would have $\alpha \neq 0$; $\alpha_{E=0}$ would depend on the illumination. None of these properties are observed in the described cases.

Additional absorption (amplification) of ultrasound was observed also in $BaTiO_3$ doped with bismuth and antimony oxide and coated with a layer of CdSe. The amplification effect turned out to be of the same order as in the preceding case. However, the growth of the sound absorption that does not depend on the electron-phonon interaction with increasing E turned out to be much less than in the preceding case. We therefore succeeded in observing an absolute amplification of sound on the order of several dB/cm.

We note that in a system consisting of the same semiconductor and a ceramic with small ϵ (T-80 ceramic, $\epsilon = 80$), no additional absorption of the ultrasound was observed upon application of an electric field and of illumination.

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METHOD OF REDUCING THE RELAXATION TIME OF A PASSIVE NEODYMIUM-GLASS LASER SHUTTER

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Theoretical investigations [1, 2] have shown that radiation of a laser with a rapidly-relaxing passive shutter should constitute single ultrashort pulses (USP) with duration $\Delta t \sim (c\Delta\nu)^{-1}$, where $\Delta\nu$ is the width of the generation spectrum. However, for the widely used neodymium-glass laser passive shutters the relaxation time of the population of the working levels is $\tau_{rel} > \Delta t$ [3, 4], and groups of closely-lying pulses are separated in the axial period of the laser radiation. The duration of these groups can be different