modulated waveguide.1)

In conclusion, the authors are grateful to Academician D.V. Skobel'tsyn for interest in the work and for collaboration in the development of the research on self-focusing.

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TRANSVERSE ACOUSTOELECTRIC EFFECT IN A LAYERED $LiNbO_3$-Si STRUCTURE

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If an ultrasonic wave (USW) propagates in a piezosemiconducting crystal in the piezoactive direction, then, as a result of the transfer of momentum from the conduction electrons to the phonon flux, electrons are dragged by the acoustic wave, and an acoustoelectric field is produced in the direction of the USW in the open-circuited sample, compensates for the action of the acoustic wave. This phenomenon is known as the acoustoelectric (AE) effect and in the case of three-dimensional USW was investigated in detail (see, e.g., [1 - 2]). The acoustoelectric effect in surface waves and its characteristic features were first considered in [3], and an experimental investigation of the AE effect, produced when purely transverse surface USW propagate in piezosemiconductors, was reported in [4]. In the case investigated in that paper, just as in the case of three-dimensional waves, the AE effect was produced in a piezoactive medium, where the USW wave itself propagated.

On the other hand, in layered structures consisting of a piezodielectric and a semiconductor, there is no acoustic contact between the media, and the

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1) We indicate, incidentally, that in spite of the statement made in [10], the process considered in [11] is not self-focusing, since [11] deals with plane waves and a longitudinal redistribution of the field and of the plasma in the direction of wave propagation, whereas in self-focusing there is a transverse redistribution and a change in the divergence of the beam in an initially homogeneous medium, as a result of the appearance of a transverse gradient of the nonlinear refractive index.

electron-phonon interaction results from penetration of the electric field of the surface USW into the interior of the semiconductor; this field, however, attenuates with increasing distance from the semiconductor surface, owing to the screening action of the free carriers. This produces circular currents in the layers that border on the sound guide, together with a transverse acoustic emf that becomes manifest as a potential difference between the semiconductor surface bordering on the sound guide and its deeper layers.

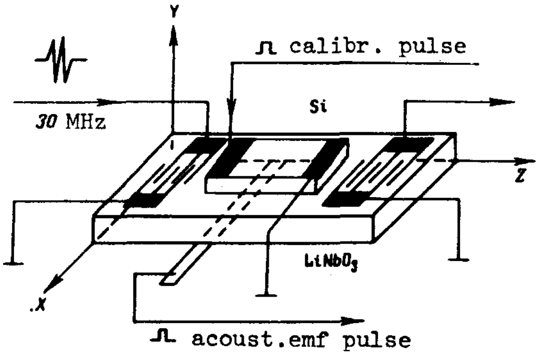

Fig. 1

In accordance with [3], the value of the transverse acoustic emf at $\omega^2\tau_M^2 << 1$ (ω is the circular frequency of the USW and τ_M is the Maxwellian relaxation time of the space charge) is given by the expression

$$V_{AE} = \frac{\alpha W \mu}{\epsilon \omega v_s} \kappa , \qquad (1)$$

where α is the coefficient of electronic damping of the USW, W the power of the sound per unit width of the sound beam, and μ the mobility of the carriers in the semiconductor. Further, ε and v_s are the dielectric constant of the semiconductor and the speed of sound in the sound guide, respectively, and κ is a quantity determined by the elastic and piezoelectric constants of the sound guide and reflecting the "mechanics" of the problem. As seen from (1), the transverse acoustic emf is proportional to the sound power and to the electron-absorption coefficient, but unlike the well-known Weinreich relation, it does not depend directly on the concentration of the free carriers.

A schematic diagram of the experiment for the observation and investigation of the transverse AE effect is shown in Fig. 1. Packets of Rayleigh USW with duration $\tau = 1$ µsec were excited in a thin (0.5 mm) sound guide of lithium niobate by a two-phase cone-like converter at a frequency 30 MHz. On the opposite side of the sound guide was located a metallic strip of 0.5 mm width, serving as a probe. The capacitance between the metallic strip and the surface of the semiconducting plate was $C \approx 1$ pF. The signal of the transverse acoustic emf, in the form of the potential difference between the surface of the semiconductor and its interior layers, was fed through this capacitance to the input of an amplifier with a large input resistance ($R \approx 500$ megohm) and was displayed on an oscilloscope screen. Since the condition $RC >> \tau$ was satisfied for the time constant of the input circuit, there was no distortion of the signal wave form. The semiconducting plate had on its outer surface two ohmic contacts, one of which was grounded, and to the other was applied a calibration pulse and a constant drawing field (when the dependence of the acoustic emf on the carrier drift was investigated).

It was observed that at the instants of passage of a packet of surface USW over the probe, a transverse acoustic emf signal is produced, the sign of which is determined by the type of conductivity of the semiconductor. The magnitude of the acoustic emf, on the other hand, at a definite value of the conductivity ($\sigma > 10^{-3}$ ohm^{-1}cm^{-1}) is proportional to the sound power (Fig. 2), and at a fixed sound power it varies in proportion to the coefficient of electronic absorption, and thus does not depend directly on the conductivity.

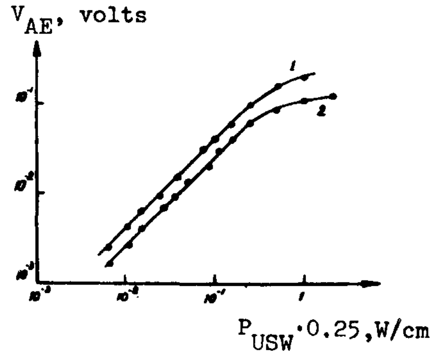

Fig. 2. Dependence of the acoustic emf on the power of the Rayleigh ultrasonic wave: 1 - $\sigma = 2.7 \times 10^{-4}$, 2 - $\sigma = 1.8 \times 10^{-3}$ $\text{ohm}^{-1}\text{cm}^{-1}$.

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) × 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