experiments exceeded 5 V/cm for a 0.5 Meg load.

The even acousto-electric effect always had a definite polarity, regardless of the surface finish of the sample and of the nature of the contacts. The latter were made by sputtering indium or silver, with or without subsequent heating to 300°C.

Positive voltage always corresponded to the $(000\bar{1})$ plane, and negative to (0001), as determined by us from the shape of etch pits [6]. Crystals in which an even acousto-electric effect was observed displayed strong luminescence under the influence of the mercury lamp radiation.

We have thus observed a strong even acousto-electric effect in zinc sulfide crystals. However, since the even acousto-electric effect, unlike the odd one, can be of diverse nature, its physical causes in the crystals investigated by us call for further explanation.

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RECOMBINATION RADIATION STIMULATED IN SILICON BY LONG-WAVE INFRARED RADIATION

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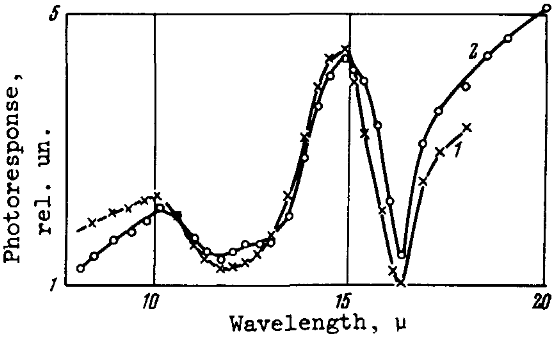
Optical charge exchange of impurity centers, observed at low temperatures in semiconductors [1], can lead to the appearance of several peculiarities in the behavior of the semiconductors. In particular, under certain conditions the charge exchange should increase the photoresponse of a semiconductor in the region of impurity absorption of light and, a fact we consider especially interesting, cause the appearance of recombination radiation stimulated by light from the impurity-absorption region.

Indeed, let us consider a semiconductor doped with acceptor and donor impurities, and let us assume that the levels of the donors are close to the conduction band and those of the acceptors to the valence band. At sufficiently low temperatures, when the thermal ionization of the acceptors and donors is negligibly small, exposure of the semiconductor to a light that produces electron-hole pairs leads to charge exchange of the impurity centers. In this case almost all the donor centers are filled with electrons, and the acceptor centers with holes. If we now expose the semiconductor to radiation corresponding to the impurity absorption region, then the photoresponse of such a charge-exchanged semiconductor should increase, compared with the equilibrium case, both because of the increase in the large number of absorbing centers and because of the decrease in the number of recombination centers. Further, the free carriers produced by the ionization (we shall take them for simplicity to be electrons) are either captured by the ionized donors, whose concentration is small as a result of charge exchange, or recombine with the holes that are bound to the neutral acceptors, whose concentration is large. The latter transitions are in the main radiative. We note that the energy of the photons emitted upon recombination is of the same order as the width of the forbidden band of the semiconductor, i.e., it is sufficiently large. Thus, the absorption of a long-wave photon should cause emission of a short-wave photon of considerably larger energy.

The existence of such a mechanism was experimentally confirmed by us, using silicon doped with boron and antimony 1) ($N_B = 8 \times 10^{13}$ cm^{-3}, $N_{Sb} = 2 \times 10^{14}$ cm^{-3}). A silicon sample measuring 2 x 2 x 6 mm was mounted in a standard helium cryostat, in which the sample could be cooled to 7 - 9°K. The sample was illuminated through a cold window (filter) of indium antimonide with modulated monochromatic radiation in the wavelength range from 8 to 20 μ. The sample could be simultaneously exposed to unmodulated light from a small incandescent lamp placed in a cryostat. Besides the sample, a commercial germanium photodiode with glass entrance window was mounted in the cryostat so that it could register the possible radiation from the sample. We registered the photoresponses of the sample and of the photodiode with a standard measuring circuit, including an amplifier, a synchronous detector, and an automatic recorder.

The photodiode did not respond to the modulated IR radiation unless the additional lamp was also on, or conversely to the additional lamp alone without the IR radiation. On the other hand, when the sample was simultaneously illuminated by the lamp and by the modulated IR radiation from the monochromator, a photoresponse signal at the frequency of the IR-radiation modulation was produced by the germanium photodiode. The Figure shows the spectral distribution of the photoresponse of the germanium photodiode (Curve 1) as well as the spectral curve of the photocurrent from the silicon sample (Curve 2). The photodiode signal and the photoresponse of the sample depend on the intensity of the unmodulated illumination. The photocurrent induced in the sample by the illumination could increase by a factor of more than 100, but without a change in the



Spectral distribution of the photocurrent in a silicon sample (2) and in a germanium photodiode (1), relative to the monochromatic power incident in the InSb cold filter.

spectral distribution of the photoconductivity.

The agreement between the spectral distributions of the silicon sample and the germanium photodiode, and also the fact that the photoresponse of the diode is produced only by simultaneous exposure of the silicon sample to the monochromatic radiation and the additional illumination, shows decisively that recombination radiation stimulated by long-wave IR light occurs in charge-exchanged silicon. The free electrons and holes produced by the IR radiation are captured by the charge-exchange recombination centers, the electrons by the neutral boron atoms, and the holes by the neutral antimony atoms. The energy of the photons emitted in this case (~1 eV) [2] corresponds to the region of photosensitivity of the germanium diode.

Thus, the long-wave radiation was transformed in this experiment into short-wave radiation with an appreciable gain (by a factor ~20) in the photon energy.

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CONVECTIVE INSTABILITY OF A PLASMA WHICH IS NOT UNIFORM ALONG THE MAGNETIC FIELD

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The stability of a plasma which is not uniform in a direction transverse to the magnetic field has been intensively investigated in recent years [1]. In practice, however, a plasma is quite frequently nonuniform also along the magnetic field. Axial plasma-density gradients are produced, for example, in the case of free diffusion of charged particles from a source to the side walls of the chamber (high-frequency discharge, cathode region of gas discharge, diffusion plasma decay, etc), in the case of volume recombination of a dense plasma, etc. We shall show that a weakly ionized plasma is subject to its own specific instability resulting from the presence of an axial density gradient.

We introduce a coordinate system with the z axis directed along H and x axis along the transverse density gradient. We then have for the electron velocity

$$\vec{v}_{e\perp} = \frac{C}{H}\left[h,\ \nabla\varphi - \frac{T_e}{en}\nabla n\right] - \frac{D_e}{(\Omega_e\tau_e)^2}\frac{\nabla_\perp n}{n} + \frac{b_e}{(\Omega_e\tau_e)^2}\nabla_\perp\varphi\ ,$$

$$v_{ez} = b_e\frac{\partial\varphi}{\partial z} - D_e\frac{1}{n}\frac{\partial n}{\partial z}\ . \qquad (1)$$

Here $\vec{h} = \vec{H}/H$, b_e is the electron mobility, D_e the diffusion coefficient, φ the electric field