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Fig. 1

Figure 1: Fig. 1

Abstract

Full Text

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CURRENT OSCILLATIONS IN CdS CRYSTALS STIMULATED BY AN EXTERNAL SOUND SIGNAL

(Presented by Academician I. V. Obreimov, 18 IV 1968)

It is shown that the introduction of an ultrasonic signal into a crystal makes it possible to pass from a saturation regime to a regime of current oscillations.

For homogeneous CdS samples there exists a critical value of the conductivity σ_{cr}, below which current pulsations do not arise. In the crystal, in this case, there is a stationary distribution of the intensity of thermal noise and a corresponding distribution of the electric field. The magnitude of the saturation current I_{s} in such a regime is less than the ohmic current I_{om} (i.e., the current at the moment when voltage is applied to the sample) and does not change with time. At $\sigma > \sigma_{\mathrm{cr}}$, current oscillations arise as a result of a redistribution of the intensity of thermal noise due to its amplification and the formation of an acoustoelectric domain ([1]).

In the present work it has been established that one can pass from the saturation regime to the regime of current oscillations also at $\sigma < \sigma_{\mathrm{cr}}$, owing to an external ultrasonic signal introduced into the crystal. For this purpose, in a CdS sample (length 10.3 mm, cross section 4.5×4.5 mm^2), oriented for the amplification of shear waves, illumination was used to set the conductivity to $\sigma = 9 \cdot 10^{-4}\ \Omega^{-1} \cdot \mathrm{cm}^{-1}$, at which current saturation occurred. An external ultrasonic signal at a frequency of 25 MHz, with a duration of 1.5 μsec and of comparatively high intensity, was introduced by means of a quartz transducer. The voltage amplitude on the quartz plate was 50 V.

Fig. 1. Appearance of current pulsations in the sample upon introduction of an ultrasonic signal. $I_{\mathrm{om}} = 26$ mA. Marks are at intervals of 1 μsec. *a*—the signal is delayed relative to the leading edge by 5 μsec, *b*—by 11 μsec, *c*—by 17 μsec.

When a voltage $U = 1400$ V was applied to the sample, the acoustoelectric emf associated with amplification of the external signal led to a substantial redistribution of the field in the sample. As a result, the current at the time preceding the exit of the signal from the sample became less than the value I_{s}.

In Fig. 1 the first current minimum corresponds to the position of the signal near the anode. The subsequent behavior of the current can be explained if one takes into account that the second current minimum lags behind the first by a time equal to the transit time of sound through the crystal. The second minimum is associated with the amplification of already amplified thermal noise, which, after multiple reflections from the boundaries of the sample, is located near the cathode at the moment when the signal exits.

The pattern of the field distribution in the specimen in this case is the same as at the moment when the drift voltage is switched on. This is evidenced by the recovery of the current after the signal has passed to the ohmic value. However, the intensity of the ultrasonic noise distributed in the specimen at this moment is higher than its initial level. As a result, with a further amplification of the noise, the possibility arises of the formation of an acoustoelectric domain and of the current oscillations associated with it, in accordance with the mechanism described in ([1]).

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Note: Figure translations are in progress. See original paper for figures.