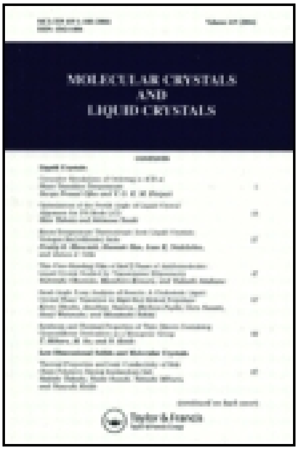

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Light Scattering by an Optically Addressed Light Modulator

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Light Scattering by an Optically Addressed Light Modulator

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Light scattering (LS), dependent on control voltage in the system—photosemiconductor–liquid crystal, has been investigated. LS hysteresis has been obtained. LS intensity and LS voltage dependence on the velocity of voltage change has been defined.

A lot of work has recently been published concerning the application of a dynamic optically addressed light modulator (OALM) based on photosemiconductor–liquid crystal (PhS–LC).[1–4]. The modulators of this kind, however, do not find wide usage because of some shortcomings conditioned both by technology and physical properties of applied materials. Besides, OALM are known where solid solutions of compounds A^2B^6 are used as PhS, as well as various mixtures of nematic liquid crystals (NLC).[5–7]

Naturally the application of OALM is conditioned by their parameters. In order to determine the ways of perfecting dynamic and static parameters of OALM, the authors have studied the transient processes which influence these parameters. For this purpose an OALM has been produced for transmission. A photosemiconductor substratum has been sprayed with ZnCdS solid solution while the nematic liquid crystal has been taken as cyanobiphenil mixture. NLC mixture was quite clear ($\rho \sim 10^{11}$–10^{12} $\Omega \cdot$ cm) and its orientation on substrata was planar. OALM operated on the basis of field *S*-effect. Anisotropy of dielectric permeability was equal to 11 ($\Delta\epsilon = +11$).

While studying the ways of perfecting the quality of OALM it has become evident that one of the shortcomings of OALM is light scattering (LS) of a reading beam. For this purpose a special desk has been constructed. A laser with the wavelength $\lambda = 633$ nm was the source of the reading beam. Surface energy density was $8 \cdot 10^{-3}$ W/cm. Applying a lens only a scattered light was collected and registered. A parallel beam of reading radiation was eliminated with the help of a screen corresponding in size to the beam size. An informative ray was formed by a homogeneous one with energy density $5 \cdot 10^{-4}$ W/cm^2. The wavelength was determined by a CC-5 filter with the maximum about 440 nm.

Scattered depolarized light intensity dependence on OALM voltage is illustrated in Figure 1. A voltage sign in the figure corresponds to the voltage polarity of the semiconductor. As seen from the figure, the LS intensity is of an obviously threshold nature. The asymmetry of LS intensity from voltage polarity can be explained by the properties of the contact between CdZnS and SnO_2 as well as a transparent conductive film. The steep rising part of LS intensity at both voltage polarities corresponds to the instability of LS to a higher degree and that of PhS to a lesser degree. The parts corresponding to saturation are mainly due to the motion, caused by an electric field, of a liquid crystal.

Note that the values of threshold voltage U_c change dependent on the voltage velocity (Figure 2). At small change velocities they are

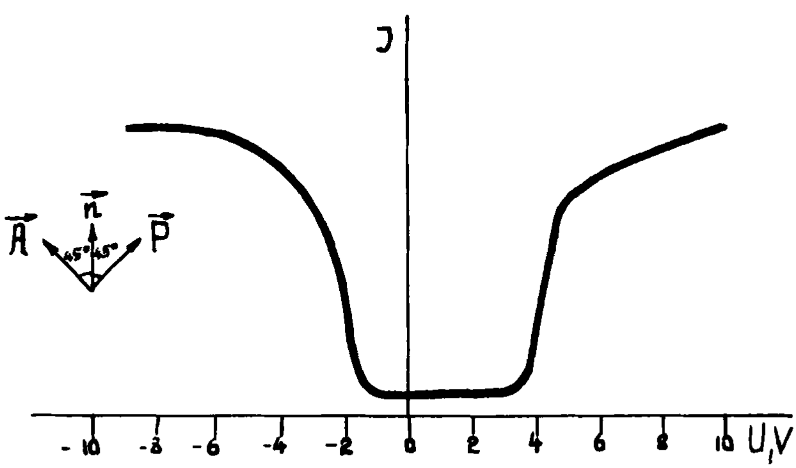

FIGURE 1 LS intensity dependence on voltage under voltage change velocity of 2.58 V/min.

higher. With the further increase in velocity they take maximum and then decrease to minimum values. At higher velocities threshold voltages only increase. Thus, selecting the change regime for OALM control voltage we are able to select working voltages U_p which would be lower than $U_c (U_p < U_c)$ and would not make the parameters of OALM worse. It is worth while mentioning that the velocity of a change in illumination may lead to analogous effects. Quantitatively maximal change in intensity due to LS under certain regimes may reach a half of the intensity change which is due to oscillations for S-effect.

For crossed polaroids we have determined only the depolarized part of LS. Naturally we are interested in LS as well, where the polarization does not change. While studying such a scattering we have pointed out a case, when a polarizer P is oriented with respect to an analyzer A and a molecular director LCn at an angle of 45°. In this case LS intensity dependence on applied voltage is shown in Figure 3. An explicitly expressed hysteresis of LS is observed for both voltage polarities. Voltage being increased (+ is connected to PhS) the oscillative nature of LS is observed. The first maximum value of LS is

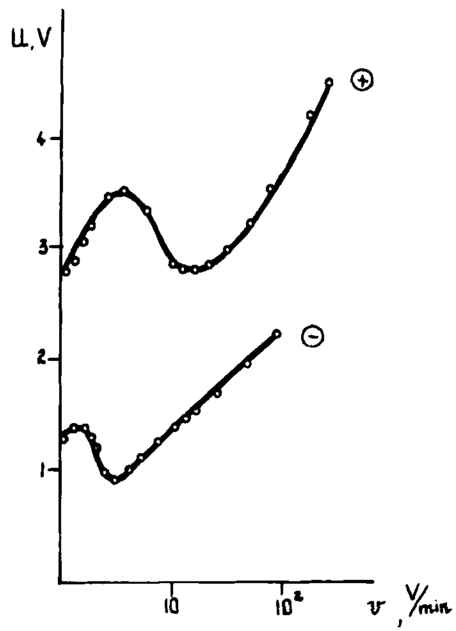

FIGURE 2 LS threshold voltage dependence on voltage change velocity. + and − correspond to voltage polarity on PhS.

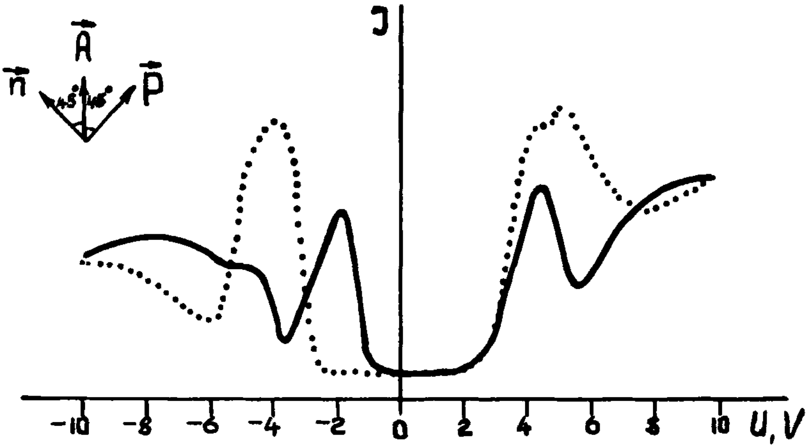

FIGURE 3 LS intensity dependence on voltage. Voltage change velocity is 2.58 V/min. A continuous line marks the dependence at the increase, while a pointed line marks the dependence at the decrease in voltage absolute value.

dependent both according to its intensity and to voltage, at which it is observed, on the velocity of a change in control voltage. The observation under microscope enabled us to determine that LS is due to bubble domains. With further *U* increase we get dynamic LS. With the decrease of control voltage we get one maximum value of LS, the intensity of which is much higher than the intensity at the increase. Both the intensity and typical voltages also depend on the velocity of a change in control voltage.

LS is of analogous nature for opposite polarity of voltage as well. The asymmetry of voltage threshold values can be explained by PhS—SnO_2 contact. In this case one ought to note the appearance of the second LS maximum at the increase and the explicitly expressed minimum at the decrease.

Thus, having defined the causes for LS, we can select the control voltage regime in such a way that LS were the least and the parameters of OALM were better. Besides, the investigated nature of LS may be technically applied as well, both to information processing and to NLC investigation.

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