SOME PECULIARITIES OF PHOTOREFRACTION IN NEMATIC LIQUID CRYSTALS WITH A SILICON SUBSTRATE

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1. Introduction

In modern technology media, where it is possible to record the optical information at high speed and density, using low light intensities, are necessary for information processing and storage. From that standpoint, materials with observable photorefracting phenomena are of special interest. Among these materials, it is necessary to single out liquid crystals (LC) as they possess a strong optical nonlinearity.

The LC photorefractive properties have been investigated recently [1-5] and despite this fact, they are widely used in ultra-modern technology. In particular, there are modern models of projection displays [4], as well as optical limiters, optical filters, devices for high-density optical information recording and control, the basis of which are the LC photorefractive properties.

As is known, the photorefraction in LC occurs due to the charge redistribution. It is worth mentioning that the semiconductor in its turn is very sensitive to external light and electric fields, therefore, the occurrence of photogenerated charges and their further redistribution take place at low intensities.

This work is devoted to investigation of such system optical properties, where in LC system a semiconductor replaces one of glass substrates.

2. Experiment

For comparison we investigated two types of systems: in one case the substrates of the investigated sample are ITO coated glasses, in the other case one of them is replaced by n-type silicon (see Fig. 1).

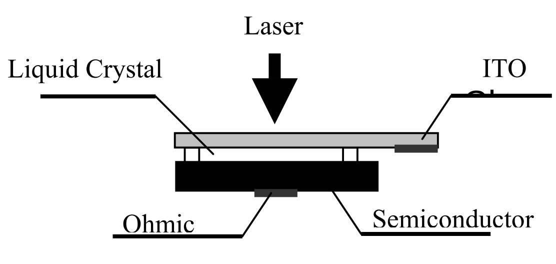

Fig. 1. Design of liquid crystal semiconductor cell.

In both cases E-48 nematic liquid crystal was used. The cells were planarly oriented, so that the long axes of LC molecules were parallel to the substrates. With this purpose each substrate was coated by centrifuge with polymer thin layer, the surface of which was lined by silk cloth. The experiment scheme is shown in Fig. 2.

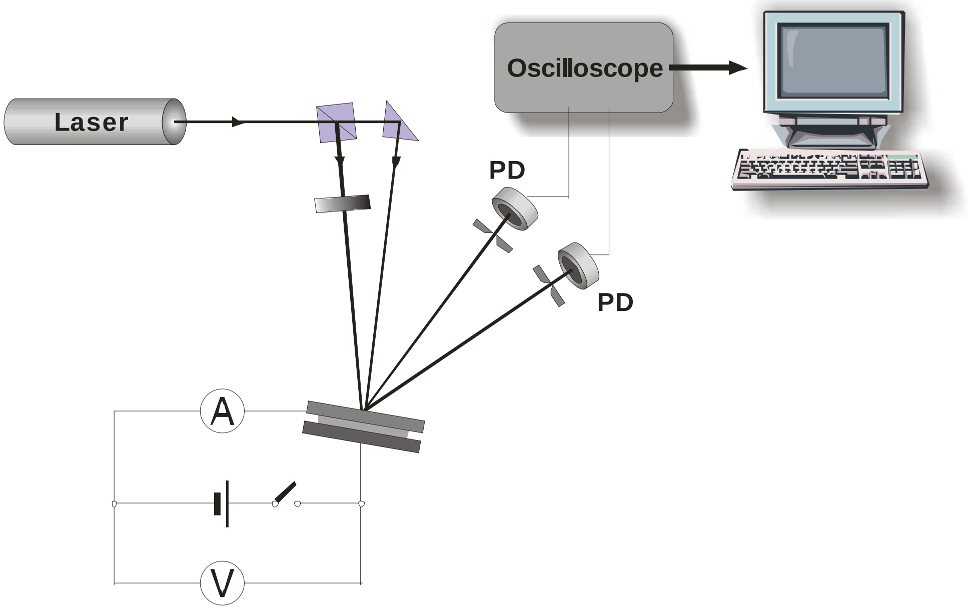

Fig. 2. Experimental setup.

By means of optical system the laser beam (0.532 μm) is divided into two beams provided with the interference condition. The two beams are polarized in the same way, thus the beams intensities are equalized by means of a neutral filter. The laser beam power is 30 mW. At the point of beams intersection the investigated sample is placed. In the areas, where the electric vectors of light beams are in the same phase, the light intensive regions appear. The interaction of these areas with LC molecules causes molecular circulation. The latter gives rise to the material refractive index change. Thus, the interference pattern "is written" in the cell.

The obtained interference pattern is shown below (Fig. 3).

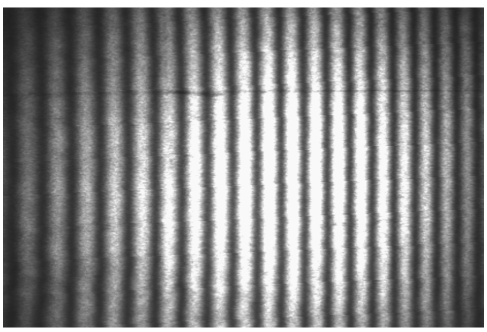

Fig. 3. Interference pattern in case of the semiconductor substrate.

The period of interference lines is determined as follows:

$$\Lambda = \frac{\lambda}{2\sin\theta/2} ,$$

where λ is the length of light beam in the media.

In our experiment Λ~40 μm in case of the given distribution of elements. The light beam, falling on to the obtained grating, undergoes diffraction (Fig. 4). The diffraction efficiency was measured for both types of samples.

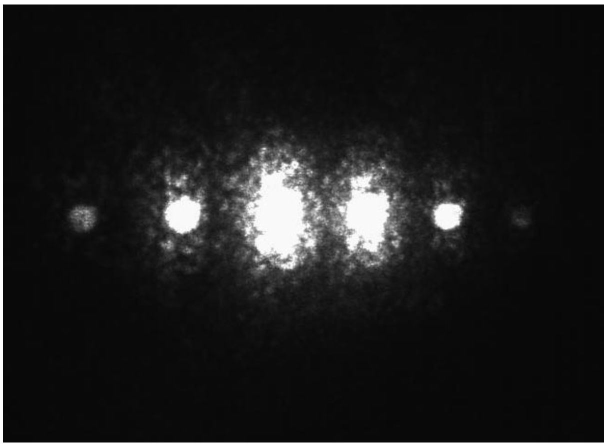

Fig. 4. Diffraction spots.

The dependences of diffraction efficiency vs. dc voltage applied to the cells for both samples are shown in Fig. 5.

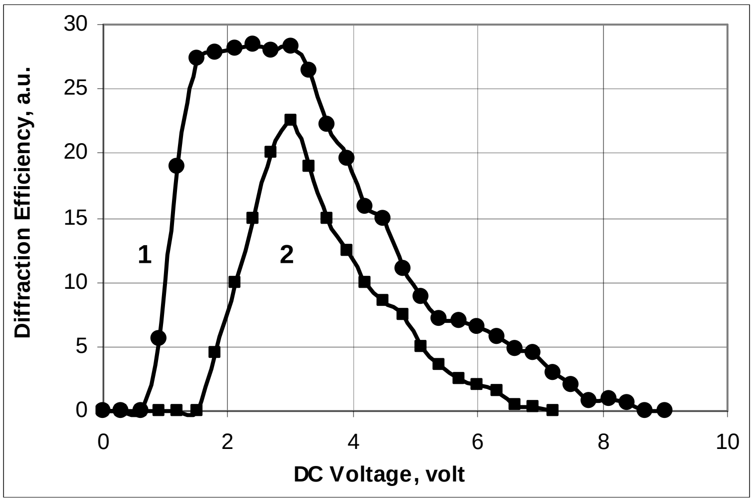

Fig. 5. Difraction efficiency vs. dc voltage for the sample with the silicon substrate (1) and with two ITO-coated glass substrates (2).

As is seen in the figure, in case of the sample with semiconductor (curve 1) the threshold value appears at considerably low voltage. It is noticeable that the comparative diffraction efficiency is higher in case with semiconductor pattern. Thus, there are qualitative differences in the systems with semiconductor: for the comparative diffraction efficiency as well as for the threshold value.

3. Conclusions

According to the obtained results, we may state that the semiconductor essential influences properties of a thin interfacial layer formed at semiconductor – LC interface. Though it should be noted that due to microscopic compound construction of the interface layer it is practically impossible to estimate the quantitative values.

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