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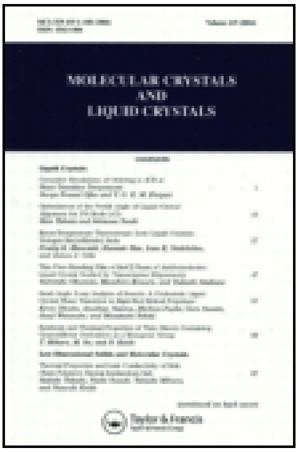

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CONTROL OF LC CELL RESOLUTION, USING THE THERMO-OPTICAL EFFECT

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Abstract The influence of thermal writing information parameters on LC cell resolution is considered in this paper. The thermo-optical effect in LC is the basis of information writing process. The addressing is realized by laser beam. The ridge-shaped polymer with lateral mesogenic groups is used as information carrier. We present the description of an experimental device for writing of information on LC cell. The authors measured and discussed the resolution of the LC cells as the function of temperature and laser scan velocity.

INTRODUCTION

The present-day state of development of automated processing of information is characterized by increased volume of work, connected with obtaining of complex highly informative graphic images. The projection displays, obtained by means of thermo-optical addressing meet these requirements.

Highly informative displays, where low-molecular LC materials were applied[1], are not in current use nowadays. Their main disadvantages are: low contrast ratio of the image and short term of written information storage. Because of the rapid development of LC polymers synthesis, the investigations dealing with the construction of highly informative displays were given a new impulse. A number of investigations[2-4], showing the advantages of LC polymers and possibilities of their applications in displays have been carried out.

Projection displays can find wide application in different branches of science and engineering. They will be able to solve various practical problems. Technical features of the devices can vary

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significantly, consequently, the construction of the devices also differs.

In order to take into account on the stage of design all the differences in the construction of the display, and to optimize their technical characteristics, it is important to know the parameters technical characteristics of the device depend on, and to study their interrelations. For this purpose the informational model of the display can be represented as four groups of parameters, which are interrelated: a) image characteristics (contrast ratio, resolution, information capacity, semitones); b) the parameters of thermal writing (the power of laser radiation, scan velocity, the medium temperature); c) physical-chemical properties of the LC materials (sensivity, viscosity, dye concentration and so on); d) LC cell characteristics (thickness of the LC layer, alignment of the LC molecules, the presence of thermoabsorption layer and so on).

The aim of the given paper is to investigate the possibilities of LC cell resolution control at the expense of parameters of information thermal writing.

EXPERIMENTAL

To reach the above-mentioned aim, the experimental projection display was constructed. The scheme of the device is presented in Figure 1. The radiation of He-Ne laser, having the 0.63 μm wavelength was deflected in two axes by means of scanning system. The scanning system consists of two unicoordinate galvo-mirrors, the system of matching lenses and control circuit. The control circuit permits to vary the laser beam scan velocity from 1.0 to 1000 mm/s due to the variation of frequency and amplitude of the signal, applied to galvo-mirror. Then, the laser beam is focused in the plane of LC cell by means of writing-projection lens (50 mm, f/1.4). When the diameter of the falling laser beam was 3.0 mm, this lens produced the calculated diameter of the focal spot of 13 μm. The LC cell was in thermal chamber, where the preset temperature was maintained. Under the local heating of LC section by laser beam to the temperature exceeding the phase transition into isotropic fusion and further sharp cooling of this section. the confocal texture is formed. which intensively diffuses light. This texture is preserved for a considerable period of time. The sections with confocal diffusing texture are the carriers of written information. By means of projection system and writing-projection lens the written information was magnified and projected on the screen. The thickness of the line written on the screen was measured by means of non-polarizing measuring microscope "MIR-3".

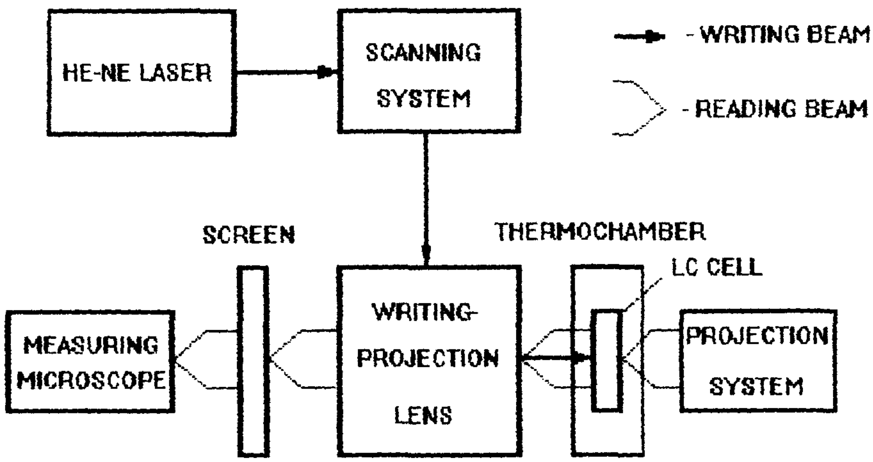
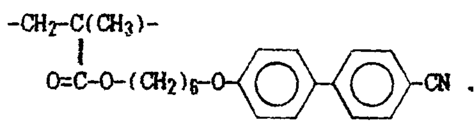


FIGURE 1 The experimental system for informational characteristics measurement of the LC cell.

As a LC material the ridge-shaped polymer with cyano-diphenyl mesogenic groups was used



having the following phase sequence: G, 60 °C, S_A, 115 °C, I; the degree of polymerization - 170. To increase the absorption factor of 0.63 μm wavelength radiation, the chinoniminic cationoidnic dichroic dye of 1% -concentration was introduced.

LC cell is a thin layer of the substance, placed between two substrates. The substrates are glass plates, their thickness is 1.3mm. They are covered from one side by the transparent conducting film of

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tin(IV) oxide, which gives the possibility to apply the electric field to LC. The layer thickness of LC is regulated by means of teflon spacers, the thickness of the spacers is 24 μm. The cell is bonded with epoxy adhesive. The filling of emply cell is realised under the influence of capillar forces at the temperature exceeding the temperature of phase transition S_A-I. Homeotropic alignment of LC polymer molecules was realised by applying of sinusoid voltage of 80V, 0.5 kHz (real value) to the electrodes of substrates.

The radiating power at the output of He-Ne laser was 10.8 mW. The power of 3.7 mW was applied to the LC cell. The calculated density of laser rediation power in the point of writing was 6.97 W/mm^2. In the course of experiment the scan velocity of the laser beam varied from 5 to 165 mm/s, the difference between the medium temperature and phase transition temperature S_A-I was from 40 to 10 ^{o}C. Power of laser radiation remained constant. The thickness of the written information, which equaled 8 - 40 μm, was registrated by means of measuring microscope. Then, the LC cell resolution was calculated taking into account the writing-projection lens magnification factor. The resolution of the LC cell varied from 25 to 125 pels/mm(pixels/mm).

RESULTS

In the course of experiment the dependences of LC cell resolution on the parameters of thermal writing of information by laser beam were obtained. Figure 2 presents the experimental dependences of LC cell resolution on difference between the medium temperature of LC cell and phase transition temperature S_A-I, when the scan velocity of the laser beam is constant. Figure 3 presents the experimental dependences of LC cell resolution on scan velocity of the laser beam at constant temperature difference. It is seen from Figure 2 and Figure 3, that the LC cell resolution can be controlled either by means of varying of laser beam scan velocity or by varying the medium temperature. LC cell resolution can be changed approximately five times. Further analysis shows that the resolution control due to the temperature variation is a slow process and needs very accurate system of thermostabilization. This results in lowering of cost efficiency of the whole device. That

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is why it is more reasonable to control the LC cell resolution by varying scan velocity, because this permits to accelerate the process of control. Besides, it is seen from Figure 2 that five times changing of resolution can be obtained only at relatively high scan velocity, that is why we need LC material having high-absorption factor or there should be additional thermoabsorption layers in LC cell.

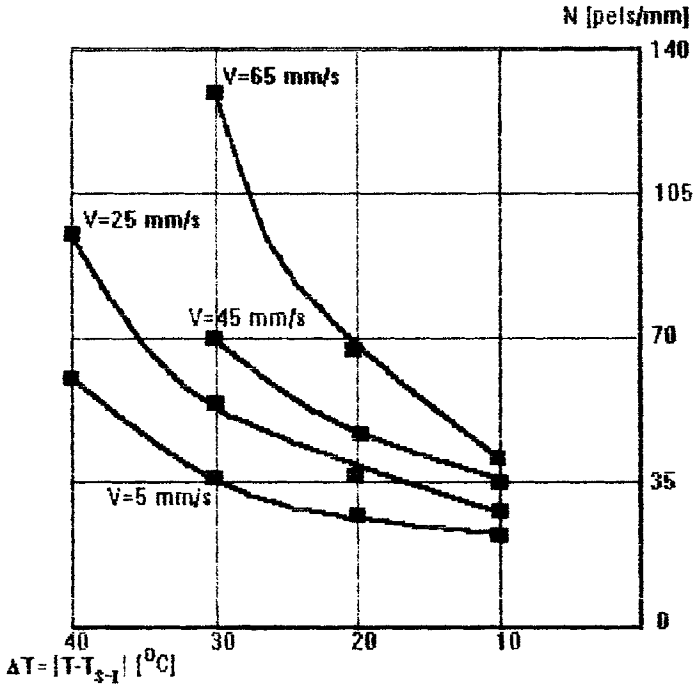

FIGURE 2 The temperature experimental dependences of the LC cell resolution N.

The results of investigations show that the important condition for obtaining the maximum range of resolution control is the approach of medium temperature to the temperature of phase transition S_A - I. Though, there exists an opinion, that the medium temperature must be lowered to the value, exceeding room temperature, approximately 10 - 20 °C.[2]

When the size of focal spot was 13 μm the thickness of written line varied from 8 to 40 μm depending on scan velosity. It is evident that scan velosity variation results in variation of absorbed thermal

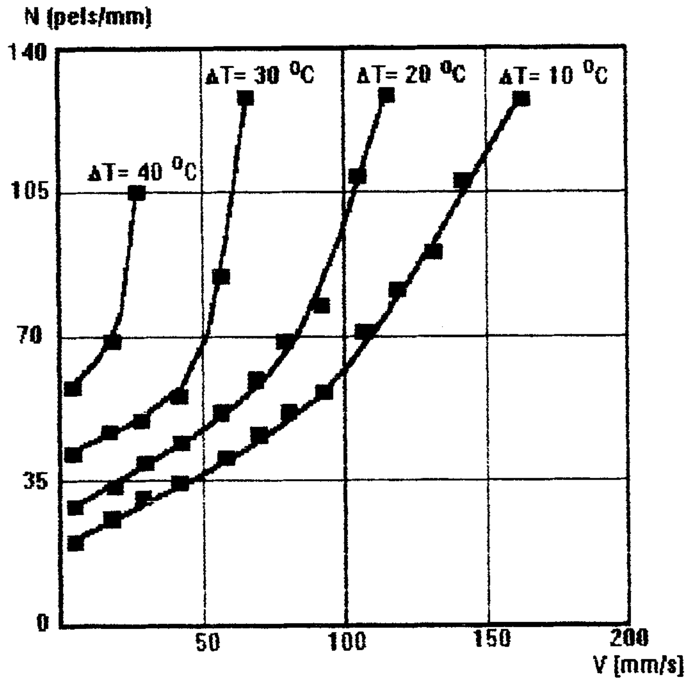

FIGURE 3 The experimental dependences of the LC cell resolution N on scan velocity V.

energy value. These results are in good agreement with[2] and prove that the resolution increase is possible.

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