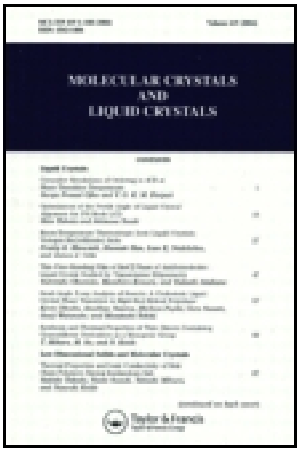

Molecular Crystals and Liquid Crystals Incorporating Nonlinear Optics

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Electrooptic Effects in Encapsulated Liquid Crystals

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ELECTROOPTIC EFFECTS IN ENCAPSULATED LIQUID CRYSTALS

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Abstract Electrooptic phenomena in the encapsulated LC under pulse and sinusoidal external fields are considered. Dynamical selection of pulsed signal and frequency doubling of sinusoidal one are observed.

Encapsulating of liquid crystals (LC) into thin envelope of polymer film has become now an acknowledged method of LC protection from environmental damage. Physical and chemical investigations of encapsulated LC showed new ways to vary their properties by choosing the components of LC-polymer mixture and changing capsules dimentions, as well as applying external electric fields[1].

Electrooptic phenomena in the encapsulated LC under pulse and sinusoidal external fields have been considered in this work. LC of cyanobiphenyl and pyridine types, encapsulated in polymeric matrix have been used as objects of our investigation. Different polymer properties have been considered and polyvinylacetate has been chosen for encapsulating. This is an amorphous thermoplastic polymer, being soluted and dried it doesn't undergo chemical changes and has good mechanical properties. Polyvinylacetate is a colourless polymer, its refractive index is close to the one of LC and LC are well wetted by it. The mixture of acetone-toluene-chlorobenzene has been taken as a solvent.

The composite film can be formed easily from organic solutions: LC is mixed with polyvinylacetate and solvent and the solution is put on the substrate. When the dissolvent has partly evaporated, the mixture dissociates into two phases and the polymer film formed after drying has nearly spherical LC droplets homogeneously distributed.

To investigate the electric field influence on the optical properties of encapsulated films they have been placed between two glass plates, covered with transparent conductor, where electric voltage has been applied. Fig. 1 shows the reaction of modulator transpatency to the rectangular pulses. The modulator does not respond to stationary field and it's working cycle is determined by the responce time to the switch-on/switch-off of electric signal, that is the dynamical selection of the control signal is observed.

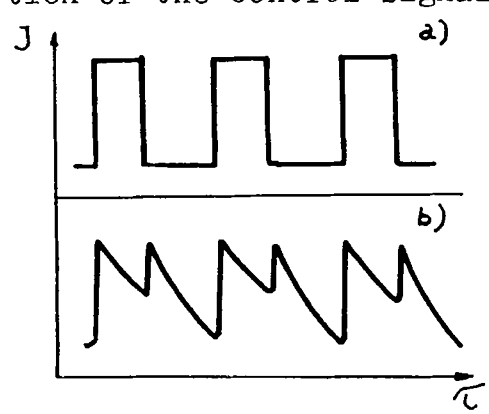

FIGURE 1. Modulator time characteristics a) electric field b) transparency response - dynamical selection of signal is observed.

We can suggest the following model to explain this effect. With no field applied LC molecules are disordered within a droplet and due to the different refractive indices LC-polymer system strongly scatters the light (Fig.2). With the field applied LC molecules within a droplet are oriented along the field and the film becomes transparent (Fig.2b). Then the LC-polymer interfase slowly reacts on the field applied, screens the external field and the initial structure is restored (Fig.2c). At the very first moment after switching-off of the external field the internal field of LC-polymer interface becomes discompensated, that causes the molecules ordering in the droplet and the sample enlightening (Fig.2d).

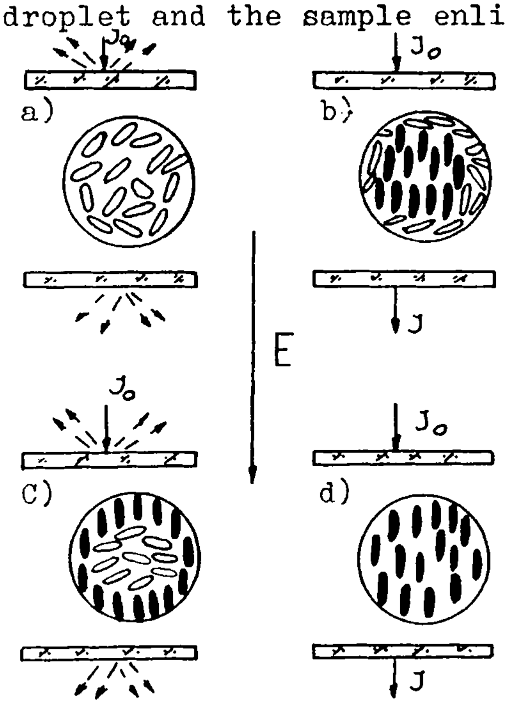

FIGURE 2. Mechanism of transparency changes under alternating field.
a) No field applied, strong scattering in the film.
b) External field is applied, LC is oriented in the droplet, scattering disappears.
c) External field is compensated by LC-polymer interface, scattering restores.
d) Just after the removal of applied field, LC is oriented by compensating field of LC-polymer.

The investigations under variable sinusoidal fields showed, that film transparence varies at double frequency ($\omega_t = 2\omega_f$) in comparison with the field applied. Fig.3 gives the frequency characteristics of transparence modulation amplitude for different amplitudes of voltage applied.

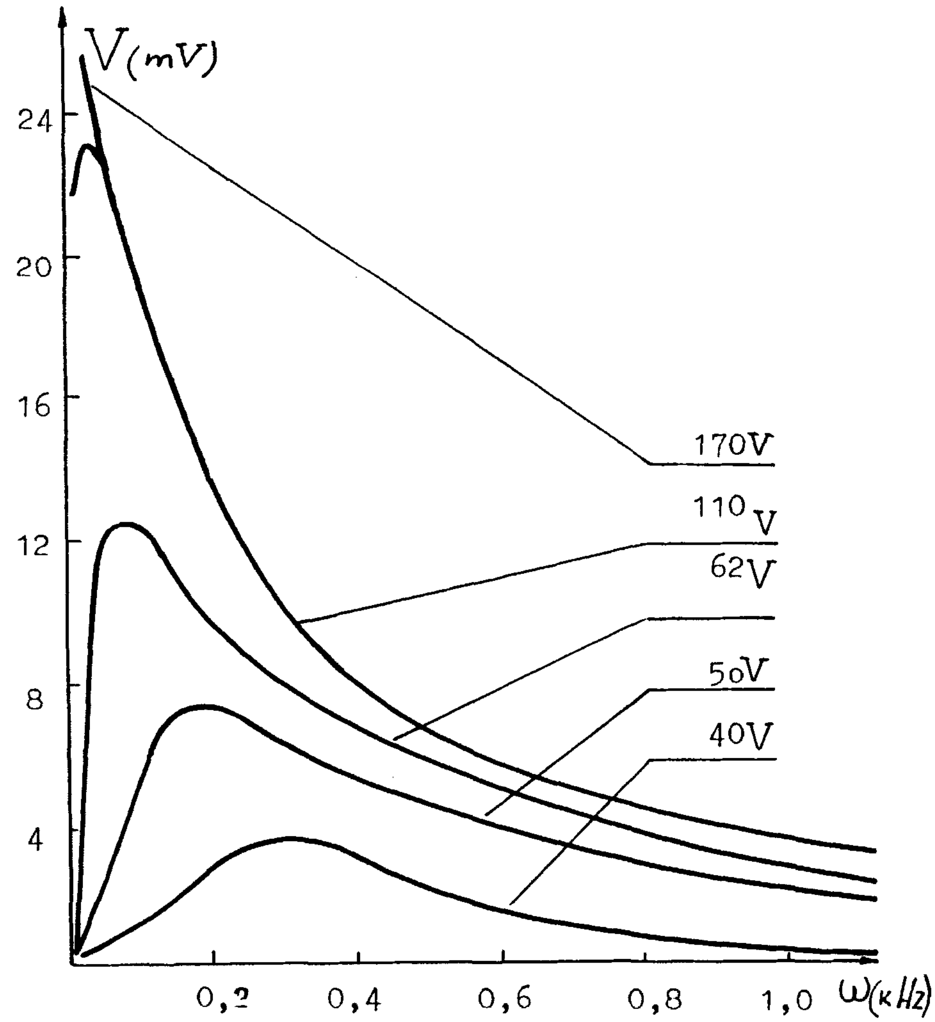

FIGURE 3. Frequency characteristics of sinusoidalexternal field.

This dependence is of the clearly resonance kind. Under field amplitude increase the transparence maximum is displaced into the low-frequency region. That may be connected with the LC interface molecules involved into the process of initial orientation, which are closely bonded with the polymer and so have longer time of responce. The increase of modulation depth under increasing of applied field indicates the rising of the volume of oriented LC.

REFERENCE

1. J.W.Doane, N.A.Vaz, B.-G.Wu and S.Žumer Appl.Phys.Lett. 48(4), pp.269-271 (1986).