Investigations on Short Pitch Ferroelectric Liquid Crystal Mixtures

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Using well known techniques, some very interesting multicomponent mixtures having a SmC phase in a broad temperature range (-10 °C to 80 °C) can be prepared. For this, disubstituted biphenylpyrimidines showing very low viscosity and low response time compared to phenylpyrimidines were used among others as basic components. Interestingly, the pitch of the helix can be maintained within the optical wavelength region but even shorter, e.g. down to 200 nm, what is equivalent to the length of about 100 molecules or 100 smectic layers, respectively.

The so-called Deformed Helix Ferroelectric (DHF) Liquid Crystal effect was demonstrated mainly on such short pitch FLCs. For this effect, a small external electric field applied perpendicular to the helix can influence the uniform distribution. This gives rise to an effective birefringence adjustment and is the basis for applications of the DHF FLC effect. The drawback of the DHF effect is the longer switching time needed, but very recently by applying higher frequency external fields of about 100 kHz and driving voltages of about 10 V on a cell with a thickness of about 2 μm a very low switching time of the order of 1-2 m which is practically independent on temperature in the region of 20 °C - 80 °C was described for such frequencies. At low frequencies were the common DHF effect hold, the response time is about 100 ms but decreases by increasing the frequency in the inverse relationship. This can be demonstrated on Figure 1, were the inverse electrooptical response time is shown as function on frequency . It is further seen that the tilt angle decreases exceeding about 1 kHz, what at the same time is a drawback.

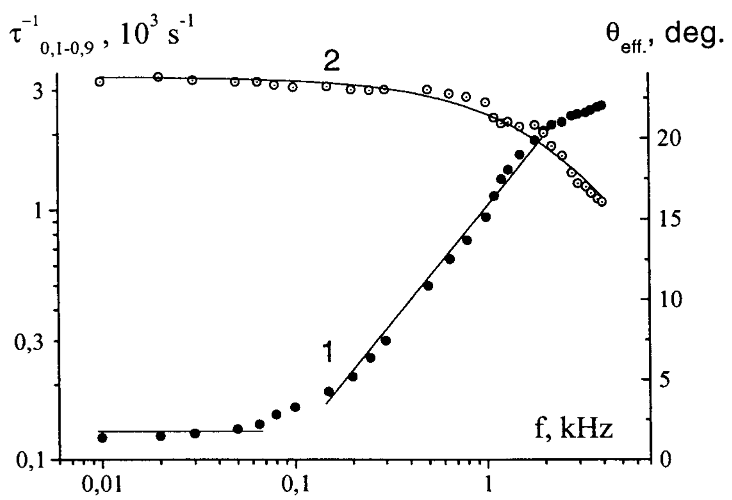

FIGURE 1. Dependence of the inverse electrooptical response time (1) and the effective tilt angle (2) on the driving voltage frequency. FLC 21 TUD, layer thickness is 1,8 μm, the temperature is 35°C, the driving voltage amplitude is 2,0 V_{pp}.

In order to characterise in detail this effect and to study the electrooptical behaviour, but by the same time to study in general short pitch mixtures close or within the optical wavelength region , we started with detailed investigations.

The electrooptical response based on the light scattering has also been investigated. Figures 2 and 3 show electrooptical responses to the triangular and rectangular applied voltages, respectively. For the measurement of the transmitted light intensity through the cell, no polarizers were used. That is, we detected the modulation of the transmitted light due to the scattering. Figures 2(a) and 3(a) indicate the responses to on-off (0 －10V) and polarity reversal (-10V － 10V) of the applied voltage, respectively. As shown in Figs.2 (a) and (b), in the case of triangular waveform application, the light scattering due to the helix wind-unwind and transient light scattering (TSM) are recognised, respectively. On the other hand, in the case of the rectangular voltage application, scattering due to the TSM can not observed at the instance of the polarity reversal, as shown in Fig.3(b). This may be interpreted that there does not exist temporal periodic texture which may be associated with the helix and is usually observed in the TSM operation. That is, uniform molecular motion caused by the polarity reversal of the applied voltage may take place.

References:

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2. E. P. Pozhidaev, S. Pikin, D. Ganzke, S. Shevtchenko, W. Haase, Ferroelectrics, in press.

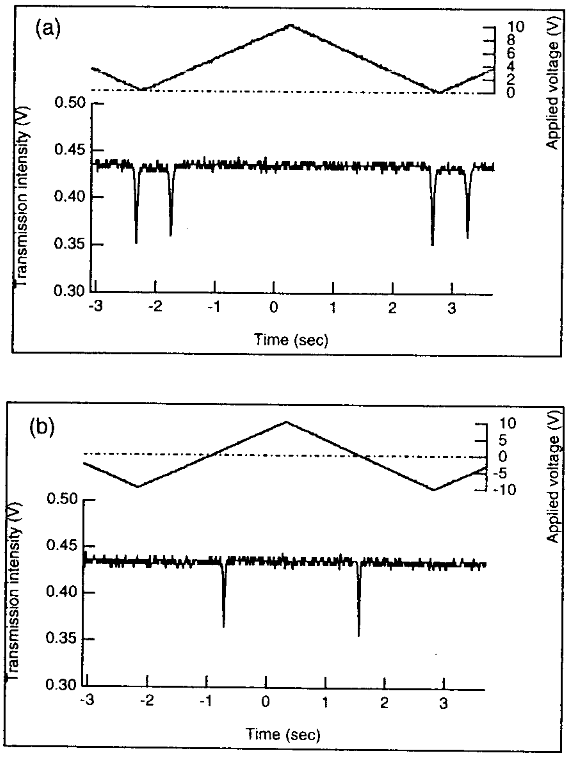

FIGURE 2. Electrooptical responses to the triangular wave of the applied voltage. (a) on-off and (b) polarity reversal of voltage.

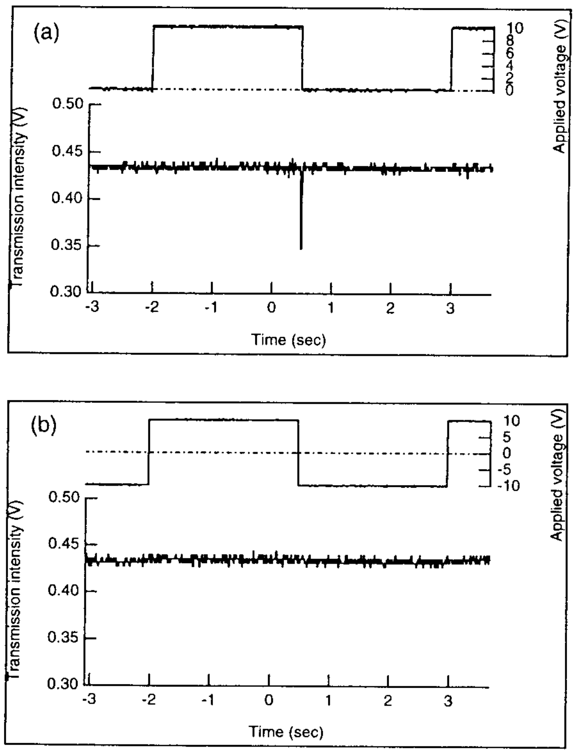

FIGURE 3. Electrooptical responses to the rectangular wave of the applied voltage. (a) on-off and (b) polarity reversal of voltage.