Anharmonic in-plane-switching electro-optical mode in chiral nematic liquid crystal structures

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We propose a new in-plane-switching mode in chiral nematic liquid crystals (ChNLC) based on the interaction of an electric field with a dielectric anisotropy of (ChNLC). An underlying physical mechanism is a field distortion of the ChNLC helical structure without a change of its pitch, which manifests itself as induced unharmonicity of helical structure [1]. The polarization of light transmitted by the layer depends on the applied electric field. Even a small degree of the induced unharmonicity results in changing the output polarization to orthogonal state. For instance, the degree of unharmonicity defined as the ratio of the amplitude of the 3rd and 1st harmonics is about 7% at the field strength of 2 V/μm. With such a distortion one can change the output linear polarization on 90^{o}. In this case the characteristic response time is less than 100 μs, the value is one order of magnitude shorter than characteristic times of other electro-optical effects used in modern display technology. Such short switching time is due to the relaxation time of the director is determined not by the thickness of LC layer d but by the quarter of the pitch of ChNLC P/4.

In experiment, we have used a cell with a system of interdigitated metal electrodes of width 20 μm separated on a distance of 20 μm. To align ChNLC the inner surfaces of the glass substrates were covered by an alignment layer.

We have investigated spectral characteristics of this effect versus on ChNLC parameters: dielectric anisotropy ε_a, optical anisotropy n_a, helical pitch P. It was found the spectral dependence of the contrast is determined by the optical anisotropy and helical pitch: the lower n_a and the shorter P, the wider the contrast spectrum. Maximum contrast ratio (CR), which can be achieved at a desired wavelength, is limited by quality of polarizers. In cases the induced unharmonicity changes the output linear polarization for 90^{o}, the measured CR is higher than 1000.

References

(1) M.I. Barnik, L.M. Blinov, S.P. Palto, N.M. Shtykov, B.A. Umanskii, *Proceedings of the 27th IDRC "Eurodisplay-2007", Moscow, Russia,* **2007**, 97.