Electro-optics and dielectric measurements in polymer-stabilized liquid crystals of high chirality

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Fast electro-optic switching in both hyper-twisted chiral nematic (N*) LCs [1] and blue phase (BP) LCs [2-4] is presented. Response times well below 500 µs were observed in both types of LCs, respectively. Structural stabilization of the LCs was provided with fitted cross-linked polymers: Polymer-stabilization is a highly useful tool to tune the electro-optic properties of these LCs. Polymer was in-situ generated: Mass-ratios of up to 10% of reactive component (a photo-reactive mixture of reactive mesogens, acrylates, and photo initiator) were added to the LCs, respectively, and exposed with a controlled dose of UV radiation. Mass-ratio and composition of the reactive component had great influence on the resulting electro-optic properties of the LCs.

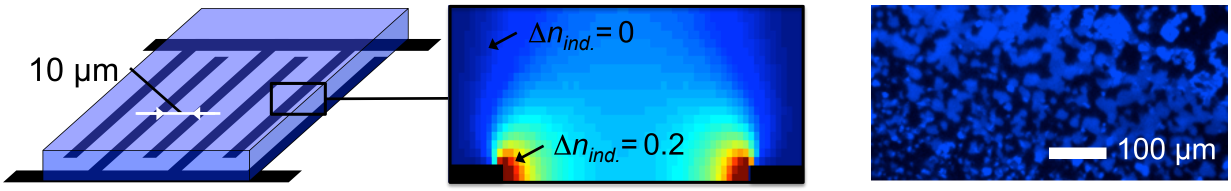

Fig. 1. (a) LC test cell with interdigitated electrodes. (b) Induced birefringence in a test cell filled with a hyper twisted N* LC. (c) Platelet-texture of a polymer-stabilized BP LC based on the liquid crystal E7.

In N* LCs, polymer-stabilization was found to effectively suppress unwanted textural transitions especially near the interdigitated [Fig. 1 (a)] addressing electrodes. Simulations of the electric field-distribution inside the test cells were carried out and could successfully be used to fit and explain experimental results: The local distribution of induced birefringence [Fig. 1 (b)] was successfully modeled and it was found that the electro-optic response was mainly caused by the flexoelectro-optic effect at low voltages and by the Kerr effect at high voltages. The polymer prevented exceedingly large elastic deformations inside the LC. Accordingly, the helix axes were fixed in their desired orientation and unwanted textural transitions were thus avoided successfully.

Polymer-stabilized BP LCs were generated and studied in reflective test cells. These test cells were assembled on a silicon wafer as lower substrate and possessed two structured aluminium electrodes, which will yield polarization independent electro-optic response. In order to study the phase modulation properties of the BP LC, test cells were covered with a double slit mask. A double-slit diffraction experiment revealed continuous, polarization-independent optical phase modulation in the BP LC layer with a maximum phase modulation depth of ≈π. A visible selective reflection of the BP LC was chosen in order to study the size of the BP platelets [Fig. 1 (c)] with polarized optical microscopy: The magnitude of the induced birefringence could be enhanced by 20% in test cells with large platelets.

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References

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