Sub-millisecond switching of nematic liquid crystals using three-terminal electrodes

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Abstract
We propose a method using a three-terminal (3T) electrode structure for sub-millisecond switching of nematic liquid crystals (LCs). A 3T electrode structure is employed to apply in-plane as well as vertical electric fields [1]. A vertical bias electric field is continuously applied to the LCs, whereas an in-plane electric field is applied for switching to the bright state.

We fabricated a homogeneously-aligned cell with the 3T electrode structure to confirm its ultrafast switching behavior. For comparison, we also fabricated a conventional fringe-field switching (FFS) cell [2] and a 3T cell triggered by a vertical electric field [1]. The measured turn-on [turn-off] times of an FFS cell, a 3T cell triggered by a vertical field, and a 3T cell biased by a vertical field were 27 [25], 9.6 [0.52], and 0.34 [0.36] ms, respectively. In a 3T cell biased by a vertical field, we experimentally obtained a total response time of 0.7 ms, which is much faster than any other method used for switching of nematic LCs.

We also measured the switching time at -20°C. As the temperature was decreased, the turn-on and turn-off times of an FFS cell and a 3T cell triggered by a vertical field were increased to longer than 100 ms because of the increased rotational viscosity. On the other hand, in a 3T cell biased by a vertical field, both turn-on and turn-off times were still less than 3 ms.

Fig. 1. Turn-on and turn-off times of an FFS cell, a 3T cell triggered by a vertical field, and a 3T cell biased by a vertical field.

Fig. 2. Dependence of turn-on and turn-off times of the fabricated LC cells.

References

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