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

Jung-Wook Kim*, Tae-Hoon Choi, and Tae-Hoon Yoon

*Department of Electronics Engineering, Pusan National University, Busan 609-735, Korea*

## 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.

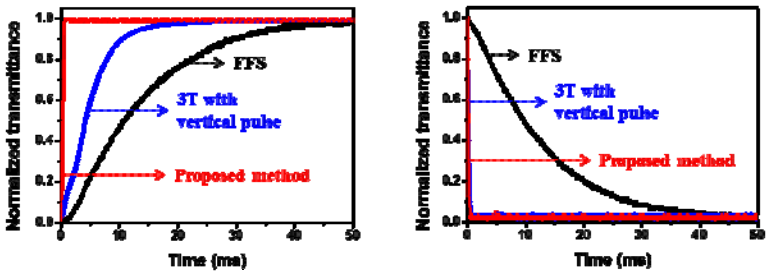


Fig. 1. Turn-on and turn-off times of an FFS cell, a 3T cell triggered by a vertical field, and a 3T cell biased by a vertical field.

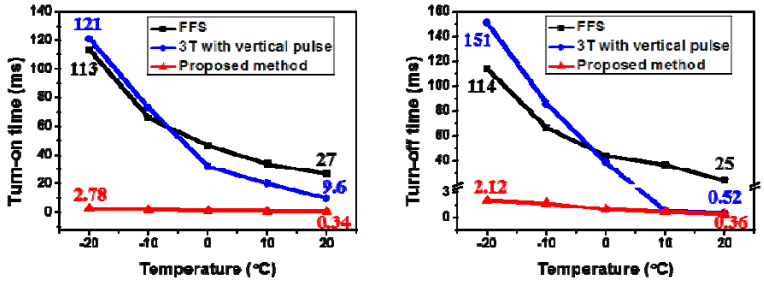


Fig. 2. Dependence of turn-on and turn-off times of the fabricated LC cells.

## References

[1] J.-I. Baek, K.-H. Kim, J. C. Kim, T.-H. Yoon, H. S. Woo, S. T. Shin, and J. H. Souk, *Fast in-plane switching of a liquid crystal cell triggered by a vertical electric field*, Jpn. J. Appl. Phys. **48**, 104505 (2009).

[2] S. H. Lee, S. L. Lee, and H. Y. Kim, *Electro-optic characteristics and switching principle of a nematic liquid crystal cell controlled by fringe-field switching*, Appl. Phys. Lett. **73**(20), 2881 (1998).

## Acknowledgement

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIP) (2011-0029198).

---

* presenting author; E-mail: k.jungwook@pusan.ac.kr