Metastable TN-LCDs: Its Performances and the Method for Stable Operation

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As 45 years have passed since the invention of the 90° TN-LCD, it is now widely used in many applications such as smaller TV sets, cellular phones and vehicle navigation systems. A significant amount of research and development effort has been devoted to realizing high-quality TN-LCDs but there still remains a strong demand for further improvement in its display performance. Regarding this issue we recently proposed two types of metastable TN-LCD modes in Refs. [1,2] which are based on the 90° twisted nematic effect as is inherited from the conventional TN-LCD. The first one is the Reverse TN (RTN)-LCD [1] which works at quite low driving voltage. Fig.1 shows a comparison of simulated results of an applied voltage-dependent transmittance between a 90° RTN-LCD and the conventional 90° TN-LCD. Over 30% reduction of the working voltage are expected. The second one is the Ultra-Short-Pitch (USP) TN-LCD [2] whose response time is notably improved, even at low temperatures. Fig. 2 shows a comparison of experimental results of both on and off response times, as well as the driving voltage V10 (giving 10% transmittance as compared to that at no bias which is applied for measurement of the response time), of the 90° USP TN-LCD with different chiral pitch-to-cell gap (p/d) ratios at room temperature. The off response time of the 90° USP TN-LCD marks 30~40% acceleration as compared to that of the conventional 90° TN-LCD.

The key factor of these newly proposed TN-LCDs is a properly adjusted helical pitch of a chiral nematic liquid crystal implemented so as to emerge a distorted liquid crystal director configuration inside a 90° TN cell with finite pretilt angles. However, the addition of chiral additives to a host nematic liquid crystal material makes the 90° TN liquid crystal director configuration metastable; it means that the RTN or USP TN-LC director configuration is not maintained when no voltage is applied. After a short retention time, those LC director configurations relax to a more stable original twist configuration. This metastability of the LC director configuration is not suitable for stable LCD operation. Thus we should apply a stabilization method to these metastable LC director configurations to raise the value of these new LCDs to the industrial level.

In the present study, we show the display performance of these metastable TN-LCDs and give a resolution to realize a stable RTN- or USP TN-LCDs based on the polymer stabilization method making use of UV curable LC monomers.

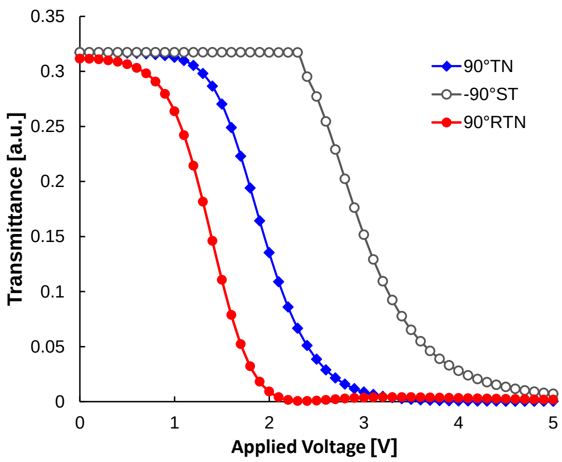

Fig.1 V-T characteristics of the RTN-LCD

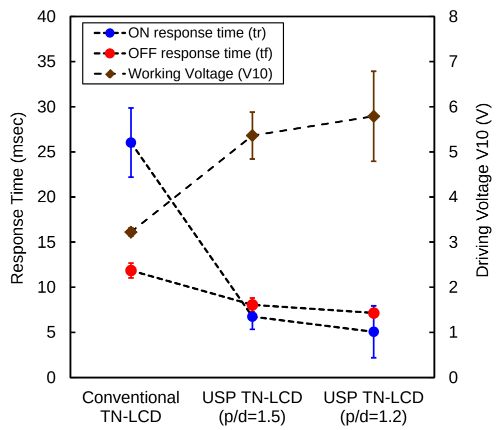

Fig.2 Response time of the USP TN-LCD

References

1. K. Takatoh, et al., *J. Appl. Phys.*, 106, 064514 (2009).
2. K. Takatoh, et al., *Liq. Cryst.*, 39, 715 (2012).