Fast switching of nematic liquid crystals over a wide temperature range for outdoor applications

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Fast response time is one of the most critical requirements for liquid crystal display (LCD) devices because it helps reduce motion-blur in fast moving picture, enhance optical officiency, and avoid color breakup for field sequential color displays. On the other hand, display markets for weable displays, automotive displays, and digital signage displays used in outdoor is rapidly growing. However, the performance of LCD is very poor at low temperature. As the temperature decreases, the response time increases dramatically because of the increased rotational viscosity of liquid crystals (LCs). This leads to serious problems when LCD devices are used under outdoor environments. Recently, we reported a homogeneously-aligned LC cell with three-terminal (3T) electrodes in an attempt to reduce the response time [1, 2]. More recently, we reported a homogeneously-aligned LC cell with fast gray-to-gray (GTG) switching between all gray levels forcibly controlled by applying an electric field at room temperature and we achieved fast GTG switching between all grey levels in a homogeneously-aligned LC cell [3].

In this paper, we investigated the switching behaviour of homogeneously-aligned LCs over a wide temperature range. We found that the slower response time at low temperature can be compensated by a higher electric field so that 3T cell using new drive scheme can offer a complete solution.

In contrary to the fringe-field-switching (FFS) [4] cell, the response time of a 3T cell showed an extremely mild increase as the temperature decreases because all GTG switching is controlled by applying a high electric field. At -20℃, the slowest GTG response time of an FFS cell was 77.33 ms, whereas the slowest GTG response time of the 3T cell using the new drive scheme was 6.15 ms at the same temperature, as shown in Fig. 1. This is approximately 12.5 times shorter than that of an FFS cell. This can be an effective solution for removing the motion blur in LCDs at a low temperature.

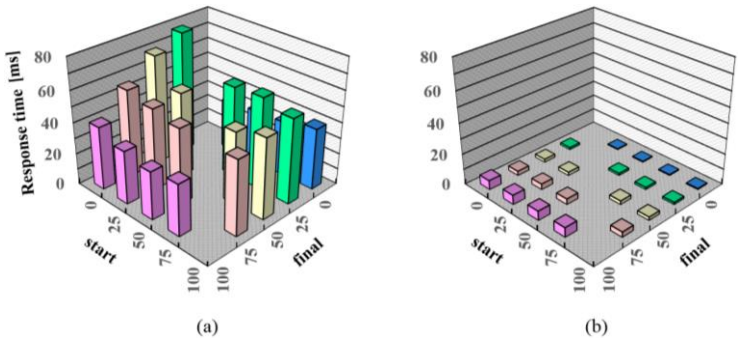

Fig. 1. Measured GTG response time at -20°C of (a) a FFS cell and (b) a 3T cell driven by a new drive scheme.

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