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Bistable chiral splay nematic LCD with RM network structure for the enhanced retention time of π-twist state

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We propose a bistable chiral splay nematic liquid crystal display (BCSN-LCD) with stabilizing π-twist state. The polymer network structure formed by polymerizing reactive mesogens acts as an obstructor that disrupts the return to the initial splay state and we could obtain BCSN-LC device with the improved memory retention time to consume less power for energy saving effect.

1. Introduction

Recently, by a increasing interest in energy-saving technology, bistable chiral splay nematic liquid crystal displays (BCSN-LCDs) come into the spotlight because of their functionality which can be switched between dynamic with a fast switching time and memory mode with a suitable retention time [1, 2]. Especially, memory mode of BCSN LC mode is considered as important characteristic in dual LC mode because memory mode can be using low power consumption which is expected to fully agree with the requirements mobile display devices. However, retention time of the memory mode is limited by troublesome problem that is instability of π-twisted LCs arrangement is limited [3].

In this letter, we propose BCSN-LC device with the enhanced memory retention time by polymer stabilized structure in π-twist state. In π-twisted arrangement of BCSN LC mixed with RMs, UV light was irradiated. Finally, we could obtain BCSN-LC device with the enhanced memory retention time by the polymer network structure polymerized and grew follow the ordered direction of LC molecules in π-twist state.

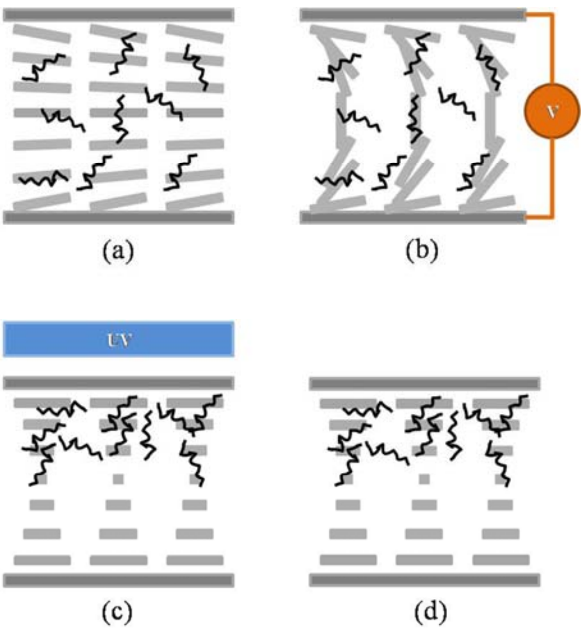

Figure 1. The schematic diagram of fabrication for the BCSN-LC device with the RM network structure: (a) the initial splay state in BCSN-LC mode with LCs and RMs, (b) high bend state by the vertical electric field, (c) UV irradiation in π-twist state after removing the electric field after removing the electric field and (d) BCSN-LC mode with polymerized RM network in π twist state.

2. Experiments

Figure 1 is the schematic diagram of fabrication for the BSCN-LC device with the RM network structure. We spin-coated polyimide alignment layer (AL22620, JSR Inc.) on substrates evaporated indium tin oxide (ITO). And then, substrates were soft-baked to evaporate solvent under 100°C for 10 minutes and were hard-baked to polymerize it under 210°C for an hour. These substrates were assembled in parallel-rubbed directions with the cell gap uniformity using by 5μm ball spacers. Nematic LCs (ZKC-5085XX, Chisso Co.) and chiral dopant (R-811, Merck Ltd.) with the right-handed helical molecular sense were mixed to get tendency of twist formation on LCs. The proportion of cell gap to pitch (d/p) is 0.15 which is more stable in splay state than in energy boundary condition in which d/p is 0.25 between splay and π twist state. Photo-initiator (1.4wt.%, Irgacure651, Ciba Specialty Chemicals Inc.) and RM (6.4wt.%, Merck Co.) were added in LC mixture. In experimental BCSN-LC cell, after the vertical electric field is applied over the level of applied voltage for high bend state (Fig. 1(b)), it was removed to derive reorientation of π twist state with topologically same phase with high bend state by the LC relaxation [4]. UV light (365nm wavelength, 0.12mW/cm^2 intensity for 30 minutes) was irradiated onto the experimental cell to compose polymer network structure for stabilizing π twist state in LC mixture. By the phase separation, the polymer network is formed from the substrate adjacent UV light source. In partial bulk region, RM network ingenerates local anchoring force to stable the π-twist state. Thus we could obtain BCSN-LC device with the improved memory retention time.

3. Results

We measured the retention time of BCSN-LC cell with/without RM networks to confirm the enhanced memory retention time. Figure 2 shows the change of microscopic textures by the relaxation from π-twist state to splay state in the respective experimental LC cell. Figure 2(a) is the textures of the measured retention time in π-twist state of BCSN-LC cells without RM networks and (b) is the BCSN-LC cells with RM networks. Conventional BCSN-LC cells without RM networks has the retention time of 10min. whereas, BCSN-LC cells with RM network structure proposed in this work has the enhanced retention time of 120min by local anchoring force of polymer network structure.

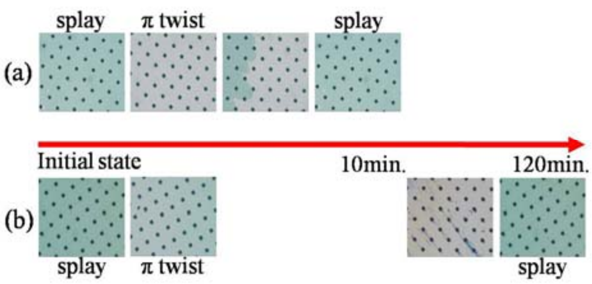

Figure 2. Microscopic textures about the memory retention time: (a) conventional BCSN-LC cell without RM networks and (b) proposed BCSN-LC cell with RM networks.

4. Conclusion

In this work, we proposed a BCSN LC device with the enhanced memory retention time. BCSN – LC device proposed in this work can be operated in memory mode with more stable π-twist state with the increased retention time by the RM network structure through UV irradiation. The method is useful improving memory retention time in BCSN-LC mode. Also, it can overcome the limitation of parameters that is d/p, cell gap, and elastic constant of LCs considering the driving properties in both dynamic and memory mode in increasing the retention time. Therefore, we can expect that BCSN –LC device by this method will be applicable to the novel display to be suitable to consume low-power for energy saving.

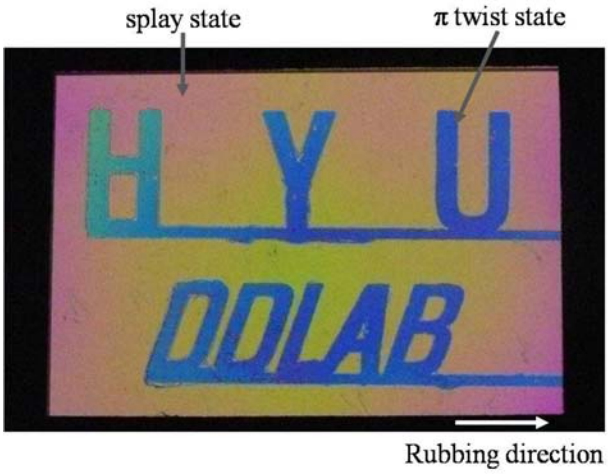

Figure 3. 2-inches prototype coexisting with splay and π-twist state.

5. Reference

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