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Surface Gliding of Nematic Liquid Crystal on UV Curable Polymer

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Surface gliding effect of liquid crystal (LC) on soft polymer has been studied by many researchers at both basic and applied sciences. It is very fundamental research area including the director reorientation mechanism on the soft-polymer surface at the LC devices. In most of such studies, thermal condition has been a crucial factor dominating surface properties of soft materials. Our experimental results show that their relaxation depends dominantly on surface anchoring of the film and physical parameters of nematic liquid crystal.

1. Introduction

We studied on dynamic property of the nematic liquid crystal (LC) director gliding at the interface between soft-polymer and nematic LC in the horizontal field [1-3]. It is very fundamental research area including the director reorientation mechanism on the soft-polymer surface at the LC devices [4, 5]. Gliding effect has been studied by many researchers who generally used two kinds of polymers as LC alignment layer of each substrate, such as the combination of dye molecules and polyimide (PI) or PVA (polyvinyl alcohol) [2, 7], polymethylmethacrylate (PMMA) and PI, polyethylmethacrylate (PEMA) and PI [1], etc.. Surface properties of these materials were mainly dominated by thermal conditions and electric [8, 9] or magnetic field strength. Surface properties of these materials were mainly dominated by thermal conditions or UV intensity. We used photo-curable polymer (PCP) material (Norland Product Inc.) as the soft-polymer layer to modulate surface condition by intensity or exposure time of light. In this paper, we demonstrate the relaxation of surface nematic director related to surface gliding effect on photo-polymer film produced from various UV conditions as another main factor determining surface properties. And study on dynamic property of the nematic liquid crystal (LC) director gliding at the interface between soft-polymer and nematic LC in the horizontal field [2, 3] is analyzed through a simple dynamic equation. Our experimental results show that their relaxation depends dominantly on surface anchoring of the film and physical parameters of nematic liquid crystal. The surface viscosity is one of crucial factors having influence on surface dynamics of nematic LC.

2. Experimental

In our experimental process, Aluminum layer of about 200 nm thickness deposited on the glass substrate using the thermal evaporation process is patterned as an electrode for applying horizontal electric field, by wet etching process with the photo-lithography method. The electrode structure is composed of electrodes with 20 ㎛ width and 60 ㎛ distance between electrodes. We cured the NOA layer using the UV lamp (≈ 1000mW) which was divided into four parts under the UV curing time on a single substrate. For four

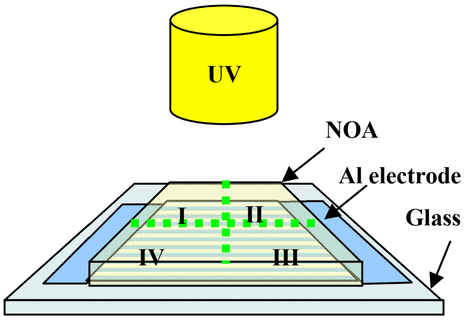

Fig. 1. Illumination of UV with four conditions (I: 5min, II: 15min, III: 30min, IV: 60min).

different UV illuminated areas, unpolarized UV light was partially cured though a photomask to generate spatially the patterned surface. The PI layer is mechanically aligned by the rubbing process that near 7° with respect to the electrode axis for enough electric field strength. As our LC material, LC ZKC-5085XX (Chisso Co. Ltd.) of Δn=0.151 and $\Delta\varepsilon$=9.8 was injected into the sandwich cell by the capillary effect near the isotropic temperature of the LC and continuously inlet and outlet of LC was sealed perfectly.

3. Result and discussion

To examine the switching characteristics of the horizontal electric field induced LC rearrangement with cured areas, respectively, we measured the dynamic electro-optic transmittance curve using the 18 ㎛ thick sample at the 632.8nm He-Ne laser under four UV curing conditions. As shown in Figure 2, we measured the twisted angle of the LC director with removed electric field. In the case of 60min curing time of UV, it shows that LC

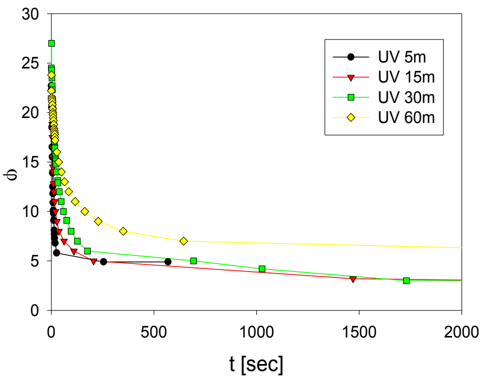

Fig. 2. The measurement of the twisted angle of the LC director axis at removed the voltage

director on the surface has a stable state near 7° with respect to initial aligned direction at 30min after eliminating the electric field. In the measured curve, the tendency shows that the relaxation time is affected by the surface energy and friction which mainly depends on the UV curing time.

4. Conclusion

In summary, we have developed and demonstrated the LC director gliding with various UV conditions in a single cell. In our LC cell, UV curable polymer was controlled by UV illumination time and then, we measured electro-optic and relaxation characteristic about four conditions using horizontal electric field. The tendency shows that relaxation time is mainly affected by the denseness of polymer chains on the surface layer. The main advantage of this system is valuable as the first step for multi-stable LC device, in which actual low power consumption is possible.

Acknowledgement

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