Reorientation of Liquid Crystals at Surface of Soft Polymer

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Abstract

The specific properties of liquid crystals (LCs) at surface interface with a weak anchoring boundary have a special attraction for new LC applications.[1,2] Currently, study on the weak interaction between the soft polymer surface and liquid crystals has a primary function for the fundamental LC device research.[3] In this paper, we demonstrate the rotation of surface nematic director on non-treated Poly-Methylmethacrylate (PMMA, T_g=110°C, Sigma Aldrich) film observed under various temperatures including the glass transition temperature (T_g) of the polymer layer.

Aluminum evaporated on glass substrates is patterned as interdigitated electrode for applying horizontal electric field, by wet etching with the photo-lithography. 5wt% PMMA solution with 95wt% toluene solvent spin-coated on the substrates at 3000rpm, and then baked on the hot-plate in 150°C for 40min. There was no any mechanical surface treatment in this process. After injecting the LC into a general sandwich cell assembled with the 5.5㎛ cell thickness using glass bid, the LC cell was sealed by UV curable sealant. The LC cell consists of two mutually orthogonal interditated electrodes fabricated on upper and lower substrates, which can control many field directions. As a manner for an initial LC alignment, a horizontal electric field by top or bottom electrodes is applied to LCs in vicinity of the T_g to align surface LCs along field direction and slowly cooled by 40°C with the field. Then, the electric field is removed and continuously, orthogonal horizontal electric field by the other electrode acts on the nematic director on the polymer surface. After removing the electric field, we acquired the reorientation of the surface nematic director that was measured by the polarizing optical microscope.

In this configuration, the easy axis of the surface nematic director is reoriented by the action of the in-plane electric field due to weak LC surface anchoring. This enables the electric field direction to control the easy axis of LC on the soft-polymer surface at 40°C lower than the glass transition temperature (T_g) of PMMA. The surface nematic LCs maintains the new orientation after field off because there is no excess free energy by deformed LC elastic state at bulk. Several surface LC states changed by several field directions are reversible. Therefore, the surface director can be controlled satisfactorily by the LC system with the soft-polymer surface and cross-assembled in-plane switching electrode which produces various LC states by controlling various field directions. This would be used as the LC device with the new multi-stability.

References

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