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Study on Pre-Polymer Effect in Polymer-Liquid Crystal System for Display Applications

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We reported the detecting method the remained pre-polymers during phase separation process. As phase separation of the LC and pre-polymers and polymerizations of the pre-polymers with UV exposure are going by, the capacitance (or dielectric constant) values are changed and saturated. The saturating conditions (UV exposure conditions) could be detected by measuring the capacitance values during the UV exposure, simultaneously. That results are well matched to other characteristics of the cell such as VHR, RDC, and so on

1. Introduction

Liquid crystal (LC) devices with plastic substrates have drawn considerable attention for next-generation information displays because of their excellent portability, such as light weight, thin packaging, and flexibility [1]. For the flexibility of plastic LC device, it requires a stabilization of LC mode, mechanical stability, and tight adhesion of two substrates. It has been wide studying to solve such problems by introducing the phase separation of polymer-LC mixture, such as polymer dispersed LC, polymer network LC, phase-separated composite film (PSCOF) of LCs, and pixel isolated LC (PILC) mode [2-6]. Among them, PSCOF and PILC mode show excellent electro-optic characteristics, good mechanical stability, and good adhesion of two substrates. After phase separation, however, the unreacted pre-polymers and unfixed floating polymers in polymer-LC composite systems give rise to degradation of the device performance.

In this paper, we report influence of the unreacted pre-polymers and unfixed floating polymers in polymer-LC composite systems on display performance. We quantitatively evaluate the in-situ polymerization ratio during phase separation in polymer-LC composite systems. Also, we discuss the correlation of the unreacted pre-polymers and unfixed floating polymers with display performance such as uniformity, image sticking, operating voltage, transmittance, response time, and so on

2. Experiments

Figure 1 shows the fabrication process of proposed measure mode. LC cells were fabricated using indium tin oxide (ITO)-coated glass substrates by photo polymerization-induced anisotropic phase separation. Alignment layers (RN-1199) were spin-coated on one substrate followed by rubbing to achieve a homogeneous LC alignment. Note that phase separation is greatly affected by an alignment layer and a prepolymer.[4] The other substrate used was untreated to enhance phase separation. Cell gap was maintained using glass spacers of 4.5 mm. A mixture of the nematic LC LCE7 and photocurable prepolymer NOA65 (Norland) with a weight ratio of 70 : 30 was introduced into the cells by capillary action at a temperature of 100℃, which is higher than the clearing point of the LC. The cells were exposed to UV light of λ= 350 nm to initiate polymerization at 100℃. The source of the UV light was a xenon lamp operated at 200 W. The UV intensity was controlled to about 0.78mW/cm^2.

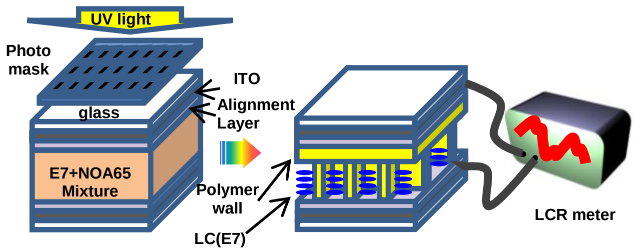


Figure 1. The capacitance were measured during UV exposure , simultaneously.

We measured capacitance of the LC cell during UV exposure using LCR meter (HP4284A). By measuring the capacitance, we could compare the basic LC and LC/pre-polymer mixture. Also voltage holding ratio, residual direct current and response time characteristics were examined.

3. Results and Discussion

Figure 2 shows the measured microscopic textures and capacitance characteristics. As time goes by, the capacitance of the normal LC cell does not changed dramatically because there are small amount of reaction. However, in mixture systems, the capacitance is reduced during the polymerization processes. Finally, it could be saturated at 3000 sec after.

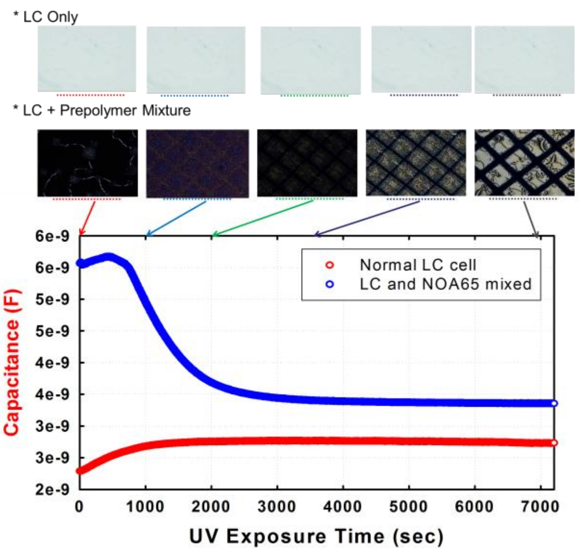
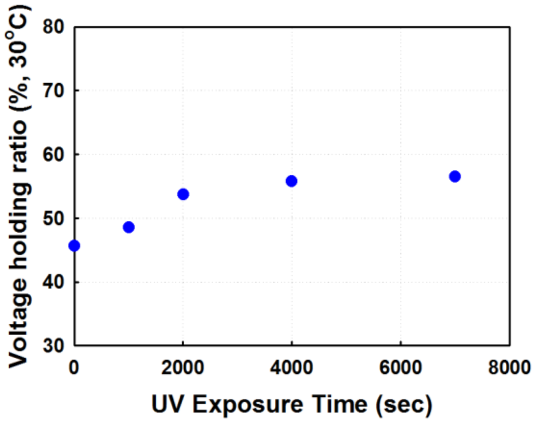
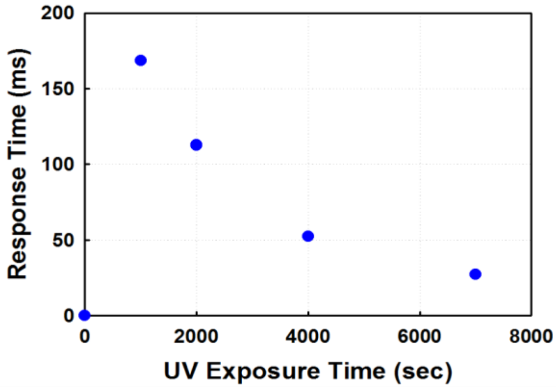


Figure 2. Microscopic Textures & Capacitance characteristics.

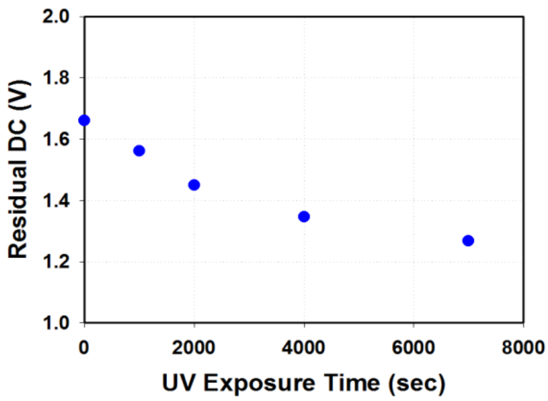
Figure 3 shows the measured VHR , RDC and response time characteristics examined during UV exposure time. As a result, as polymerization is going by, VHR increase RDC and response time decrease. These results were well matched to the one of the capacitance characteristics



(a)



(b)



(c)

Figure 3. The measured during UV exposure time Capacitance characteristics of (a) VHR(voltage holding ratio), (b) RDC(residual direct current) (c) Response time.

4. Conclusion

In summary, we reported the detecting method the remained pre-polymers during phase separation process. As phase separation of the LC and pre-polymers and polymerizations of the pre-polymers with UV exposure are going by, the capacitance (or dielectric constant) values are changed and saturated. The saturating conditions (UV exposure conditions) could be detected by measuring the capacitance values during the UV exposure, simultaneously. That results are well matched to other characteristics of the cell such as VHR, RDC, and so on.

5. Acknowledgements

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