Direct observation of molecular alignment in a polymer dispersed liquid crystal using synchrotron x-ray micro-diffraction

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Introduction

A polymer dispersed liquid crystal (PDLC) is a material utilized for light valves and displays. It has been reported that the dual frequency driven PDLC exhibits electrically reversible bistable switching [1][2]. The PDLC device retains the memory state even after removal of driving voltage. It is considered that the liquid crystal (LC) molecules hold their orientation by the interaction of the molecules with the polymer matrix. We performed x-ray micro-diffraction experiments using synchrotron radiation at the Photon Factory on beam line 4A to investigate the LC molecular alignment of the memory state.

Experimental

A dual frequency driven nematic liquid crystal and prepolymers with photoinitiator were thoroughly mixed and polymerized by UV irradiation in a LC cell with a gap of 7μm. The LC cell consists of two glass substrates with ITO-coating [2]. The device initially is in the scattering state (Fig.1a). Voltage pulses with low frequency (2.5kHz square/60V/>100ms) result in the transparent state. By removing the voltage, the system changed to "the transparent memory state"(Fig.1(b)). Voltage pulses with high frequency (100kHz square/60V/500ms) return the cell to the initial scattering state.

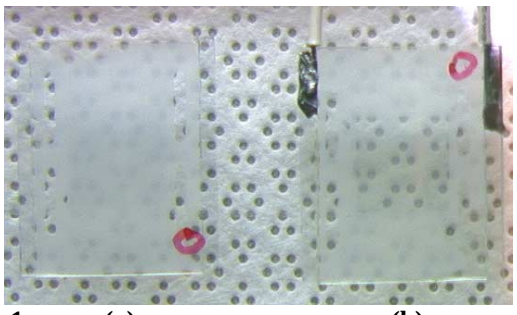

Fig.1 (a) (b)
PDLC cells
(a) Scattering state , (b) Transparent memory state

Synchrotron x rays were monochromated with a W-Si multilayer monochromator. X rays tuned at 8keV were used. Using Kierkpatrick-Baez system consisting of a pair of elliptical mirrors x-ray microbeam was formed. The mirrors were made of platinum-coated fused quartz. The beam size was about 6 x 6 μm^2 at the sample position [3].

The samples were mounted on XZ translation stages that were mounted on a rotation stage with a vertical rotation axis. A CCD x-ray detector was placed at a distance of 250mm from the sample to record the diffraction patterns. After removing one side of the glass substrates, we measured x-ray diffraction patterns of the PDLC on the other substrate. The grazing incidence geometry was used (Fig.2).

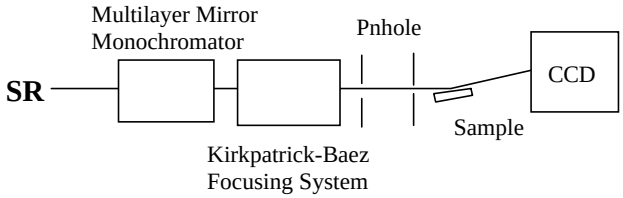

Fig.2 Experimental arrangement

Results and Discussion

Figure 3(a) is the x-ray diffraction pattern of the PDLC in the scattering state. The Debye ring is observed, which indicates the LC did not have selective orientation. Figure 3(b) is the x-ray diffraction pattern of PDLC in the transparent memory state. The arc shaped diffraction spot is observed, which shows that the LC molecules are aligned.

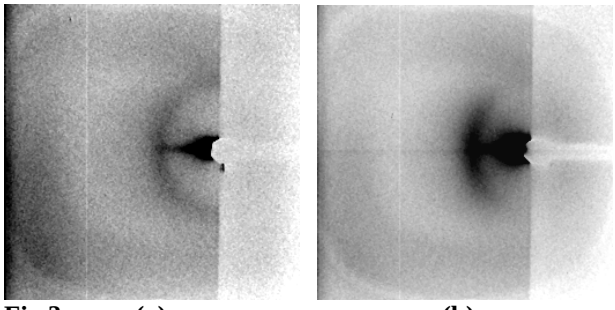

Fig.3 (a) (b)

(a) Scattering state , (b) Transparent memory state

References

[1] J.Ohyama et al., SID Dig. Tech. Papers, 648 (1999).
[2] J.Ohyama et al., SID Dig. Tech. Papers, 794 (2000).
[3] A.Iida and T.Noma, Nucl. Instrum, Methods B **82** (1993) 129.

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