Dynamic study of layer structure and molecular orientation of ferroelectric liquid crystal under asymmetric electric Þeld.

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Introduction

Liquid crystals have several meso-phases; isotropic, nematic, smectic and crystal. Smectic phase has one-dimensional order of density wave and layer structure of molecular alignment. Ferroelectric property in the smectic phase is caused from chirality and electric dipole moment of molecules. Recently, surface stabilized ferroelectric liquid crystal (SSFLC) has been studied in order to develop a new liquid crystal display (LCD). However, SSFLC has a "layer rotation" property applying an asymmetric electric Þeld, which is reported by Ref [1]. This property is decreasing the contrast characteristic as the display. In Ref. [1], an optical microscope was used for observation of the "layer rotation". In general, stripe patterns is appeared in the smectic phase. Most of researchers have believed that the stripe patterns is made from the layer structure of smectic phase, and aligned along with the layer normal direction of the smectic phase. However, it's not been conÞrmed directly. An X-ray diffraction study of the "layer rotation" is reported in Ref. [2]. They concluded that the "layer rotation" is caused by a realignment of the liquid crystal molecules. However, they only observed long range order of the layer structure. An investigation of the short range order is required due to clarifying a mechanism of "layer rotation". An X-ray diffraction technique shows short range order of the molecules and molecular orientation in higher angle scattering. We have developed time-resolved simultaneous observation system, which consist of a CCD-based X-ray detector [3] and a polarized optical microscope [3]. This system allows us to observe time-resolved X-ray diffraction/scattering with a time resolution of micro second. In this report, "layer rotation" observation by using developed system at BL-15A is introduced.

Experimental setup

The sample is CS-1024 (Chisso Co.) with a phase sequence on cooling given by; I-N*-SmA*-SmC*-Cryst. The sample cell consists of two ITO-coated glasses and rubbed polyimide alignment layer. An experimental setup is shown in Fig. 1. The CCD-based X-ray detector is used for recording an X-ray diffraction image. The sample area on which an X-ray impinge is observed with the polarized microscope equipped with a video capturing in PC. The experiment is done in BL-15A and BL-18C.

Result

Fig. 2 shows the time series of the azimuthal plot of the liquid crystal under asymmetric electric Þeld induced. In Fig. 2, the bragg spots in the SAXS which is originated from the smectic layer spacing is shown as the vertical solid line. The peak centers of each azimuthal plot coincide to the rotation of the bragg spots in the SAXS. It can be indicated that the smectic layer is rotated without the realignment of the liquid crystal molecules. This result is not coincide to Ref. [2].

Conclusion

We have developed the time-resolved simultaneous observation system which consists of a CCD-based X-ray detector and a polarized optical microscope. This system is applied to observe the "layer rotation" of the liquid crystal under asymmetric electric Þeld induced. We have succeeded to observe the "layer rotation" by both an X-ray diffraction and an optical microscopic image simultaneously. The result is that the bragg spots rotation and the optical images are perfectly coincided. In addition, the rotation of the bragg spots in the SAXS and the rotation of the scattering peak in higher angle are also perfectly coincided. Further discussion have to be required to obtain better signal-to-noise ratio data.

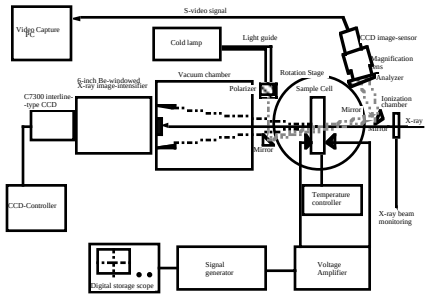

Fig. 1: Schematic drawing of the simultaneous observation apperatus.

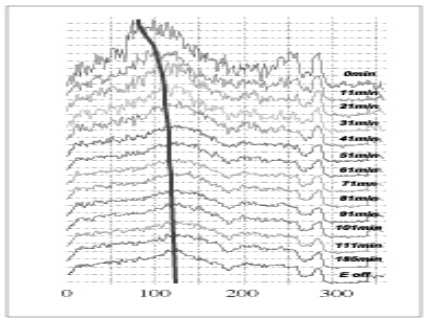

Fig. 2: Series of the azimuthal plot in higher angle region and the positions of the bragg spots (vertical solid line).

References

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