TIME RESOLVED MICRO X-RAY DIFFRACTION MEASUREMENTS OF DYNAMIC LAYER RESPONSE UNDER ELECTRIC FIELD IN FERROELECTRIC LIQUID CRYSTALS

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Introduction

Recently, microbeam x-ray diffraction has elucidated the local layer structure of the ferroelectric liquid crystal (FLC)[1]. We have also observed the reversible transition of the layer structure under the ac electric field in the antiferroelectric liquid crystal (AFLC) for the first time [2]. The comparison of the transient layer response between AFLC and FLC is important to investigate the nature of the layer ordering in smectic liquid crystals.

In this report, the transient layer responses to a step form electric field in FLC cells are described using time resolved microbeam X-ray diffraction method.

Experimental

The experiment was carried out on BL-4A. The x-ray energy was 8 keV. Experiments were performed with a beam size of about $3\times4\ \mu m^2$. The diffracted intensity was measured by a PSPC as functions of ω and χ angles; ω and χ correspond to a layer rotation angle from the rubbing direction in a horizontal plane and around surface normal, respectively. Time resolved measurements were done with a MCS mode and a gated PHA mode for α and χ-profiles, respectively. X-ray diffraction data were collected synchronized with an applied electric field, which was a step form with 25 and 100 Hz, $\pm$50V.

The sample was a FLC, TK-C101 (Chisso), sandwiched between ITO-coated glass plates rubbed one-side after coating polyimide. The cell gap was about 5~7 μm. The sample was kept at room temperature during experiments, where T_c, SmA* $\rightarrow$ SmC* transition temperature, was 56°C.

Results

The time resolved microbeam x-ray diffraction profiles are shown in Fig.1. The MCS-mode ω-profile measured with 0.05ms time resolution (a) indicates that a peak near $\omega = 0^o$ at high voltage changes to a broad one at 0V, and peak center shifts about 1^o. Corresponding to this peak, PHA-mode χ-profiles were measured with 0.2 and 0.05ms time resolution (b), (c). The reversible transition between a pair peak (at high field) and a single peak (at 0V) was observed. These results indicated that the local layer relaxed from the horizontal chevron to the quasi-bookshelf within 0.2ms after the electric field changed to 0V. When the electric field rose up to 50V, the layer changed also within 0.2ms. This process is similar to the deformation in ferroelectric state of AFLC.

The peak shift of the ω-profile was confirmed as the effect of the rubbing method.

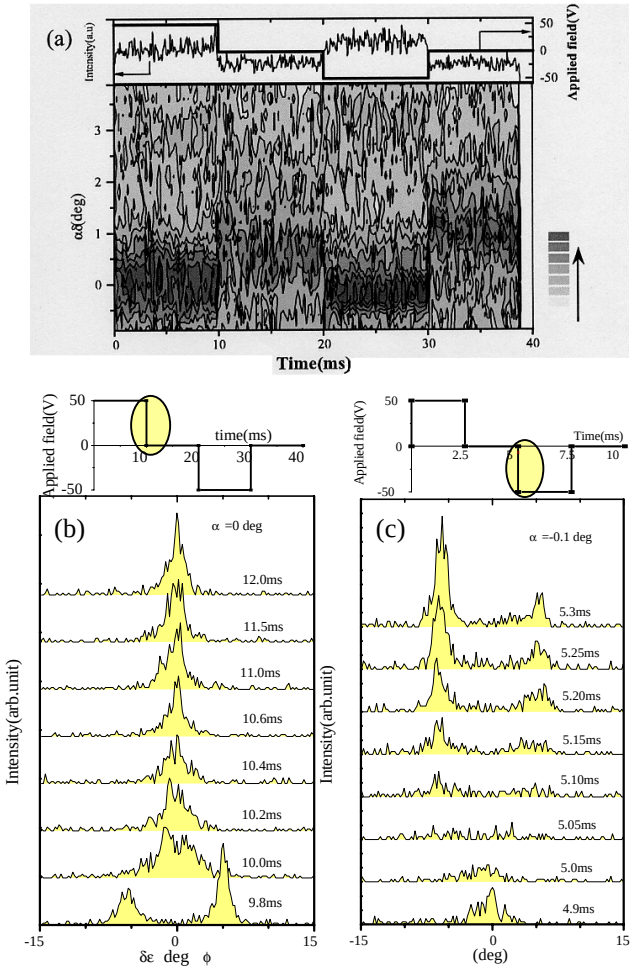

Fig.1 Time resolved micro x-ray diffraction profiles. MCS-mode ω-profile (a) and PHA-mode χ-profiles (b), (c). Time resolution was 0.05ms (a), (c) and 0.2ms(b).

References

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