4A/2002G293

Fast Layer Response in Electroclinic effect of Ferroelectric Liquid Crystals by Time Resolved X-ray Micro-Diffraction

Yumiko TAKAHASHI*[1], Atsuo IIDA[2], Yoichi TAKANISHI[3], Michi NAKATA[3], Megumi TOSHIMITSU[3], Ken ISHIKAWA[3] and Hideo TAKEZOE[3]
[1] Nihon Univ., Surugadai, Kanda, Chiyoda-ku, Tokyo 101-8308, Japan
[2] KEK-PF, Tsukuba, Ibaraki 305-0801, Japan
[3] Tokyo Institute of Technology, O-okayama, Meguro-ku, Tokyo 152-8552, Japan

Introduction

The dynamic response of the smectic layer of ferroelectric liquid crystals (FLCs) has been studied using x-ray micro-diffraction [1]. Recently, the local layer response to an electric field in SmA phase was revealed for the first time [2]. This result indicates an electroclinic (EC) effect, which is a tilt of the director due to the electric filed, influences the layer structure directly. Consequently, the quantitative measurement of the transient layer deformation is of great interest from both device applications and fundamental physics. In this report, the transient local layer response to the polarity change of the electric field in SmA phase is measured using time resolved X-ray micro-diffraction

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 2.5×3.5 μm^2. The diffracted intensity was measured as functions of ω and χ angles which 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 ω and χ-profiles, respectively. X-ray diffraction data were collected synchronized with an applied electric field, which was a rectangle form (1KHz, ±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 6~7μm. The sample was kept at T_c +1°C during experiments, where T_c, SmA*→SmC* transition temperature, was 56°C.

Results

The MCS-mode ω-profile (Fig.1 (a)) indicates that the combination of the horizontal chevron structure, corresponding to a peak near ω =0°, and the vertical chevron structure, peaks at ω =6° and ω =-5°, are stabilized under the rectangle form wave field. When the polarity of the electric field changes, however, the vertical chevron angle decreased from -5° to -3° within 1μs and returned to -5° in about 6 μs. At the same time, in the χ-profile the angular separation of the double peak becomes small (Fig.1 (b)). This is the fastest local layer response which has been ever observed by X-ray diffraction. It is shown that the local layer deformation follows the change in the electric field.

References

[1] A. Iida et al., Jpn. J. Appl. Phys., **40**, 1345 (2001), Y. Takahashi et al., Jpn. J. Appl. Phys. **40**, 3294 (2001)
[2] Y. Takahashi et al., Photon Factory Activity Report Part B, **19**, 152 (2001)

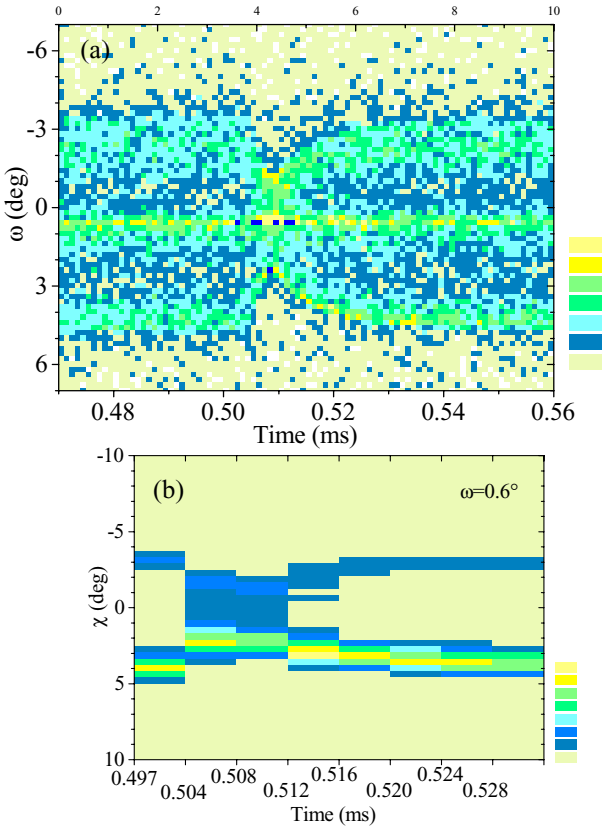

Fig.1 Time resolved x-ray micro-diffraction profiles. (a) MCS-mode ω-profile and (b) MCA-mode χ-profiles. 1μs and 3μs time resolution for (a) and (b), respectively.

*yumikot@shotgun.phys.cst.nihon-u.ac.jp