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Electric Field induced Chiral Smectic sub-phase observed by Resonant X-ray Scattering

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1 Introduction

In chiral smectic (tilted) C liquid crystals, one dimensional layer structure is realized and the average tilt angle depends on the material and the temperature. The molecular tilt direction (the director) among adjacent layers characterizes various phases in chiral smectic C phases such as ferroelectric (SmC*), antiferroelectric (SmC_A*) and ferrielectric phases. Since these smectic phases also undergo the electric field induced phase transition, the phases and their layer structure in the field induced transition have been also studied to reveal the interaction mechanism which realizes the intriguing phase transition. The chiral smectic intermediate phase appearing under the electric field has the possibility of revealing a new insight into the successive phase transition [1]. In order to identify the smectic phase, resonant X-ray scattering (RXS) has been the most powerful technique [2].

In this report, the device geometry sample cell and X-ray micro-beam RXS are adopted to identify the phases appearing near the field induced phase transition and to investigate the layer structure.

2 Experiment

The liquid crystal used was the (*S*,*S*)-bis-[4'−(1-methylheptyloxycarbonyl)-4-biphenyl] 2-bromo-terephthalate which contains a bromine atom in the central core part, and is sandwiched between 80 μm thick glass plates coated with indium tin oxide as an electrode. The phase sequence of the material is Iso 201.3°C SmA 155°C SmCα* 151.5°C SmC* 147°C SmC_A*(qT=1/2) 145°C SmC_A*(qT=1/3) 142°C SmC_A*(qT=0). The detailed characterization of this new chiral smectic liquid crystal was reported previously [3]. The applied electric field was a square wave form with 20Hz.

Resonant X-ray scattering (RXS) experiments were performed on the beam line 4A using a KB focusing system. The incident energy was set at the absorption edge of Br (13.48 keV) and the beam size was about 5 x 5 μm^2. A pixel array detector (Pilatus-100K, DECTRIS) located at 80 cm from the sample (focusing point) was used for the measurement.

3 Results and Discussion

At 141°C, RXS showed a 1/2 order satellite reflection (Fig.1) and SmC_A* phase was confirmed to be realized up to the applied field of ± 20 V. After the coexistence of 1/2 order and m/3 (m=1, 2) order reflection phases, only m/3 order reflections exist as shown in the figures up to ± 40V applied field,. When the applied field increased around ± 44V, the phase boundary between SmC_A*(qT=1/3) and SmC* appeared. Though the satellite peaks due to the m/3 order were still strong, the weak scattering or diffuse streak running along the layer normal can be observed. With the further increase in the applied field, the phase transition to the ferroelectric phase occurred and the satellite reflections vanished.

The detailed measurement of the diffuse streak showed that it consisted of weak reflections corresponding to the 12-layer periodicity, which might suggest the transient sub phase occurred in the field induced phase transition.

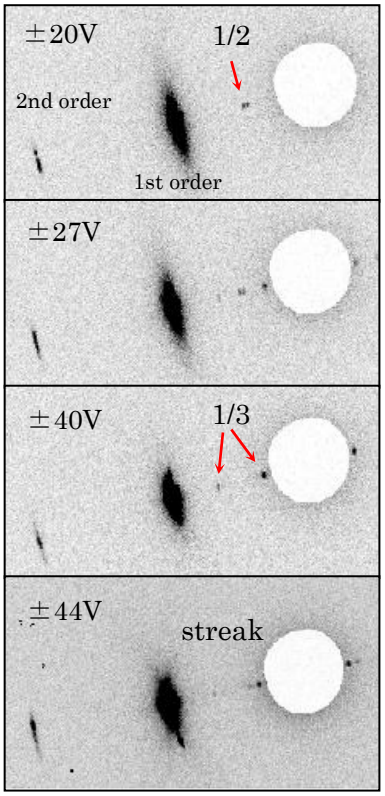

Fig. 1: Resonant X-ray scattering from a chiral smectic liquid crystal as a function of the square wave form applied electric field at 141°C. White circles correspond to the central direct beam stop. Red arrows show the RXS satellites.

References

[1] K. L. Sandhya *et al., Liq. Cryst.* **36**, 1101 (2009).
[2] R. Mach *et al., Phys. Rev. Lett.* **81**, 1015 (1998).
[3] Y. Takanishi *et al., J. Mater. Chem.* **21**, 4465 (2011).
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