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Chiral smectic transition phases appearing near the electric field-induced phase transition observed by resonant micro-beam X-ray scattering (2)

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1 Introduction

Liquid crystals show rich structures and complex phase transitions due to the temperature change. Among them, chiral smectic C liquid crystals are characterized by a one-dimensional layer structure and an average molecular orientation tilted from the layer normal. The general sequence of the sub-phases in the chiral semctic C phase is SmC* (synclinic), SmC_A* (two-layer periodicity), SmC_γ* (three-layer periodicity) and SmC_{AF}* (four-layer periodicity) phases as the temperature is decreased. Recently new phases other than three or four layer periodicity were reported [1][2]. Since an electric field also induces sub-phases, it is important to investigate electric field induced phase transition to study the origin of these sub-phases [3]. In our previous resonant X-ray scattering (RXS) measurement [4], a new electric filed induced transition phase having a very long periodicity of twelve-layer was found in a novel Br-contained liquid crystal. In this paper, a Se-contained liquid crystal, widely used for the RXS measurement, was investigated near the electric-field induced phase transition.

2 Experiment

The Se contained liquid crystal used was AS657 [5] 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 95.8°C SmA 88.2°C SmC* 86.3°C SmC_A*(qT=1/2) 83.6°C SmC_A*(qT=1/3) 82.6°C SmC_A*(qT=0). The applied electric field was a square wave form with 100Hz.

RXS experiments were performed on the beam line 4A using a KB focusing system. The incident energy was set at the absorption edge of Se (12.65 keV) and the beam size was less than 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

Figure.1 sows the intensity distributions along the layer normal for various applied field at 80.1°C as a function of the normalized scattering vector obtained from the 2D diffraction pattern. Below 30V, the RXS diffraction pattern shows the SmC_A* phase (fig.1(a)). At 30V, the SmC_γ* phase appears (fig.1(b)) and it lasts until 80.0 V. No transition phase was observed at 30V. Above 80.2V, the 1/3 order peak shifts to the low q value and becomes broad while a new peak appears as shown in fig.(d) which indicates the new 6 layer periodicity. At higher applied voltages, the peak intensity decreases (fig.1(e)) and then only the streak is observable (fig.1(f)). After the ferroelectric (SmC*) transition, RXS disappears. In this sample, in contrast to the Br-contained liquid crystal [4], no twelve-layer periodicity phase appeared near the phase boundary between the SmC* and SmC_γ*. The phase sequences at other temperature are now under investigation.

References
[1]Y.Takanishi *et al., Phys. Rev.* E**87**(2013)050503(R)
[2] S.Wang *et al., Phys. Rev. Lett.* **104**(2010)027801
[3] K. L. Sandhya *et al., Liq. Cryst.* **36**, 1101 (2009).
[4] A.Iida *et al., Phys. Rev.* E. **89** (2014)032503
[5]L.S.Matkin *et al., Phys. Rev.* E**64**(2001)021705
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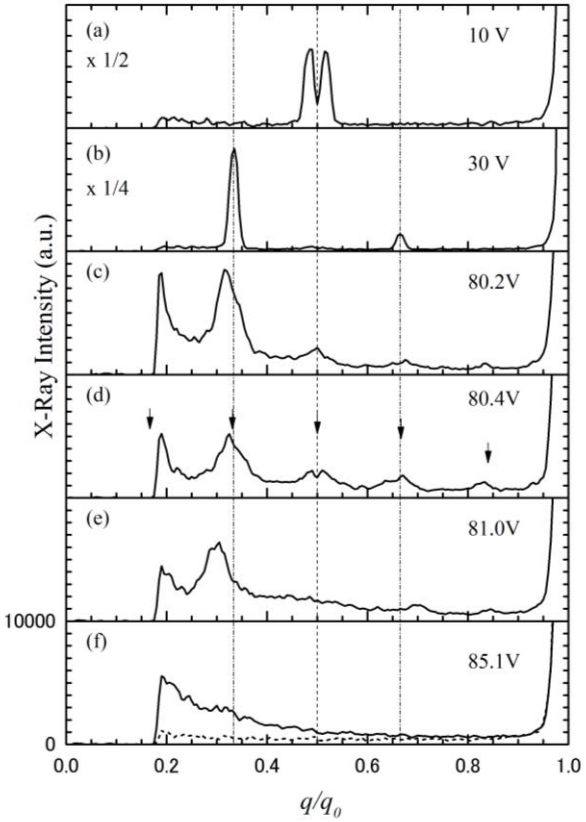

Fig.1 RXS intensity distributions along the layer normal. A dotted line in fig (f) shows the diffraction pattern from the ferroelectric phase at 86V. Missing data q/q_o = 0 through 0.18 are due to the shadow of a direct beam stopper.