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# Chiral smectic transition phases appearing near the electric field-induced phase transition observed by resonant micro-beam X-ray scattering (4)

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## 1 Introduction

Various subphases of chiral smectic-*C* liquid crystals (LCs), which are characterized by an azimuthal arrangement of molecular orientations among the layers, were discovered between the lower-temperature $SmC_A^*$ (antiferro) and higher-temperature $SmC^*$ (ferro) phases. In an electric field, these LCs undergo an electric field-induced phase transition to the $SmC^*$ phase with increasing electric field. For the smectic phase identification, resonant X-ray scattering (RXS) has played a crucial role. In our previous RXS measurement [1, 2], 12-layer and *n*-layer (*n* = 5 to 8) periodicity subphases were revealed in Br- and Se-containing LCs, respectively, near the field-induced phase transition. The observed transitional subphases, however, were different for the two LC samples. In this report, we use a Se-containing mixture LC sample which shows the typical case of the frustration between the $SmC_A^*$ and $SmC^*$ phases [3].

## 2 Experiment

A Se-containing LC mixture sample comprises 80% AS657 and 20% AS620 (Kingston Chemicals Ltd, University of Hull, Hull, U.K.) and is sandwiched between 80 μm thick glass plates coated with indium tin oxide as an electrode. The sample had a typical phase sequence of $SmC_A^*$ (85.8 °C) $SmC_\gamma^*$ (87.7 °C) AF (89.8 °C) $SmC^*$ with heating. The applied electric field was a square wave form with 100 Hz. 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 $\mu m^2$. A pixel array detector (Pilatus-100K, DECTRIS) located at 100 cm from the sample (focusing point) was used for the measurement.

## 3 Results and Discussion

The transitional subphases were formed during the transition from the three-layer periodicity phase to the ferroelectric phase. In the lower temperature range (86.3 °C, see Fig.1) where the three-layer SmCγ* phase appeared under the low electric field (Fig1(a)), nine-layer (Fig.1(b)) and six-layer subphases (Fig.1(c)), and "streak" pattern appeared in sequence after the transition from the SmCγ* phase with increasing applied electric field; the ferroelectric phase was finally realized (Fig.1(d)). In the higher temperature range (88.0 °C) where the four-layer AF phase appeared under a low electric field, the AF phase changed to a three-layer phase at the medium electric field. The twelve-, nine-, and six-layer subphases subsequently appeared in sequence, and finally the ferroelectric phase was generated with increasing electric field.

For the molecular arrangements of the newly-found nine-layer periodicity phase, the {RRR RRL RRL} configuration is found to be a potential candidate, where {· · · } represents the molecular configuration in a unit cell, and "R" and "L" indicate the smectic layer with directors tilted to the right and left, respectively.

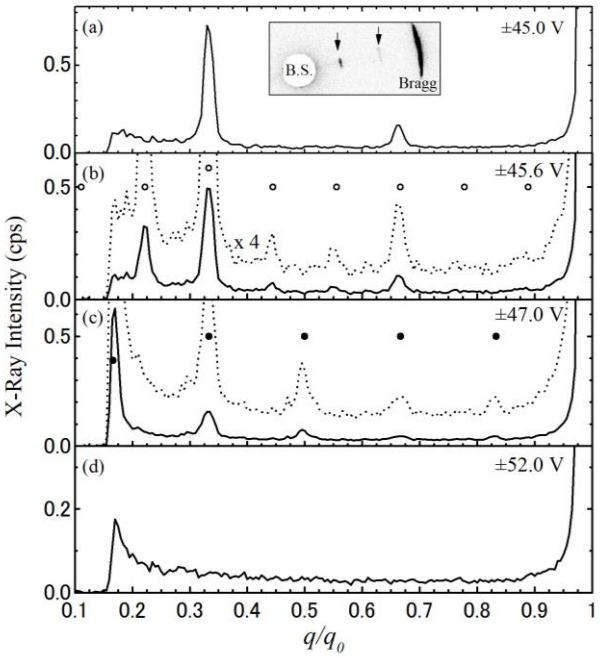


Fig.1 A series of RXS profiles obtained at applied fields from ±45.0 V to ±52.0 V at 86.3 °C. Open circles in (b) and filled circles in (c) indicate positions where reflection peaks owing to nine- and six-layer configurations, respectively, are expected to appear. Inset in (a) shows a original two-dimensional diffraction pattern.

References
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