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Chiral smectic transition phases appearing near the electric field-induced phase transition observed by resonant micro-beam X-ray scattering (3)

Atsuo Iida[1] and Yoichi Takanishi[2]
[1]Photon Factory, Institute of Material Structure Science, 1-1 Oho, Tsukuba, Ibaraki 305-0801, Japan
[2]Kyoto University, Kitashirakawaoiwake-cho, Sakyo-ku, Kyoto 606-8502, Japan

1 Introduction

Chiral smectic (tilted) 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* (ferro), SmC_A* (antiferro), SmC_γ* (ferri) and SmC_{AF}* (antiferro) phases with decreasing temperature. 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 been the most powerful technique. In our previous RXS measurement [1], a 12-layer periodicity subphase in a Br-containing liquid crystal and a 6-layer periodicity subphase in Se-containing liquid crystal were found near the field-induced phase transition from the SmC_γ* to SmC* phases. In this paper, a new field-induced transitional subphase which showed the peak shift from the conventional peak positions was investigated in a Se-contained liquid crystal.

2 Experiment

The Se containing liquid crystal used was AS657 (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 phase sequence of the material is SmC_α*(85.9°C) SmC_{AF}*(83.5°C)SmC_γ*(82.0°C)SmC_A*. 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 μm^2. A pixel array detector (Pilatus-100K, DECTRIS) located at 85 cm from the sample (focusing point) was used for the measurement

3 Results and Discussion

The upper panel of fig. 1 sows the RXS intensity distributions along the layer normal for various applied field at 83.9°C (0.4 °C above the SmC_γ^* to SmC_{AF}* phase transition temperature) as a function of the normalized scattering vector obtained from the 2D diffraction pattern. The RXS pattern up to ±19 V indicates the SmC_{AF}* phase. The SmC_γ* phase was stable up to ±28 V. Then, the *m*/3-order peaks gradually shifted to the *m*/4-order peaks up to ±36 V (Fig. 1 (c), (d), and (e)). At ±31 V, extra subpeaks appeared around q/q_o = 0.42 and 0.58.

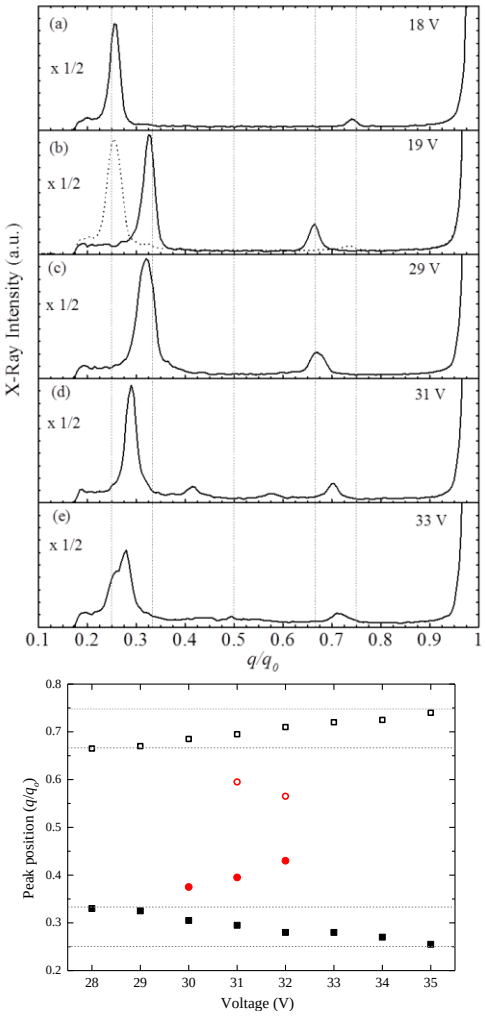

Fig.1 A series of RXS profiles obtained at applied fields from ±18.0 V to ±36 V at 83.9 °C (upper panel). RXS satellite peak positions as a function of the applied voltage (lower panel).

The lower panel in fig. 1 shows the RXS peak positions as a function of the applied voltage. The main peak (squares) and weak subpeak (circles) positions depend on the applied voltage. To explain this continuous peak position shift, the effect of the helical structure and the large unit cell structure were examined.

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Reference

[1] A.Iida et al., Phys. Rev. E. **89** (2014)032503

* atsuo.iida@kek.jp