

**Experiment title:**

Probing biaxial order in the nematic phase of bent-core liquid crystals

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SC-3985

**Beamline:**

BM26B

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9

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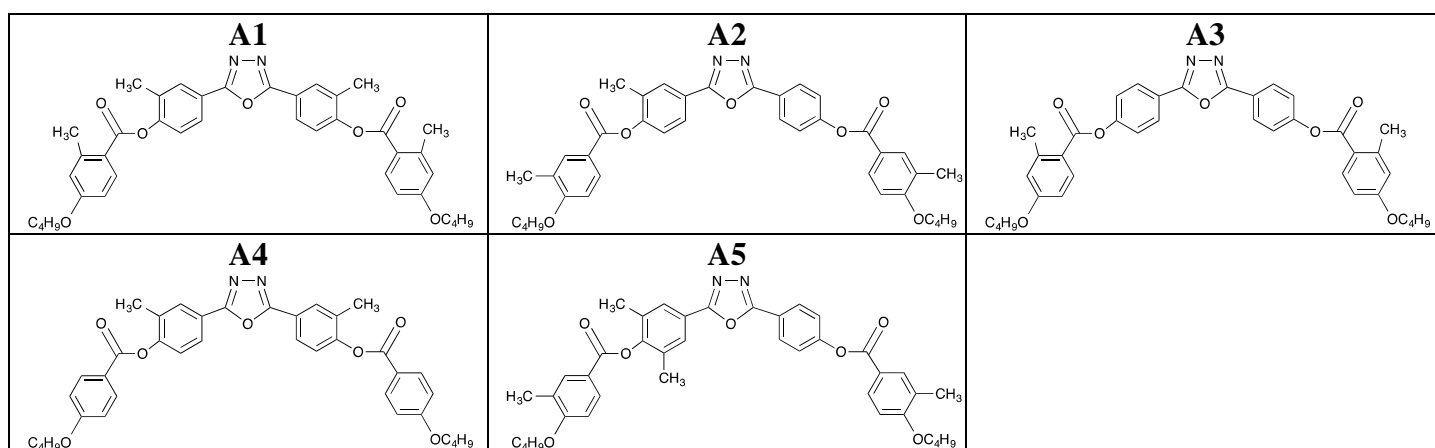
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**Report:**

This document is a preliminary report on the measurements carried out in a very recent experiment performed at BM26B in February 2015. Aim of the experiment was to search for biaxial order in the nematic (N) phase of a family of bent-core mesogens (BCMs), namely liquid crystals (LCs) with a bent molecular structure. The experiment was in the wake of the results obtained in a previous experimental session (SC-3082), where a split of the wide-angle (WA) pattern in the supercooled glassy N phase of a few laterally substituted BCMs revealed enhanced biaxial orientational correlations in the transverse molecular packing, an effect never observed before in low molecular weight thermotropic nematics.

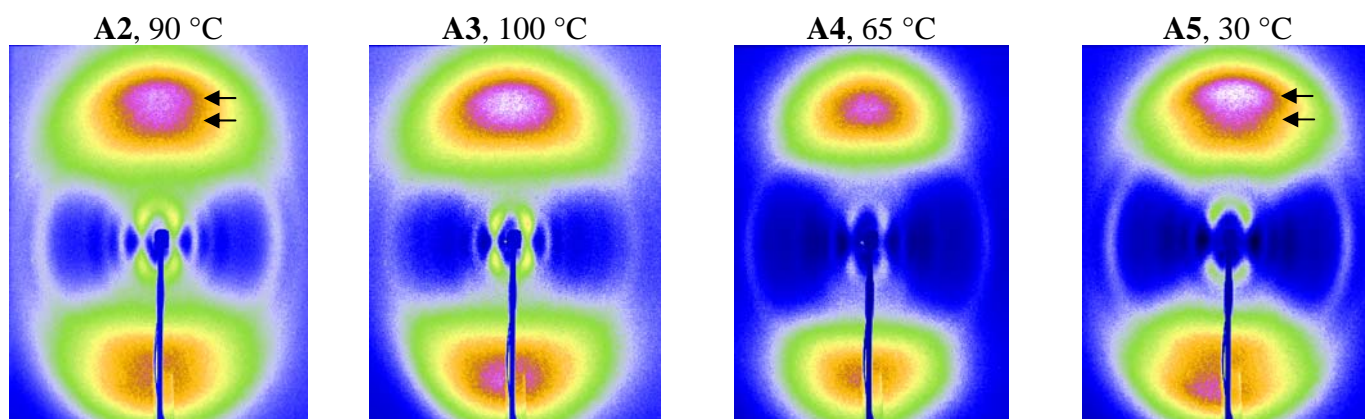
**Table 1.** Chemical structure of the investigated bent-core LCs.

We performed two sets of measurements, SAXS and WAXS, on a series of newly synthesized bent-core LCs (A1-5 in Table 1), aligned by a 1 T transverse magnetic field. Samples were studied in 1.5 mm glass capillaries, in the whole N temperature range. Additional WAXS measurements were performed with the magnetic field parallel to the X-ray beam direction (an experimental configuration we never used before) on selected samples, including a few LC compounds studied in the previous experiment.

While the detailed analysis of the data is still in progress, here we report a first summary of the main findings.

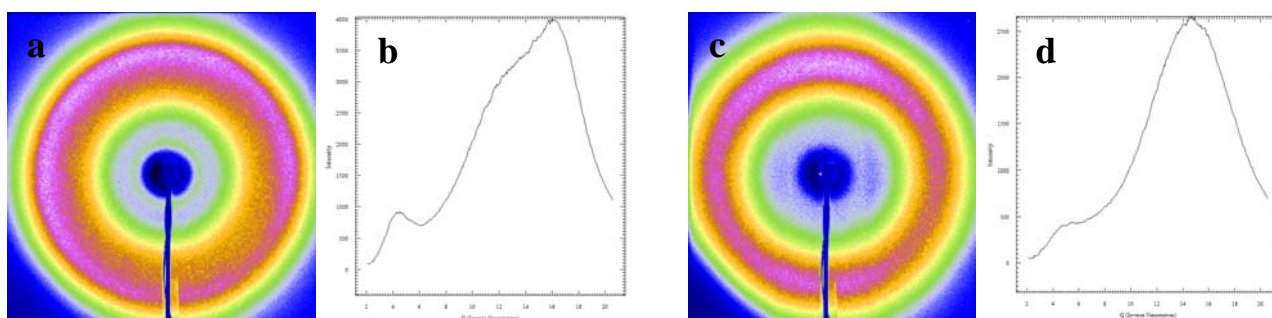
i) The previous experiment had pointed out the crucial role played by lateral substitutions of the mesogenic structure in determining the thermodynamical properties of the N phase (transition temperatures, formation of a room temperature glassy phase preserving N order) and the presence of enhanced biaxial correlations (evidenced by a splitting of the WAXS diffuse reflections). Thus, mesogens **A1-5** were synthesized to explore different substitution patterns. The observation of four spots in the SAXS region of the diffraction patterns (Fig. 1) confirmed the cybotactic nature of the N phase, i.e. the presence of nano-sized clusters of molecules possessing layered (smectic-like) positional order and biaxial orientational order. The N phase of LC **A1** was monotropic with a temperature range strongly depending on the cooling rate. On the other hand, LC **A5** exhibited a supercooled glassy N phase at room temperature.

ii) We paid particular attention to the possible splitting of the WAXS crescents into two distinct (though largely overlapping) diffraction reflections. Such effect was observed over the whole N range of compounds **A2** and **A5**, while other mesogens showed only a single-peak wide-angle feature (Fig. 1). Compared to previous results, the splitting was still observed in asymmetrically substituted mesogens, but here it was present also in a mesogen (**A2**) that did not form a glassy N phase.



**Figure 1.** Representative WAXS patterns of samples **A2-A5** aligned in a horizontal magnetic field. The four-spot pattern in the small-angle region is a signature of cybotactic order. The arrows indicate the two overlapped WAXS reflections in the patterns of **A2** and **A5**.

iii) Finally, we looked for the presence of *macroscopic* biaxial order by studying the mesogens aligned along the direction of the X-ray beam (magnetic field parallel to the beam). We still observed a splitting of the wide-angle feature for LCs **A2** and **A5**, as evidenced by the  $q$ -scan in Fig. 2. However, we did not observe a segregation of the two reflections along two orthogonal transverse directions. On the contrary, all the patterns were substantially isotropic, indicating that the enhanced biaxial order present in LCs **A2** and **A5** did not spontaneously extend over the length scale of the probed volume. However, on the sole basis of these results we cannot conclude whether the biaxial order evidenced by the WAXS splitting is just local, i.e. limited to the scale of nano-sized biaxial clusters, or instead is due to much larger (micron-sized) randomly-oriented biaxial domains. Discriminating between these two possibilities would require a monodomain specimen, with all three molecular directors uniformly aligned over the probed volume. In principle, this could be possible by exploiting the combined action of external fields (magnetic and electric) and surface interactions, a strategy that will be pursued in a next experiment.



**Figure 2.** Representative WAXS patterns of samples **A5** (a) and **A4** (d) aligned in a magnetic field parallel to the X-ray beam direction and the corresponding radial intensity profiles (b and d). The splitting of the WAXS feature is evident in b.