ESRF	**Experiment title:** A novel nematic mesophase with ferroelectric ordering in mesomorphic banana-shaped 1,2,4- oxadiazoles: X-ray diffraction study	**Experiment number:** SC-1276
Beamline: BM26	**Date of experiment:** from: 22/11/2003 to: 24/11/2003	**Date of report:** 20/02/2004
Shifts: 8	**Local contact(s):** Dr. Dolbnya Igor	*Received at ESRF:*

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Report:

After the paper of Niori et al. [1], bent "banana-shaped" (BS) molecules exhibiting LC mesomorphic behavior have become the focus of great scientific interest because of their ability to exhibit spontaneous polarization without chiral groups. As a consequence of the sterically-induced special molecular packing of the bent molecules, smectic layers with C_{2v}, C_2, and possibly also C_{1h} or C_1 symmetry could occur giving rise to ferro-, ferri- or antiferroelectric properties. We have carried out a X-ray diffraction study (XRD) of the mesomorphic behavior of new BS 1,2,4-oxadiazoles (Fig.1) exhibiting spontaneous polarization (**Ps** $\approx$ 200-300 nC/cm^2) and ferroelectric swithing behavior in both the nematic (N) and the smectic (S) phase [2]. These compounds provide one of the very few examples of polar ordering in nematic LCs whilst they represent the *first experimental evidence* of ferroelectric ordering in a fluid N phase of BS molecules. The energy of the incident beam was 18 KeV and the sample-to-detector distance was 34 cm. The samples were aligned under magnetic field (B=0.6 T). Simultaneous 2D SAXS-WAXS patterns were recorded using a multiwire gas-filled detector. In all samples we could identify the smectic (SmA) and nematic nature (structure and symmetry) of the mesophases. In particular, in the N phase the splitting of the SAXS signal into the four symmetrically-located diffuse spots revealed the cybotactic nematic nature of the N, consisting of "cybotactic" clusters with pronounced short-range smectic C-like ordering, embedded in the surrounding nematic. The size of these clusters (estimated from the profiles of the small-angle diffuse spots) was on the order of a few tenths nonmeters (nanoclustres). Evidence was also been found (fig. 2) of a permanent macroscopic polarization of the sample, which persists after the field is switched off, pointing to a spontaneous polar ordering of the clusters (long-range polarization), which explains the observed ferroelectric switching behavior of the sample [3].

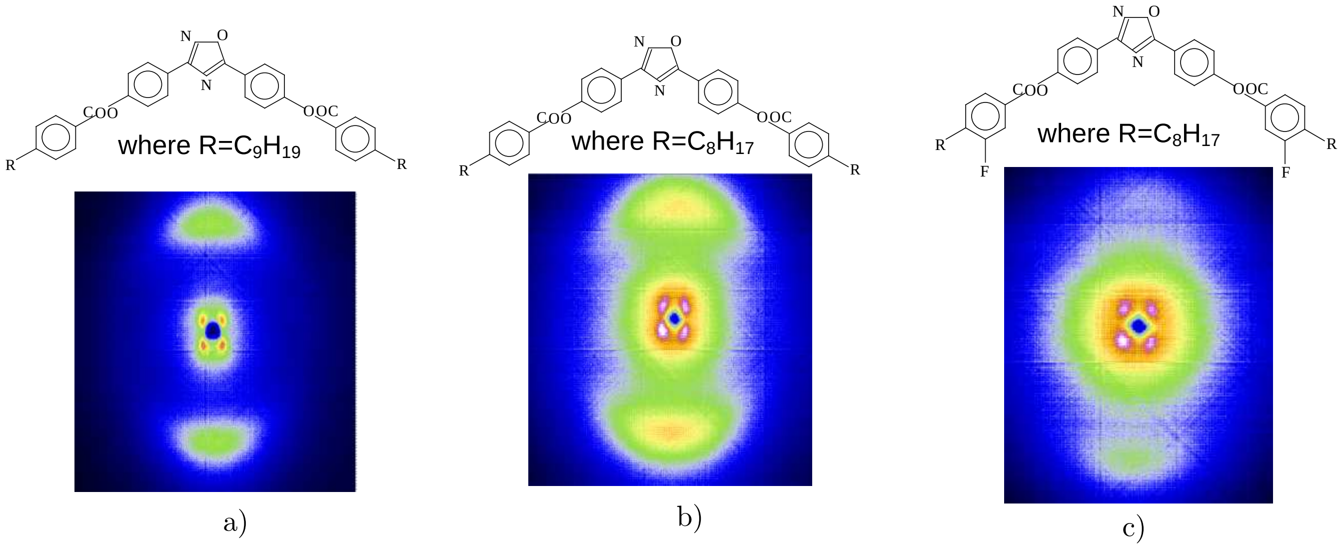

Fig. 1. XRD pattern of the nematic phase oriented in the magnetic field:
a) at T=145 °C, sample I; b) at T=179 °C, sample II; c) at T=220 °C, sample III.

Measurements of the relaxation time of the long-range polar ordering were carried out in the N phase of sample I (at T=145 ° C), following the time-evolution of the anisotropy of the XRD patterns after switching off the aligning magnetic field. In a next experiment we will study the relaxation of the macroscopic polarization after aligning the sample in an electric and will investigate the uni- or bi-axial of the nematic phase.

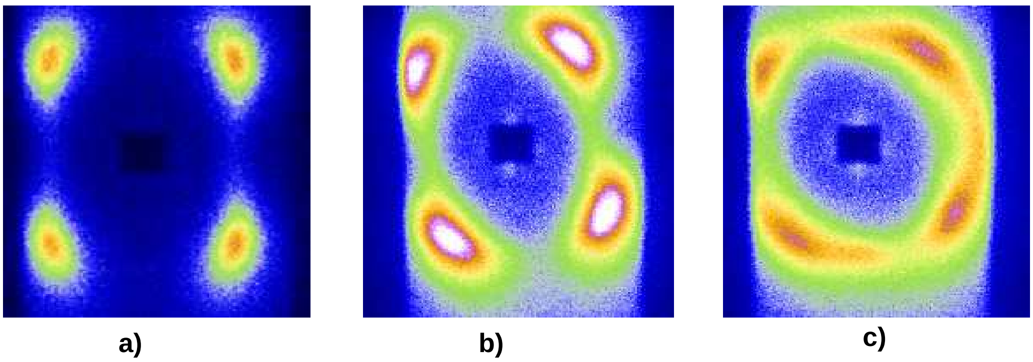

Fig.2. SAXS patterns of the sample I; a) magnetic field on;
b) 1 minute and c) 120 minutes after, switching off of magnetic field.

References

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