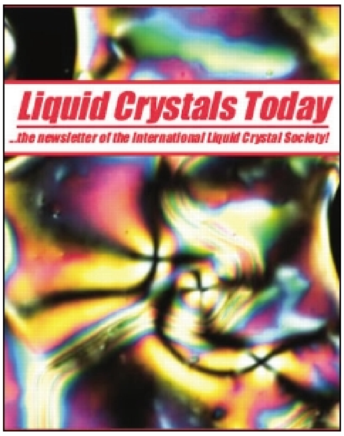

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Recent Advances in Understanding Smectics O,O* and C_A, C_A* — developments reported at the 14th ILCS, Pisa

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Recent Advances in Understanding Smectics O,O* and C_A, C_A* — developments reported at the 14th ILCS, Pisa,

highlighted by Pat E Cladis, AT&T Bell Laboratories, New Jersey, USA.

About 100 contributions on ferroelectricity at the 14th ILCC in Pisa, Italy provided an overview of the evolution in our thinking over the past 10 years of chiral smectic phases. This was well illustrated by research on smectics O (O*) and C_A (C_A*).

In 1983, Levelut *et al* [1] reported the existence of a new smectic liquid crystal phase in m7tac. They called this phase O (or O* in the chiral species), and they proposed a structure for smectic O* (O) that was similar to smectic C*.

In 1988, Chandani *et al*[2] first observed a double hysteresis loop characteristic of antiferroelectric phases in MHPOBC and later in several different compounds. They called their new phase smectic C_A*. This was an important observation for the flat panel display technology because it introduced a novel way to expand the grey scale of ferroelectric displays. Indeed, at Japan Display '92, researchers from Nippon Denso and Showa Shell Co. will discuss their 6 inch multi-colour, video-rate, antiferroelectric liquid crystal display [3].

Chandani *et al* proposed a layered chevron structure for the director in smectic C_A* where a chevron was composed of two molecules in a plane with one molecule tilted one way relative to the layer normal and the second one inclined at an equal but opposite angle to the layer normal. A similar structure had been first proposed to account for the x-ray observations in a smectic phase of the main chain polymer BB-5 [4]. Watanabe and Hayashi added chiral dopants to BB-5 to form a double helix structure in the main chain polymer with a phase difference of π between the two helices and noted that the polarization vectors in successive layers would cancel. They also pointed out that the possibility for such a structure [5] had been raised as far back as 1977, with some experimental evidence [6] that polarization states in "bi-layer" smectic structures could be qualitatively different from classical smectics. The existence of a chevron structure was first observed (~ 1987) in the main chain liquid crystal polymer, BB-5 [4]. Recently, we have discussed the possibility of ferrielectricity or antiferroelectricity implicit in the chevron structure of their non-chiral main chain polymer [7].

Based on optical studies of a thin layer of smectic O (O*) sandwiched between bulk isotropic liquid and air, Galerne and Liebert [8] proposed a chevron structure for smectic O* (and O). At the 1992 German Liquid Crystal Meeting, Heppke *et al*[9] reported that the smectic O* phase of m7tac and the "antiferroelectric" smectic phase discovered by Chandani *et al* [2] were miscible.

At Pisa, observations of a field induced phase transition in chiral m7tac were reported by Komitov *et al*[10] and by us [11]. From the photographs shown of the field induced state, it seemed that both contributions were addressing the same phenomenon. Our results [11] were in the high field (- 10 volts/μm) and high frequency (1kHz) regime in bulk samples. We observed striking colour changes in both chiral and racemate m7tac with increasing field and a 45° rotation of the optic axis at the transition to the high field state. After the field was turned on, there is an initial fast response (faster than 0.1s, the time resolution of our VCR) associated with a colour change but no rotation of the optic axis. The field induced transition, involving a 45° rotation of the optic axis, took place by front propagation after a time delay and was slow (10's of seconds).

General symmetry arguments [7,11] imply interesting electrical properties such as antiferro-, ferri-, and ferro-electricity for chevron structures even for non-chiral systems. In view of these results, the report by Nishiyama et al [12] that a non-chiral "swallow tail" compound mixed with the "chiral anti-ferroelectric" phase of Chandani *et al's* compound is indeed very interesting. A clear next step for the non-chiral "swallow tail" compounds is to investigate their hysteresis loop and the orientation of **P** relative to the plane of the dimers.

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