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## Liquid Crystals Today

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## Polymer Liquid Crystals

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# Meeting Reports

## **From Chiral Molecules to Chiral Liquid Crystal Phases**

Report on a workshop held in Berlin

1-2 December 1994

Professor H.-G. Kuball (University Kaiserslautern) and Professor G. Heppke (Technical University Berlin)

**D**uring the last decade, the topic of chirality and symmetry in physical sciences has become extremely important, particularly as nature itself is often described as being "handed" or chiral. In liquid crystalline systems many important properties are known to be related to chirality, for instance chirality is reflected in helical structures, in special cases of strongly twisted systems novel frustrated phases may appear such as Blue phases and Twist Grain Boundary phases. In addition, many modern high technology applications, such as ferroelectric displays depend entirely on the presence of chirality in the liquid-crystalline materials employed.

At a molecular level chirality may only be marked by a small structural variation on a non-chiral structure, in direct contrast to the large macroscopic effects produced. Although experimentally secondary chirality observations are measurable (e.g., the pitch of helical structure or the circular dichroism), it is difficult to quantify chirality on the molecular level. Moreover, the mechanism by which chirality is transferred from a molecule to a liquid crystal phase is not at all well understood. In order to discuss the nature of these and related aspects, the Sonderforschungsbereich "Anisotropic Fluids" organized a scientific 'Workshop on Chirality' at the Technical University of Berlin on 1 and 2 December 1994. The scientific program arranged by Professor H.-G. Kuball (Kaiserslautern) included some 15 lectures by delegates from various parts of the world. The meeting was attended by about 60 participants, mainly people associated with the Berlin Liquid Crystal Research Groups.

The morning session of the first day, chaired by Professor H.-G. Kuball, was devoted to the definition of chirality and to chiral molecules. Professor A. Schönhofer (Berlin) delivered a lecture entitled "Chirality observations for a molecule and for a phase" followed by the talks of Professor G. Gottarelli (Bologna) entitled "Elements of structure which are the origin of chirality in a molecule" and of Professor D. Dunmur (Sheffield) on "Quantifying molecular chirality".

After lunch, Professor A. Saupe (Halle) chaired sessions concerned with the chiral liquid crystal phases and the intermolecular chirality transfer. The themes of the lectures were "Polymorphism of chiral phases determined by structural elements of the molecules" by Professor J. Goodby (Hull), "Chirality as a physical parameter" given by Professor P. Collings (Swarthmore), "Interrelation between chiral invariants in the free energy and chiral intermolecular interaction potentials" by Dr. M. Osipov (Moscow) and "Computer simulation of chiral liquid crystal phases" by Dr. R. Memmer (Kaiserslautern).

The last session addressed the molecular phenomena connected to the properties of chiral phases. The topic of the helical twisting

power was discussed in the talks "Odd-even behaviour of the molecular twisting power and helix inversion in induced cholesteric phases" by Professor G. Scherowsky (Berlin) and "Helix inversion in cholesteric phases: a molecular property" by M. Müller from Professor Heppke's group in Berlin was presented in the evening session with Professor M. Labes (Philadelphia) as chairman.

On the second day of the meeting this topic was continued, chaired by Professor G. Scherowsky, with the lectures "Temperature dependence of the pitch in cholesteric and induced cholesteric phases" by Professor G. Chilaya (Tbilisi), "Non-symmetric effects of enantiomers and conformers on right- and left-handed cholesterics" by Professor Labes, "Molecular configuration related to the chirality of the mesophase" by Dr. F. Gieelmann (Clausthal) from Professor Zugenmaier's group and "Intramolecular chirality transfer and the anisotropy of intermolecular chirality transfer in chiral induction" by Professor H.-G. Kuball. In the last part of this session, chaired by Professor Heppke, the topic of ferroelectricity was discussed in the lectures "Polarization sign inversion in ferroelectric liquid crystals measured by the pyroelectric technique" given by Professor L. Blinov (Moscow) and "Spontaneous polarization directly connected to chirality" given by Professor H. Stegemeyer (Paderborn).

The workshop was especially successful in drawing attention to the phenomenon of chiral induction, due in no small part to the efforts of the speakers. They not only succeeded in capturing the attention of researchers from a wide range of scientific disciplines but provoked much lively discussion. Although no absolute view prevailed, the participants agreed that they obtained new insights into the challenging problem of chirality transfer. The organizers felt that the meeting was highly successful and are sure that the insights gained may provoke further ideas for future experimental and theoretical research.

## **Polymer Liquid Crystals**

One day meeting

8 February 1995 London

Helen Gleeson, University of Manchester

**T**he field of polymer liquid crystals is encompassing an increasingly wide range of research areas and applications, as was demonstrated at a recent one day meeting devoted to the subject. The meeting was held in London at the Scientific Societies Lecture Theatre, and was organized by the Institute of Physics Polymer Physics Group and co-sponsored by the British Liquid Crystal Society and the Royal Society of Chemistry.

Geoff Mitchell (Reading University) was the first speaker, talking about experimental aspects and applications of elastomeric liquid crystals. The fascinating properties of lightly crosslinked elastomeric systems were described, concentrating on memory effects where alignment induced during crosslinking in a mesophase is restored after heating into the isotropic and subsequent cooling. The physical

properties, which were dependent on the phase in which the crosslinking took place, led to a wide range of effects and applications, including bifocal contact lenses, media for optical data storage and various transducers. The following talk by Eugene Terenjev (Cambridge University) was an illuminating summary of the theory of elastomeric liquid crystalline systems. His work complemented the experimental data of the Reading group, deriving an expression for the critical strain needed for orientation and ordering transitions. A lively discussion followed these two presentations. Perhaps one of the most interesting questions raised by the two speakers was whether or not a network swelled in chiral solvent (possibly liquid crystalline) and crosslinked would itself be chiral on removal of the chiral solvent. An interesting possibility from both the experimental and theoretical point of view.

The morning presentations were brought to a close by David Coates of Merck Ltd who beautifully summarized the vast applications areas of polymer liquid crystalline systems. The talk spanned the well known laser writing and storage effects in sidechain polymeric devices, through polymer liquid crystal networks (including elastomers), polymer dispersed liquid crystal devices and rigid polymer networks (which may or may not be strictly liquid crystalline) as additives to mechanically strengthen low molar mass based displays. Chiral polymer liquid crystals had very clear applications in ferroelectric devices with high structural integrity as well as the iridescent cholesteric systems used for specialist filters and beamsplitters. It was nice to see that polymer liquid crystalline systems have the breadth of applications which would be expected from such a rich research area.

The afternoon session began by examining physical properties and structures of polymer liquid crystals. Graham Williams (University of

Wales) discussed the use of dielectric relaxation spectroscopy as a tool for the study of alignment in plcs. Rob Richardson (Bristol University) explained the invaluable role of X-rays and neutrons in the study of plcs, showing the backbone orientation, as well as the occurrence of otherwise unobservable structural transition to a face centred rectangular lattice in smectic-C polymers. Continuing in the theme of X-ray studies, an enthusiastic and lively lecture was given by Tony Ryan (UMIST) on simultaneous techniques at synchrotron sources. The combination of small and wide angle X-ray scattering with DSC, FTIR and, very recently, Raman spectroscopy, is producing detailed and unique information about ordering and phase transitions in polymeric systems. The final talk of the day was by Neville Boden (Leeds University) on 'do it yourself polymers'. It was entirely appropriate that such a talk should end a day which showed the richness and diversity of the subject of polymer liquid crystals. Neville introduced the subject of self assembling 'polymers' in which binding forces between the monomer units are Van der Waals or hydrogen bonds rather than covalent bonding. These systems self-assemble into equilibrium states which may exhibit nematic, chiral nematic, smectic, discotic, and possibly even blue phases. The materials are often lyotropic, and there is a strong link with biological systems. Definitely systems of the future.

The meeting was a great success. It showed that the area of polymer liquid crystals has expanded well beyond the early days of mainchain reinforcing polymers or sidechain systems for optical data storage. Whilst such applications remain important, it is good to see that the subject is undergoing a rapid and very interesting expansion. The breadth of physical aspects of polymer liquid crystals was well demonstrated during the meeting, and a similar meeting on synthetic aspects would be welcome.

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