ADVANCED MATERIALS

they have been able to achieve a carrier to noise ratio (CNR) of 60 dB ($v = 0.5$ MHz, $bw = 30$ kHz, $v = 10$ m/s). By depositing the same layers on glass substrates the CNR dropped to 50 dB. Most papers in the session on magneto-optical recording materials were devoted to multilayers (or layered structures) consisting of alternating Co and a non-magnetic metal e.g. Pt or Pd, each individual layer having a thickness of only a few atomic layers. *Ochiai, Hashimoto* and *Aso* (Sony) reported on the magnetic and magneto-optical properties of Co/Pt and Co/Pd ultrathin multilayered films. *Tsunashima, Nagase, Nakamura* and *Uchiyama* (Nagoya Univ.) discussed the possible role of magnetostriction in Pd/PdCo multilayers. *Zeper, Greidanus* and *Carcia* (Philips-Du Pont) were the first to report on thermally written domains and recording experiments in Co/Pt multilayers. In thin (20 nm) films they obtained a CNR of 53 dB ($v = 1.0$ MHz, $bw = 30$ kHz, $v = 5$ m/s). This value approaches the CNR-values obtained in GdTbFe thin films. Multilayers of Co and Pt offer the advantage of increased magneto-optical efficiency in the blue, an important feature for future higher density recording. Furthermore, they are very resistant against corrosion and oxidation and there is no need to apply protective layers. The application of multilayers for magneto-optical recording is an exciting possibility, and increased activitity in this area is anticipated.

In this short report it is impossible to review all subjects discussed at the 1989 INTERMAG. Those who are interested in further information I refer to the contributed and invited papers which will be published in the IEEE Transactions on Magnetics.

Liquid Crystals in Schladming

By Peter Laggner*

One hundred years after the discovery of liquid crystals by the Austrian botanist *Friedrich Reinitzer* was a good time for the VI. European Liquid Crystal Winter Conference (5.–10. March 1989) to be held in Schladming, Austria. This triennial series of 'European' conferences tends to be different from the bigger 'International' conferences as the program is topically confined in order to promote coherent discussion, to reflect the interests of the groups in the organizer's country, and to leave plenty of time and opportunity for less formal interaction.

A specific attraction of this series of conferences is the choice of venue. Previous conferences were held at Les Arcs (France), Madonna di Campiglio (Italy), Garmisch-Partenkirchen (FRG), Bovec (Yugoslavia) and Borovets (Bulgaria) all being winter sports centers. A sport hotel at Schladming this year served this purpose admirably.

The aim of this conference was to bring into fusional contact the two traditionally separate nuclei of liquid crystal research, biology and technology, in order to cross-fertilize the separately developed but related physical and chemical concepts. Thus, under the title "Liquid Crystals in Biology and Technology: Supramolecular Structure, Dynamics and Function" about 130 scientists from 21 nations (not only European) gave 17 lectures (35 min.) and 20 oral contributions (15 min.) and presented 69 posters, representing fields of interest ranging from medical biophysics, chemistry and physics to polymer and display science and technology.

[*] Prof. P. Laggner
Institut für Röntgenfeinstrukturforschung
Österreichische Akademie der Wissenschaften
Steyrergasse 17, 8010 Graz (Austria)

The topics covered in biology included the following: Biomembrane structure and dynamics, polymorphism and dynamics of lipids, Langmuir-Blodgett films, and carbohydrate liquid crystals. Technological topics included amphotropic polymer liquid crystals, chiral main-chain liquid crystals, thermal imaging systems and plastic materials.

An overlap region was presented in the fields of molecular engineering, membrane mimetic chemistry, and drug delivery systems. The first day was devoted to these overlapping topics where concepts from the study of biological membranes combined with synthetic chemistry are used to design devices in the true sense of molecular engineering. *A. Ruaudel-Teixier* (CEN, Saclay, France) and *J. Fendler* (Syracuse University, USA) presented two technically distinct approaches, the LB-film technique on solid interfaces and the BLM (bilayer lipid membrane) technique, where a single membrane of a few nanometers thickness separates two macroscopic aqueous compartments. Both approaches were originally analytical tools in membrane biophysics but are now developing rapidly in the direction of molecular electronics, photonics and sensing devices of ultimate miniaturization. Still in its infancy, as far as marketable products are concerned, this line of research was shown to hold great promise.

Ambitious molecular engineering projects require intelligent chemistry combined with structural information. *L. Feigin* (USSR Academy of Sciences, Moscow) emphasized this point and showed how X-ray small-angle diffraction techniques can provide useful data on the supramolecular architecture of oligo- and multilayer systems of high complexity. Particularly instructive, also in this context, was the

presentation of new X-ray and neutron reflectivity techniques on monolayers at a liquid surface (*J. Als-Nielsen,* Risø National Lab., Denmark). The spectacular achievement of performing the X-ray structure analysis of a single monolayer, can only be realized with high-flux photon sources such as synchrotrons.

The second day's program moved further into the more classical field of lyotropic liquid crystal phase structures and dynamics. An analytical approach to the interpretation of periodic, two-dimensional domain patterns in monolayers under conditions of 'solid-fluid' phase coexistence was presented and discussed in terms of electrostatic and interfacial forces by *R. M. Weis* (Univ. of Massachusetts, Amherst, USA). *P. Fromherz* (Univ. Ulm, FRG) discussed conservative and dissipative instabilities in lipid bilayers which are involved in the formation of different supramolecular structures, such as micelles or closed bilayer vesicles, and in the appearance of oscillatory or solitary waves in a 'fluid-mosaic' membrane containing ion-channel proteins.

A long standing problem of general physico-chemical interest concerns the kinetics and mechanism of phase transitions. This problem was addressed by *B. Tenchov* (Bulg. Acad. of Sci., Sofia, Bulgaria) and *P. Laggner* (Institute for X-ray Fine Structure Research, Graz, Austria) with time-resolved X-ray diffraction studies, using synchrotron X-ray sources, on the specific question of the thermal transitions of lipid bilayers. A wealth of hitherto unavailable information on short-lived intermediate states promises to fill the gap between largely unknown structural mechnisms and the thermodynamic and spectroscopic data which have already reached a high standard but which contain less structural information. Fluorescence spectroscopy on liposomes and LB-films, was reported by *P. Kinnunen* (Univ. Helsinki, Finland) to show indications of regular distribution patterns which might be related to the minimization of steric elastic strain in an assembly of host-guest molecules of different sizes. This phenomenon may be functionally important in biomembranes but also has implications for technological lipid film design.

Deuterium NMR spectroscopy, as a tool to probe molecular interactions at membrane surfaces, was covered by *A. Watts* (Univ. Oxford, U.K.). Being practically nonperturbing and amenable to site-specific labeling, this technique continues to provide new and important information, particularly with regard to lipid-protein interactions. Still with a strong analytical accent in membrane biophysics, but already pointing towards a potential in biosensor development, *L. Tamm* (Biocenter, Univ. Basel, Switzerland) presented studies on monoclonal anti-lipid antibodies and their interaction with fluorescence labeled lipid membranes supported on silicon wafers. Lateral diffusion and domain segregation depending on the thermotropic state of the lipids were analyzed. Similar investigations were extended to other interesting membrane proteins, such as signal peptides which are important components in cellular protein biosynthesis and processing.

Both biologically and technologically important systems were discussed on the third day. *D. Small* (Boston Univ., USA) presented a comprehensive overview on the lyotropic and thermotropic phase behavior of soaps and acid-soap complexes. A profound combination of thermodynamic and X-ray diffraction data linked to the scholarly use of Gibbs phase rule demonstrated the value but also the complexity of physical chemistry in this field. The potential of lipid/bile salt systems, analyzed with respect to their mesomorphic structure and dynamics by NMR and light-scattering techniques as suitable media for controlled drug delivery systems was discussed by *B. Lindman* (Lund Univ., Sweden). Cubic phases formed by monoolein-water were described as particularly promising candidates for systems that can encapsulate both hydrophilic and lipophilic drugs as they are stable under the wide range of conditions required for pharmaceutical purposes.

The chemical and structural aspects of a hitherto rather neglected class of mesogenic substances based upon inositol-derived compounds were reviewed by *K. Praefcke* (Techn. Univ. Berlin, FRG). These discotic carbohydrates form strongly hydrogen-bonded superlattices with thermotropic liquid crystalline behavior and frequently contain hexagonal columnar phases.

Structure-property relationships of liquid crystalline polymers were discussed by *E. Chiellini* (Univ. Pisa, Italy). His presentation focussed on chiral main-chain polyesters produced by the poly-condensation or polyaddition of chiral and non-chiral components. These polymers offer opportunities for the design of materials with specific properties and a wide variety of thermotropic states. The concept of amphotropic liquid crystal polymers was presented by *F. Kuschel* (Univ. Halle, GDR). Here, lyotropic properties are confered to linear polymers by the attachment of alcohol side-chains resulting in comb-like polymeric structures. These structures, which are in principle rather similar to smectic lipid multilayer systems, show stable mesomorphic behavior which can be influenced discretely by variations in main chain flexibility, length and nature of the side chains, and by swelling in water. Apart from being interesting models for the investigation of the intermolecular forces that govern mesomorphism, these systems also show promise as matrix components in pharmaceutical applications.

The last day of the conference was devoted to liquid crystal materials in fields where industrial applications already exist or are imminent. *B. Holcroft* (Thorn-EMI Res. Labs, Hayes, UK) discussed recent advances in the fabrication of thermal imaging films based upon the Langmuir-Blodgett technique. LB films optimized for pyroelectric properties and low thermal conductance of the substrate have been shown to be promising as practical devices for low-light thermal imaging.

Finally *D. Fleischer* (Hoechst AG, Frankfurt, FRG) gave an overview on high performance polymers based upon thermotropic liquid crystals. This presentation highlighted the manifold merits of such materials for extreme applications,

ADVANCED MATERIALS

e.g. in microelectronic devices, in chemical industry, aerospace technology and medicine. He also gave an impression of the many criteria that have to be optimized in industrial high-tech product development.

The framework of lectures complemented well the short contributions and poster presentations. A best-poster award was presented to *G. Hertel, H. Hoffmann* and *J. Kalus* (Univ. Bayreuth, FRG) for their neutron small-angle scattering study on the magnetic field alignment of the nematic phases of surfactants.

On the whole, the attempt to combine biological and technological aspects of liquid crystal research in one conference was well received and stimulated much discussion.

A book of abstracts is available from the author of this report.

Ferromagnetic and High Spin Molecular Based Materials in Dallas

By Joel S. Miller* and Dennis A. Dougherty*

The first symposium focusing on several aspects directly related to high spin and molecular/polymeric ferromagnets convened April 9–12, 1989 as part of the 197th National American Chemical Society meeting in Dallas, Texas, USA. This multidisciplinary meeting brought together inorganic, organic, organometallic, polymer, and physical chemists as well as theoretical and experimental condensed matter physicists from Japan, the USSR, the UK, France, Germany, Italy, Spain, Bulgaria, and the USA. The symposium was comprised of a tutorial and sessions devoted to the preparation and characterization of a 'designer magnet' from organic, organometallic, inorganic, and polymeric materials. This broad interdisciplinary symposium was unusual as it was co-sponsored by the Divisions of Inorganic, Organic, Polymer, and Physical Chemistry of the ACS and additionally supported by the Petroleum Research Fund and Gordon & Breach (Science Publisher). A total of 39 verbal and 25 poster papers were presented and the proceedings will be published as a forthcoming volume of *Molecular Crystals, Liquid Crystals.*

The tutorial session enabled attendees to appreciate the conceptual framework on which the current understanding of cooperative magnetic phenomena in molecular/organic/polymeric systems is based. *D. A. Dougherty* (Caltech) concisely reviewed the key criteria for stabilizing a triplet ground state, the building block of a high spin molecule or polymer. *J. S. Miller* (Du Pont) described the existing paradigms, while the fundamental physics of magnetism were reviewed by *A. J. Epstein* (Ohio State). Models for magnetic order and neutron diffraction aspects were presented by *P. Day* (Institut Laue-Langevin) and insight into the realities of opportunities for molecular based magnets was provided by *R. M. White* (Control Data Corp.). Due to their low density, high molecular weight, and low spin-orbit coupling, competition with existing magnets seems unlikely; however, opportunities might exist in fine particle and magnetooptic recording.

The strategies for designing molecular/polymeric materials with ferromagnetic coupling include: a) unpaired electrons in orthogonal orbitals sharing the same spatial region, b) Heitler-London spin exchange, c) antiferromagnetic coupling of sites with differing S values (ferrimagnet), d) conjugated odd-alternate hydrocarbons, e) polaronic, conjugated block copolymers, and f) configurational admixture of triplet charge transfer excited states. High spin systems demonstrating the feasibility of several of the strategies were discussed and a few high moment materials were described. It was emphasized universally that the rational design of solid state structures remains an art that limits our ability to prepare the secondary and tertiary structures needed to test many concepts in solid state science. Frequently, complex, solvated compositions with undesired or new structure types form instead of the desired phase. Additionally, several polymorphs may form in lieu of the desired structure type. This is particularly crucial for the formation of a bulk ferromagnet as ferromagnetism is a 3-D (bulk) not a 1-D property.

[*] Dr. J. S. Miller
Central R & D Department
E. I. du Pont de Nemours & Co., Inc
Wilmington, DE 19880-0328 (USA)
Prof. D. A. Dougherty
Department of Chemistry
California Institute of Technology
Pasadena, CA 91125 (USA)