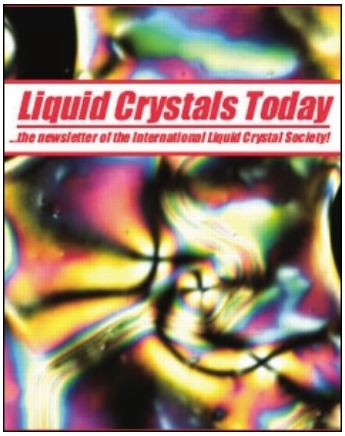


Liquid Crystals Today
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713681230

Dynamics and Defects in Liquid Crystals Honouring Alfred Saupe

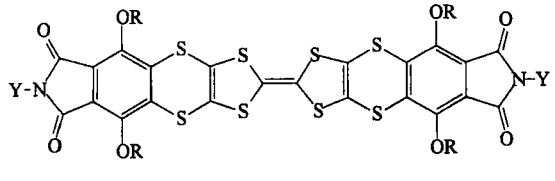
O. D. Lavrentovich[a]
[a] Kent State University, Kent, Ohio, USA

To cite this Article Lavrentovich, O. D.(1996) 'Dynamics and Defects in Liquid Crystals Honouring Alfred Saupe', Liquid Crystals Today, 6: 1, 4 — 5
To link to this Article: DOI: 10.1080/13583149608047630
URL: http://dx.doi.org/10.1080/13583149608047630

electron gas in the inversion layer of the silicon. This coupling is strong enough to give rise to a hybrid band structure in the inversion layer with the effect of amplifying perturbations in the molecular wires via restrictions imposed on quantum pathways. In this way we can transform molecular signals arriving in the molecular wires into electronic signals in silicon chips. Once in the chip, molecular signals, in the form of local current changes, or channel switching events ('on – off'), can be processed in the usual way.

Developments in design and synthesis

In our work we have used mainly hexaalkoxytriphenylenes. They are stable to heat, light and redox processes and their chemistry is fairly accessible. We are now able to produce large quantities of these materials of high purity and at an economic price. Routes for synthesizing low molar mass discotics [8], (Scheme 1), polymeric discotics [9], (Scheme 2), and for introducing substituents into the triphenylene ring [10], (Scheme 3), are now available. The latter enables the electrical properties and phase behaviour to be fine-tuned. Device applications of discotic liquid crystals require the development of materials which are liquid crystalline at room temperature and can be easily processed as polymers.



$R = CH_2CH_2((CH_2)_8CH_3)_2$, Y = 4'-pyridine

On Cooling	On Heating
glass(36) K(89) S_A (112)I	glass(45) K(103) S_A(115)I

Figure 4. A liquid crystalline tetrathiafulvalene derivative.

Smaller band gaps can be achieved by using porphyrin, phthalocyanine or larger delocalized aromatic cores. Significantly, we have recently made smectic A phases from calamitic molecules with tetrathiafulvalene (TTF) cores having band gaps of order 2.5 eV, figure 4. The in-layer conductivity ($1.99 \times 10^{-6}\ \Omega^{-1}\ cm^{-1}$ at 110°C) is 10^4 greater than that along the normal to the smectic layer. This behaviour stems from local $\pi - \pi$ stacking of TTF cores. By intelligent design it should be possible to build charge transport into all of the calamitic phases with the tantalizing prospect of new applications for liquid crystals.

References

1. Chandrasekhar S., Sadashiva B.K. and Suresh K.A., 1977, *Pranama,* **9**, 471.
2. Boden N., Bushby R.J. and Clements J., 1993, *J. Chem. Phys.,* **98**, 5920.
3. Adam D., Closs F., Frey T., Funhoff D., Haarer D., Ringsdorf H., Schuhmacher P., and Siemensmeyer K., 1993, *Phys. Rev. Lett.,* **70**, 457.
4. Markovitsi D., Lécuyer I. , and Simon J., 1991, *J. Phys. Chem.,* **95**, 3620.
5. Markovitsi D., Germain A., Millié P., Lécuyer I., Gallos L.K., Argyrakis P., Bengs H. , and Ringsdorf H., 1995 *J. Phys. Chem.,* **99**, 1005.
6. Boden N. , Bushby R.J., Clements J., Movaghar B., Donovan K., and Kreozis T., 1995, *Phys. Rev. B,* **52**, 13274.
7. Adam D., Schuhmacher P., Simmerer J., Häussling L., Siemensmeyer K., Etzbach K.H., Ringsdorf H., and Haarer D., 1994, *Nature,* **371**, 141.
8. Boden N., Bushby R.J., Borner R.C., Cammidge A.N. , and Jesudason M.V., 1993, *Liq. Cryst.,* **15**, 851.
9. Boden N., Bushby R.J., and Cammidge A.N., 1995, *J. Am. Chem. Soc.,* **117**, 924.
10. Boden N., Bushby R.J., and Cammidge A.N., 1995, *Liq. Cryst.,* **18**, 673; Boden N., Bushby R.J., Cammidge A.N., and Headdock G., 1995, *J. Mater. Chem.,* **5**, 2275.

Conference on

Dynamics and Defects in Liquid Crystals

Honouring Alfred Saupe

Report by O. D. Lavrentovich, Kent State University, Kent, Ohio, USA

At ALCOM's international symposium on 12 – 13 October, 1995, over 100 participants gathered in beautiful Cuyahoga Falls, Ohio, to discuss current developments in dynamics and defects in liquid crystals and to honour Professor Alfred Saupe on the occasion of his 70th birthday. ALCOM, the US National Science Foundation and Technology Center on Advanced Liquid Crystalline Optical Materials, is a consortium of Kent State, Case Western Reserve and Akron Universities.

During the conference, it became evident that the areas of defects and dynamics in liquid crystalline materials, topics which have played an important role in many of Alfred Saupe's contributions, were opening doors onto new challenges in the development of liquid crystal physics as well as onto new strategies to advance our understanding of non-linear non-equilibrium systems. Contributions made during the conference also clearly demonstrated that during his scientific career, Alfred Saupe laid the groundwork in the physics of liquid crystals on which much of the current knowledge and research is based.

The first of these was the clear recognition that H. Pleiner (Mainz, Germany) gave the Symposium's Keynote Address: 'Alfred Saupe – 40 Years of Research'. This lecture was an efficient (one year per minute) and thorough overview of Alfred Saupe's classic pioneering contributions to the science. These include the Maier–Saupe model of the nematic phase; predictions of a cubic defect structure for blue phases; prediction of helix structures in chiral smectics; discovery of biaxial nematics in lyotropic systems; first hydrodynamic theory of biaxial nematics and smectic C liquid crystals; modern presentation of the divergence terms in the elastic free energy, the first calculations of the elastic constants based on model intermolecular potentials. The talk was divided into four parts, covering contributions in the areas of

- structure and order
- defects, dynamics and instabilities
- new phases and phase transitions, and
- applied research.

In the discussion following Pleiner's lecture, P. Palffy-Muhoray (Kent, USA) drew attention to unpublished work (1972) where Saupe first observed and correctly explained the light-induced Fredericksz transition.

G. Durand's (Orsay, France) lecture on order parameter dynamics at the nematic – isotropic phase transition showed that thermal effects associated with changes of orientational order (the orientational equivalent of adiabatic demagnetization) are not only observable, but can play a key role in the dynamic response of nematics to external fields. This talk was followed by A. Saupe's (Halle, Germany) observations using the atomic force microscope of complex defect structures in glass forming nematic and smectic A polymers.

The next four reports concerned dynamics and defects in layered smectic and cholesteric liquid crystals. C. Rosenblatt (Cleveland, USA) showed that in the vicinity of a threshold field, the dynamics of an electric field driven antiferroelectric – ferroelectric transition was consistent with expectations of a 'double sine gordon' equation. O. Lavrentovich (Kent, USA) reported experimental results and models to interpret light-induced instabilities and defect formation in smectics doped with azocompounds. A. Jakli (Budapest, Hungary) discussed electrically induced vibrations and flows in ferroelectric liquid crystals, and discussed applications. These included electromechanical transducers with potential for audio applications. Prototype earphones were developed and presented to Alfred Saupe on his birthday. The photograph shows the earphones undergoing tests.

D.-K. Yang (Kent, USA) discussed the competing mechanisms responsible for the transitions from the homeotropic to the planar and focal conic states of cholesteric liquid crystals which are responsible for the observed bistability of cholesteric cells. He described how insight into these mechanisms enabled the development of fast addressing strategies for displays using polymer and surface stabilized cholesteric materials. The first day adjourned with presentations by D. Allender (Kent, USA) who discussed the competition between director distortions and eigenvalue exchange and the role of surface interactions in thin nematic cells. P. Palffy-Muhoray considered wavelength selection in slowly quenched systems. He argued that the lack of fixed quench depth implies the existence of a new selection mechanism, and proposed a scaling hypothesis which allows experimental verification.

The poster session gave a broad sampling of work performed within the ALCOM Center. In the area of phase transitions, confined critical behaviour was studied using NMR, calorimetry and optical methods, and configuration transitions were examined both experimentally and theoretically. Pattern formation was studied on a variety of phase separating systems, in

The celebration banquet from right to left: Alfred Saupe, Pat Cladis, Frank Leslie, Jim Fergason, Noel Clark and Tony Jakli (courtesy of T. Kosa).

configurational transitions, and as excitations in helical structures. Experimental research was reported for symmetry breaking resulting from the divergence terms in the Frank elastic energy. Surface anchoring studies were presented, and display related topics included polymer stabilized stripe free OMI displays, the use of negative birefringence films to achieve wide viewing angle, as well as electro-optically controlled diffractive liquid crystal elements.

Following reception and cocktails, the evening banquet was held in the Cuyahoga room. Wine was provided as a special gift from the reserves of J. Fergason (Optical Shields, Menlo Park, CA). Banquet speakers were J. Fergason and R. Varga (Kent, USA) Director of the Institute for Computational Mathematics, who shared recollections and anecdotes of the early Saupe years at Kent State University. A. Saupe recalled learning English as a young prisoner of war in England. Congratulations and gifts from colleagues unable to attend were presented. M. Schadt (Rolic, Basel, Switzerland) sent a liquid crystal cell with high resolution optically written image of A. Saupe. F. Leslie displayed his impressive gifts as a raconteur and the evening ended on a warm and informal note.

The second day was devoted primarily to issues of dynamics. F. Leslie (Strathclyde, UK) gave an elegant argument for the existence of flow alignment in biaxial and discotic nematics. N. A. Clark (Boulder, USA) addressed the question: 'How fast CAN a liquid crystal switch?' and presented experimental data suggesting that the lower limit has not yet been reached for electric field driven reorientation in nematic liquid crystals. In his discussion on dynamics of confined liquid crystals, S. Zumer (Ljubljana, Slovenia) examined fluctuations and stability of nematics in a cylindrical geometry. On a related topic, to understand light scattering from polymer dispersed liquid crystal films, J. Kelly (Kent, USA) studied the normal modes of a radially anchored nematic droplet. As in the planar case, the normal modes of a spherical nematic droplet with a radial ground state are found to be a twist–bend

'Needs more work' — Alfred Saupe's reaction on the world's first FLC headphones.

and splay–bend mode; the structure factor can now be calculated in terms of these. T. Kyu (Akron, USA) discussed different dynamics of phase separation driven by polymerization compared to temperature quenches. They observed an initial decrease in the length scale of the emerging structure, and proposed a domain insertion model to explain these observations. P. Cladis (Murray Hill, USA) revisited an old idea that flexoelectric effects are responsible at low electric fields for subtle reorientations in cholesteric liquid crystals. She showed that expanding the free energy, assuming that the electric field was the small parameter, a non-linear non-uniform helical director field was found which topologically could lead to complete destruction of the helix at higher fields without introducing any defects. Finally, S. Chandrasekhar (Bangalore, India) discussed contributions arising from bond-orientational order to switching dynamics in hexatic liquid crystals.

A Festschrift in honour of Alfred Saupe is in preparation together with a special issue of *Mol. Cryst. Liq. Cryst.* It will include contributions from this Symposium as well as contributions from many of Alfred Saupe's colleagues unable to attend but who nevertheless wished to record their deep appreciation of his many pioneering and ground breaking contributions to the fundamental physics of liquid crystals.

The Conference on Dynamics and Defects in Liquid Crystals honouring Alfred Saupe was sponsored by ALCOM, Kent State University, the US National Science Foundation and Gordon and Breach Science Publishers. Its organizers were P. E. Cladis and P. Palffy-Muhoray. Brenda Buck (Kent, USA) was the conference secretary.