BRITISH LIQUID CRYSTAL SOCIETY

LIQUID CRYSTAL NEWS

June 2001

The GW Gray Medal Winner 2001
Peter Raynes

Every inventor dreams of seeing their creation become commercial reality. Amongst his many inventions in the field of liquid crystal materials and devices, this year's recipient of the George Gray medal has had four make an indelible impact on all of our lives. From defect-free alignment of twisted nematic (TN) displays used in watches and calculators, wide temperature range nematic mixtures and design principles that maximize the number of lines that a TN can be driven, to the invention of the Supertwist nematic (STN), few scientists have made as much an impact on consumer electronics as Peter Raynes.

Peter Raynes was recruited to the nascent displays group at the Royal Radar Establishment (R.R.E) in Malvern after completing his Ph.D. on superconductors at the Cavendish Laboratories in April 1971. This brought him into contact for the first time with George Gray, who, with his team at Hull, was soon to synthesize the cyano-biphenyls, the worlds first stable room temperature liquid crystals. These compounds seemed ideal in all aspects except their limited temperature range: the manufacturers of digital watches would require a operation from -10°C to +60°C before liquid crystals could displace the LED as the display medium of choice. Developing a novel technique based on detailed thermodynamics, Peter formulated a series of non-ideal eutectic compositions that met the manufacturers' difficult targets. One of these, E7 was licensed to BDH (now Merck Ltd.) giving them an early lead as a supplier to, and indeed enabler of, the world LCD market. Hull University, BDH and the Royal Signals and Radar Establishment (as RRE had then become) shared the Queen's Award for Technological Achievement in 1979 for this work. Peter was also co-recipient of the Rank Prize for Optoelectronics in 1980 for the role that he had played in this success story.

The success of the TN also depends on reproducibly achieving displays with a high optical quality. In the early 1970's, however, the devices often suffered from a patchy appearance. Peter thought the patches were obviously caused by areas of opposite handedness of twist, which he corrected easily by weighting one handedness using a small amount of chiral additive to the nematic mixture. Although this ensured a good initial alignment, patches were still observed after the application of the field. Peter made the intuitive leap that the surface alignment was not parallel to the surface, the accepted wisdom at the time, but had a small pre-tilt caused by the rubbing process. He proved this to be the case using conoscopy, and by correctly matching the tilt directions with the twist handedness, Peter was able to cure this problem.

Having achieved uniform alignment and wide temperature range of operation, the TN became a success for use in digital watch displays. However, it could not be used for more complex displays due to the limits of matrix addressing. Applying a strobe signal to a particular row Vs simultaneously with a data signal Vd on the columns leads to either a high resultant voltage $|Vs+Vd|$ or a low resultant voltage $|Vs-Vd|$ at each pixel along the row. The net RMS voltage at the pixel then includes the effect of the remaining rows over the frame, each at $\pm$Vd. For a low complexity display, good discrimination is achieved, since the data on the column represents a significant proportion of the voltage experienced at the pixels. However, as the number of rows increases, the proportion of the total signal due to the discriminating row signal becomes smaller and the On and Off voltages closer together. Early TNs were limited to simple character displays.

Increasing the gradient of the electro-optic response curve, and therefore the number of lines that could be addressed, is an issue that has engaged many of the world's material scientists and display engineers, but again it is Peter that has had the most success in solving this important issue.

His initial approach was to design mixtures with the ratio of bend and splay elastic constants k_{33}/k_{11} as low as possible. Peter found that the combination of terminally cyano-compounds with di-alkyl ester-linked compounds led to the desired increase in multiplexibility. Working closely with Ben Sturgeon and Ian Sage at BDH, Peter was instrumental in the commercial success of these hybrid mixtures. They continue to be used in a growing plethora of applications that need up to 60 addressed lines, from calculators, point of sale registers etc. In 1992, this work led to a second Queen's Award for Technological Achievement that included Peter's work, awarded to DRA and Merck (as BDH has then become).

Peter's next success came whilst working with Colin Waters on increasing the speed of dyed LCD using higher percentages of chiral dopants to give twist angles greater than 90°. When Peter and Colin tried a 270° they noted that the display had a significant hysteresis. At first they thought of using this to achieve infinite multiplexibility using the inherent "bistability" to address the display a line at a time. However, they then had the idea of reducing the degree of hysteresis to, or close to, zero. Suitable choice of liquid crystal material (this time with a high k_{33}/k_{11}) and twist angles between 225° and 270° led to virtually infinite gradient of the electro-optic characteristic. Despite the 500 or so lines that could be addressed using STN, the UK manufacturers that had first sight of the STN idea thought the tolerance on cell gap was too severe for a manufacturing process. The opportunity for an early lead was lost and it was left to Japanese industry to turn the STN into a global success story and enable products such as the computer laptop, mobile-phone and personal digital assistant.

Peter has never sat back on his laurels, working on Ferroelectric Liquid Crystal devices throughout the late eighties and nineties, and more recently becoming interested in organic light emitting diodes (OLED) for display application. After leaving DRA (as RSRE had then become) in 1992 he founded the Liquid Crystals group at Sharp Laboratories of Europe. In 1998, he took a chair in the Engineering Department at Oxford, where his experience is invaluable, helping to develop the center of excellence in liquid crystal research that is burgeoning there. Other accolades that he has had throughout his career include the Paterson Prize from the IoP in 1986, a special recognition award from the Society of Information Display in 1987 as well as being made a Fellow of the Royal Society in 1987, Fellow of the Institute of Physics in 1990 and Fellow of the SID in 1994. He was made Honorary Professor at the Chemistry Department at Hull in 1991, and at the Engineering Department at Oxford from 1996.

From my own experiences of working with Peter, I would say that a young inventor could learn a lot by studying his qualities. Of course, he has the deep basic understanding of the underlying physics, and the ability to apply himself and stay committed even when things do not work at first. He is an excellent team player, being the first to admit the contribution of his co-inventors. However, there are two attributes that I have noticed to be particularly strong in Peter. He has an uncanny ability to spot what the real problem is, even when all about him have come to accept the conventional wisdom, and he has a talent for recognizing discovery and applying it to the relevant problem. These are similar qualities to those of George Gray himself, and it is fitting that someone who has worked so closely with George throughout his career should become the latest winner of the British Liquid Crystal Society George Gray Medal.

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Next Issue articles: Sept 2001

The GW Gray Medal Winner 2000
Professor Lev Blinov

Lev Blinov was born on the 27th of June 1939 in Arhangelsk which is a big industrial city in the northern part of historical Russia, on the coast of the cold White sea. In 1956 he became a student of the Electrotechnical Institute of Telecommunications in Leningrad (now St.Petersburg). After graduation in 1961 Lev have got a position of an engineer at the State Optical Institute, also in Leningrad, where he was measuring the noise spectrum in semiconductors. After 6 months he moved to a branch of that institute in Kazan, and it was in Kazan where he has begun his research activity in physics of semiconductors and where he has written his first paper. He decided to continue as a scientist and took a post graduate course at the Department of Semiconductors at the Moscow State University. A significant part of his research at that time has been undertaken at the Lebedev Physical Institute in Moscow, in the semiconductor laboratory of famous Prof. Vul.

Lev Blinov has obtained his Ph.D at the Moscow State University in 1967, and directly after that he has got a senior position at the Organic Intermediates & Dyes Institute in Moscow. During those years Lev has developed an interest in organic semiconductors, and these materials appeared to be a bridge to liquid crystals. In 1968 the importance of liquid crystals for future applications in display devices has been recognized and in few years Lev Blinov's main interests have been focused into this new area. It should be noted that by that time Lev Blinov has already made a contribution to the physics of semiconductors. In particular, he has discovered the 'plasma mirror' effect and developed the Stark spectroscopy technique for organic semiconductors which is still in use now.

In the Organic Intermediates & Dyes Institute lev Blinov has made a very fast career. Already at the age of 28 he became the Head of a laboratory with the staff of 50 people. However, he wanted to concentrate on liquid crystals, and, following his initiative, the big laboratory has been split into parts. Lev became the Head of a smaller lab with only 10 people working with him, but all of them working on liquid crystals. After few years the amount of people in his lad has grown up to about 30, and Blinov became the so called 'Chief Scientist' in charge of the good part of all research undertaken at the institute. The Ogranic Intermediates & Dyes Institute was an industrial institute, and it did not belong to the Academy of Sciences. However, at that time it was the main center of research amd manufacturing of liquid crystals in the Soviet Union. Various liquid crystal materials have been synthesized there and their characterisation was performed in research departments supervised by Blinov. During the period of his work at the O. Intermediates & Dyes Institute Lev Blinov and his coworkers have made a significant contribution to the physics of electrohydrodynamic instabilities and electro-optic effects in liquid crystals. Some of those results are summarized in his book 'Electro-Optical and Magneto-Optical Properties of Liquid Crystals' published in Russia in 1978. The extended english version of this book has been published by Wiley in 1983. In late 70s Lev Blinov was also very active in the field of ferroelectric liquid crystals. In his laboratory the whole set of characterisation methods has been used, including his famous pyroelectric technique, to investigate many new materials synthesize at the same institute. Later Blinov has also started experimental studies of Langmuir-Blodgett films.

lev Blinov had very serious administrative duties and responsibilities at the O.Intermediates & Dyes Institute, and after some years it became clear that these duties are taking more and more time at the expense of the actual research work. It was a proper time to make a decision. And in 1982 Blinov has moved to the Institute of Crystallography of the Academy of Sciences where he became a head of the liquid crystal laboratory. The laboratory was relatively small and poorly equipped compared with the big lab at the O.Intermediates & Dyes Institute. However, now Lev could entirely concentrate on his research. And in few years he has been able to rise the lab to a very high standard and to perform a pioneering research in the field of ferroelectric and antiferroelectric liquid crystals, mesogenic polymers and Langmuir- Blodgett films. At the Institute of Crystallography Blinov with his coworkers have discovered the first polymer ferroelectric liquid crystal in 1984, made the first observation of ferroelectricity in achiral (polyphilic) liquid crystals (together with F.Tournilhac, Nature, 1992) and , finally, discovered a two-dimensional ferroelectricty in thin Langmuir-Blodgett films (Nature 1998).

After the collapse of the Soviet Union Lev Blinov continued to work at the Institute of Crystallography in Moscow, but he has also been able to establish fruitful collaborations with several laboratories throughout the world. Blinov has undertaken an extensive research together with his colleagues from the Laboratoire de Physique des Solides in Orsay, Ecole Superieure de Physique et de Chemie Industrielles in Paris, Technische Universitat in Darmstadt, Osaka University and many other places. In particular, during the past 5 years Lev Blinov has split his time between the Institute of Crystallography in Moscow and the University of Calabria where he was supervising an active research group.

Mikhail Osipov
University of Exeter

The Ben Sturgeon Lecture, BLCS 2000

Field-Induced Alignment of Smectic A Phases

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Although the alignment of the director in a nematic phase by electric or magnetic fields is reasonably well understood far less seems to be known about the field-induced alignment of smectic A phases. This process is necessarily complex for, in addition to the change in the average molecular orientation caused by the field there must also be translational motion of the molecules resulting from their interactions if the smectic layers are to be established orthogonal to the director. The relative magnitude of these interactions will then determine the extent of the coupling between the two processes and hence the overall complexity of the field-induced alignment of the smectic A phase.

Deuterium NMR spectroscopy provides a powerful technique with which to monitor the director orientation as a function of time. This situation obtains because the quadrupolar splitting, $\Delta\tilde{\nu}(\theta)$, observed for a monodomain sample of a liquid crystal is a sensitive function of the director orientation, θ, with respect to the magnetic field of the spectrometer. In fact

$$\Delta\tilde{\nu}(\theta) = \Delta\tilde{\nu}_o(3\cos^2\theta - 1)/2,$$

where $\Delta\tilde{\nu}_o$ is the quadrupolar splitting when the director is parallel to the magnetic field. In addition, if the director is not uniformly aligned then the observed spectrum is a weighted sum of the spectra for all director orientations. This composite spectrum or powder pattern is shown in figure 1 simulated for a director orientational distribution function which spans the range from a uniformly aligned sample with the director parallel to the magnetic field to one with the director randomly distributed in a plane containing the field. As the distribution function begins to deviate from the uniformly aligned state so the spectral lines broaden and become asymmetric. With further increase in the breadth of the director distribution two new peaks appear in the spectrum and these are associated with the director being orthogonal to the magnetic field. In the limit that the director is randomly distributed in a plane then the peaks for the parallel and perpendicular director orientations become comparable in intensity. The form of the spectrum then provides a very clear indication of the director distribution as well as the director orientation when it is uniformly aligned within the sample.

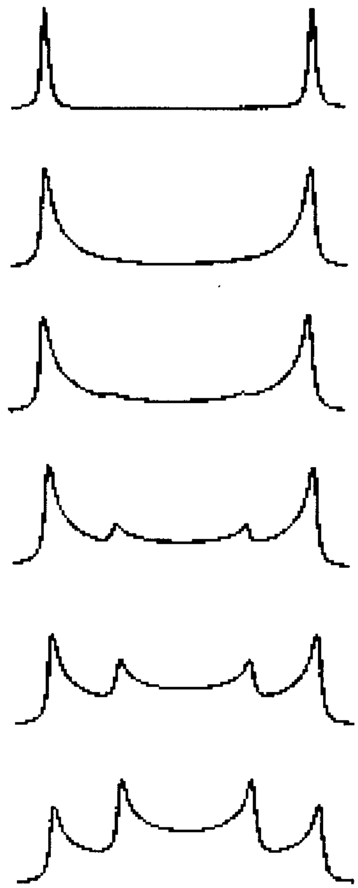

Figure 1 The simulated deuterium NMR spectra for a group of equivalent deuterons with the director distribution starting as a monodomain and then broadening to become randomly distributed in a plane containing the magnetic field

The mesogen selected for our studies is 4-octyl-4′-cyanobiphenyl (8CB) since this has a room temperature smectic A phase that is followed by a nematic phase which facilitates the production of a monodomain sample of the smectic phase. The mesogen was deuteriated in the α-position of the octyl chain to give 8CB-d_2. The NMR spectrum of this in its smectic A phase is shown in figure 2; prior to rotation of the sample it contains the expected quadrupolar doublet with a large splitting. After rotation through 41° the quadrupolar splitting decreases, as expected from the equation for $\Delta\tilde{\nu}(\theta)$. There is then an induction period of several minutes after which the spectrum begins to change. However, the spacing between the spectral lines does not simply increase as expected if the sample was realigned as a monodomain. Rather there are new peaks spread over a large range of quadrupolar splittings corresponding to director orientations between 41° and 0°. As time evolves so the intensity of the peaks associated with the director parallel to the field grows at the expense of those at larger orientations. This process is essentially complete after about 18min although the lines continue to sharpen beyond this point as the director distribution narrows still further.

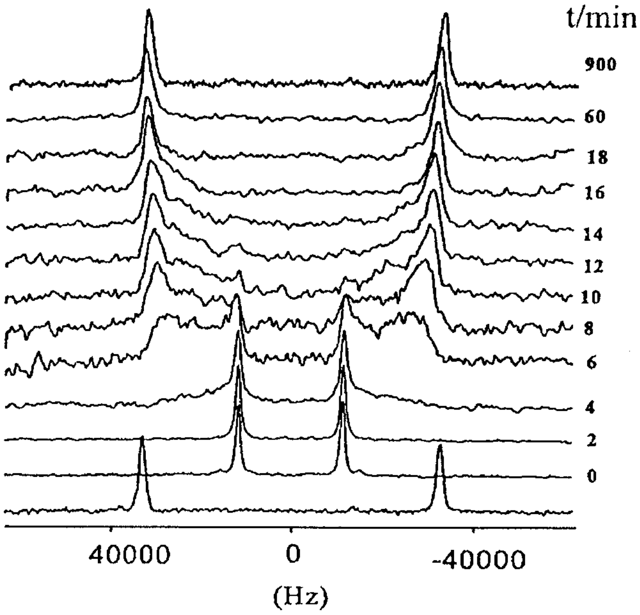

Figure 2. The deuterium NMR spectra of 8CB-d_2 in its smectic A phase with the director parallel to the magnetic field and then as a function of time after rotation by 41°.

In marked contrast to this complex spectral behaviour, that following 90° rotation of a monodomain sample is apparently far simpler as we can see from the spectra shown in figure 3. The first spectrum recorded following the rotation has the expected small splitting and this does not change for the first few minutes, again suggesting an induction period. Then two new spectral lines appear with a quadrupolar splitting equal to that for the director parallel to the magnetic field. These features grow at the expense of the quadrupolar doublet for the director aligned orthogonal to the field; however even after 60min some of the director remains in the metastable position orthogonal to the magnetic field. One interpretation of this behaviour is that there is a small interfacial region between domains having director orientations differing by essentially 90° and that the interfacial region facilitates the rotation of the director through a large angle. If the director reorientation does rely on such defect mediation then we might expect to see different field-induced director alignment if the concentration of defects is large. This can be achieved by starting with a focal conic structure created by heating a polycrystalline sample into the smectic A phase.

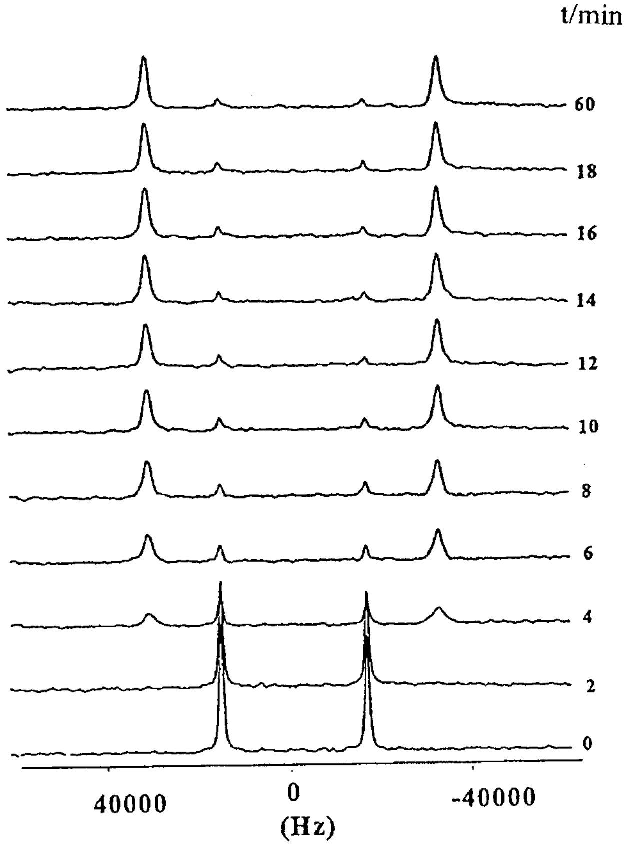

Figure 3. The deuterium NMR spectra of 8CB-d_2 recorded as a function of time immediately after the monodomain sample had been rotated through 90°.

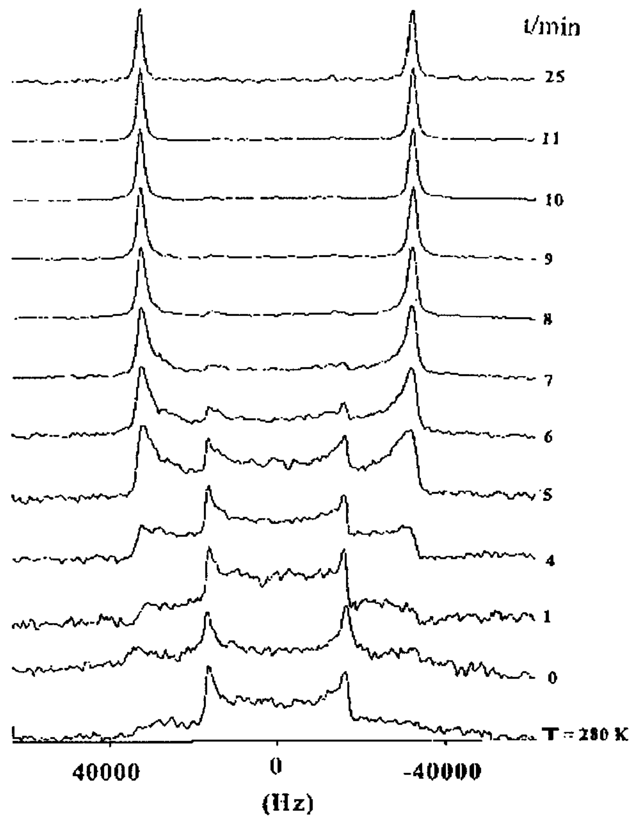

Figure 4. The time dependence of the deuterium NMR spectra of 8CB-d_2 after forming a polydomain sample prepared by melting a polycrystalline sample of the mesogen.

The magnetic field will then align the director thus producing monodomain sample from a polydomain smectic A phase. The NMR spectra obtained from such a sample are shown in figure 4 where the spectrum at 280K exhibits a typical three dimensional powder pattern. On heating into the smectic A phase this pattern begins to change without any indication of an induction period; the intensity at the extreme spectral edges grows indicating the alignment of the director parallel to the field. This process continues with the intensity being reduced in other regions of the spectrum although again the removal of the director from its metastable position orthogonal to the field appears relatively slow. However, after 9min virtually none of the director remains orthogonal to the field. The field-induced alignment of the director from the polydomain sample would appear to be a significantly faster process than for a monodomain system.

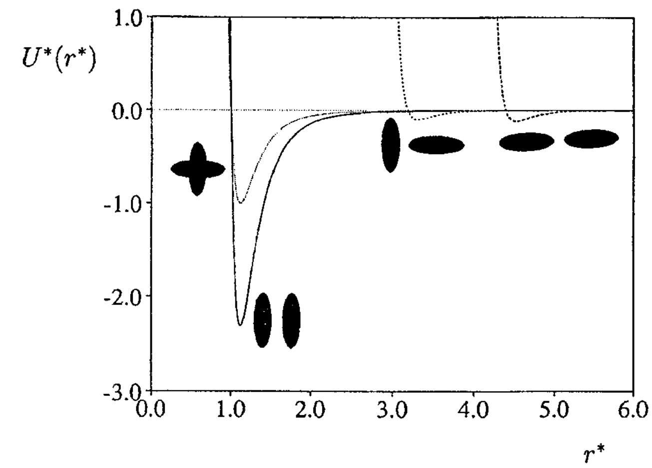

Figure 5. The potential energy as a function of the separation of a pair of Gay-Berne molecules GB(4.4, 20.0, 1, 1) for different relative orientations of the molecules and the intermolecular vector.

These and other results which reveal the major influence of surface forces on the alignment of a smectic A phase suggest that this process is fascinatingly complicated. To help understand such complex field-induced behaviour we have turned to computer simulations using the Gay-Berne model mesogen. This is a generic model in the sense that it does not represent a particular mesogen but has the features essential for liquid crystal formation, namely an anisotropy in both the shape and the attractive forces. This is clearly apparent from the potential energy curves shown in figure 5, these indicate the potential energy as a function of the separation between two molecules for different relative orientations. For example, if the molecules are parallel and side-by-side then the contact distance is small and the well depth is large. In contrast if the molecules are parallel and end-to-end then the contact distance is large and the well-depth is small. Just as for real mesogens there is, in principle, an infinite number of Gay-Berne mesogens which differ essentially in their length-to-breadth ratio and the ratio of the well depths for the side-by-side and end-to-end configurations. These ratios are 4.4 and 20.0 for the particular Gay-Berne mesogen, GB (4.4, 20.0, 1, 1), studied; this material exhibits isotropic, nematic, smectic A and smectic B phases. To explore the validity of the methodology used in the computer simulation, the field-induced alignment of the nematic phase was investigated. The angle between the field and the director was found to decay according to the continuum theory prediction, namely

$$\tan \theta_t = \tan\theta_0 \exp(-t/\tau).$$

In addition doubling the torque due to the field was found to reduce the relaxation time τ by a factor of two, again in accord with the continuum theory prediction.

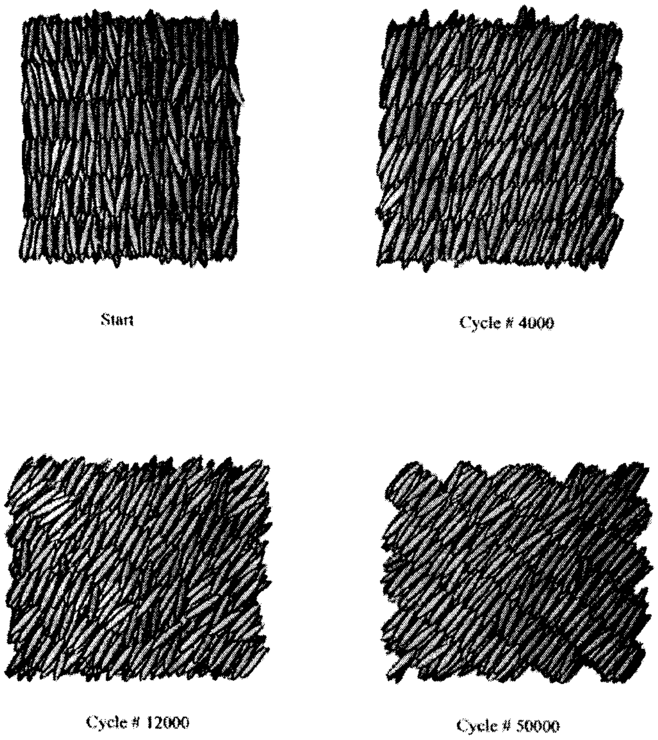

Figure 6. Snapshots, showing the molecular organisation in the mesogen GB(4.4, 20.0, 1, 1), taken during the field-induced alignment of the smectic A phase when the field was originally at an angle of 45° to the director

The alignment of the smectic A phase reveals a far more complex behaviour which is most readily apparent from the snapshots of the configurations taken during the alignment process for the field applied at 45° to the original director orientation. These snapshots are shown in figure 6. On application of the field the molecules tilt relatively rapidly while the smectic layers do not move; this corresponds to a field-induced smectic C phase and as the molecules tilt so the thickness of the sample is reduced. The next snapshot shows that the tilt angle has increased and that the layers are more or less intact. However, in the following picture the layers have been disrupted which has facilitated the alignment of the molecules parallel to the field. This alignment process is virtually complete in the penultimate picture while the final snapshot reveals that the layers have been reformed orthogonal to the director which is now parallel to the field.

The behaviour is somewhat more complex when the field is originally orthogonal to the director. This complexity results from the degeneracy in the alignment pathway, that is the molecules may move either

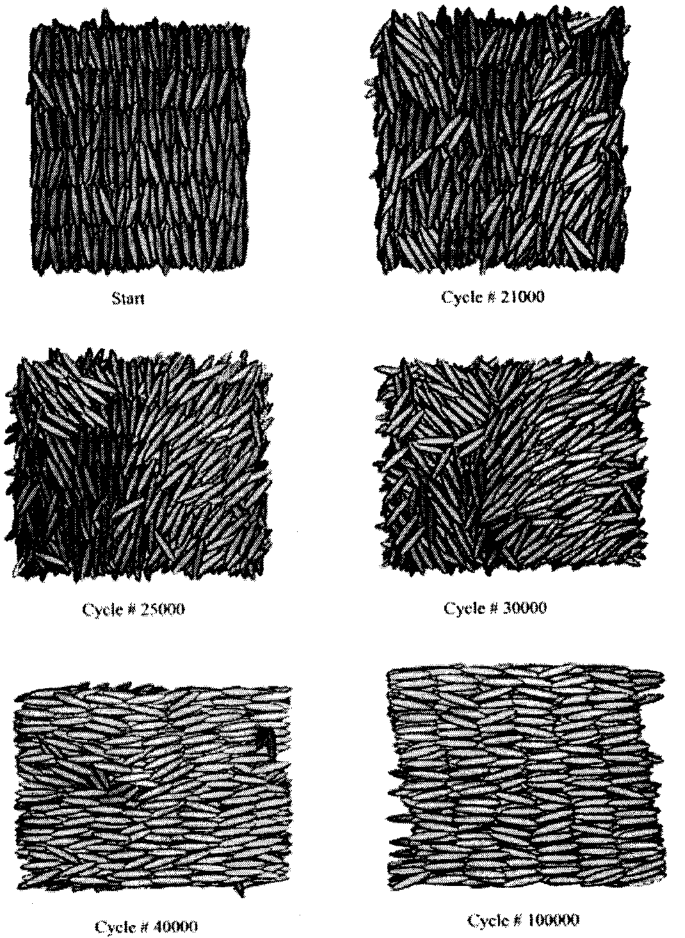

Figure 7. Snapshots, showing the molecular organisation in the mesogen GB(4.4, 20.0, 1, 1), taken during the field-induced alignment of the smectic A phase starting with the field orthogonal to the director.

clockwise or anticlockwise. This is apparent from the snapshots taken during the field-induced alignment process and shown in figure 7. There is an interval while apparently no change takes place and then the first steps of the movement of the molecules in opposite directions occur. As a result there is a region in the centre of the sample where the molecules remain orthogonal to the field which is a metastable state. This domain wall is still apparent in the third snapshot which shows the continuing movement of different groups of molecules in opposite directions. In addition the smectic layers are essentially destroyed which aids in the molecular orientation process; this feature is clearly seen in the fourth snapshot although the remnants of the domain wall are apparent. In the penultimate snapshot the molecules are seen to be parallel to the field although the layer structure has not yet reformed. This does occur but only after a long interval and even then the molecules are tilted with respect to the layers corresponding to a metastable smectic C phase with a small tilt angle.

In these two sets of computer simulations of the field-induced alignment process the combination of the inhomogeneous structure of the smectic A and the standard periodic boundary conditions act to produce a torque on the molecules at the boundaries which can be considered as being analogous to the surface interactions for real systems. The extent to which such interactions influence the field-induced alignment process is not yet clear. None-the-less certain features of the simulations match those found by the deuterium NMR experiments but remain to be investigated by X-ray scattering experiments to see to what extent the smectic layers are preserved during the field-induced alignment process. If the influence of the boundary conditions is removed then the smectic A phase is aligned as a monodomain in keeping with observations of the alignment of a droplet of 8CB-d_2 in its smectic A phase.

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British Liquid Crystal Society Annual Conference

St. John's College, Oxford
19th to 21st March 2001

Every year as Easter approaches, with the prospect of an excellent summer ahead, we all look forward to the Annual British Liquid Crystal Society Conference. Only this year the conference was to be held rather earlier than usual, so no Easter break to immediately follow, never mind!!

Anyway, we arrived to a rather cold, but dry and sunny Oxford, or should I say the delightful 'park and ride outskirts' of Oxford. Some of us cleared our three-day stay at the park and ride, others were not so lucky and ended up going back each day to obtain a new ticket!! The bus journey to Oxford was very pleasant, and the walk from the bus stop provided a great deal of historic atmosphere.

We received a friendly greeting on arrival at St. John's College, which proved to be a truly excellent setting for the conference. The accommodation was very spacious, but the rather small bathroom facilities were a little too cramped for the larger members of the society!!!!

The conference got off to a good start and it was nice to see lots of familiar faces as well as lots of new ones. The lecture theatre and the poster room, were both very impressive, certainly ideal for the conference. The presentations, oral and poster, were all of a very high standard, and as ever, it was very encouraging to see the enthusiasm of the young researchers; this certainly bodes well for the future.

Overall the conference provided an excellent balance of theory, physics, chemistry and device engineering, all blending together in terms of the topic of liquid crystals and researchers like no other area of science. One particular presentation by Susanne Klein on the use of dyes in liquid crystal mixtures are a means of improving the brightness of displays stands out for the humorous and down to earth presentation style, like last year it will linger in the memory. All the oral presentations were truly excellent, but by a unanimous decision, the prize for the best oral presentation went to Lesely Parry-Jones, from the home team of Oxford, for her unified description of switching in antiferroelectric liquid crystals.

So on to the posters, well, the high quality of the posters clearly illustrates the role of new technology in terms of large area colour printing and laminating; the days of hand-written posters is now a distant memory!! Of course, lots of hard work goes into conference posters, both in the preparation and the actual presentation, and all were excellent in the former aspect, but some were a little lacking in the latter aspect; perhaps the bar proved a more attractive prospect. The best poster prize was awarded, again by a unanimous decision to the presentation by Owen Lozman, of Leeds, for his contribution on the unusual properties of discotic liquid crystal mixtures.

The Sturgeon Lecture was presented by Professor Geoffrey Luckhurst, and provided a nice historical touch to the success of Ben Sturgeon in bringing nematic liquid crystals to the market place. Also part of the team that set liquid crystal displays on the road to success in the early 1970s were the winner of this year's GW Gray Medal, Professor Peter Raynes, and of course Professor George Gray himself.

It was disappointing not to have any trade representatives such as publishers, scientific equipment or liquid crystal device manufacturers at the conference, they would have added an extra dimension to what was a truly excellent conference. The catering is always an important aspect of a conference, and this year it was outstanding, especially the conference dinner, so our gratitude should be extended to all the staff at St John's College for helping to make the 2001 BLCS Conference such an enjoyable, and scientifically successful one.

Dr Steve Cowling and Dr Mike Hird
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Invasion of the Liquid Crystal Start-ups!!

The last past few years has seen an explosion of new liquid crystal based high-tech start-up companies. Venture capitalists from all over the world have been swarming into the UK, with open chequebooks, eager to invest in a variety of clever ideas and developments. The past few years have also seen an evolution in some of the more established liquid crystal companies, with restructuring and new ventures, however there is still vibrant new industry forming in its wake. A selection of these new and established companies are listed below.

Kingston Chemicals Limited

Kingston Chemicals Limited has recently been launched to operate out of the Department of Chemistry at the University of Hull. The company has been founded to exploit appropriate areas of research within the liquid crystals and advanced organic materials areas. The people involved in the company are Professor George Gray, Professor John Goodby, Professor Ken Toyne, Dr Mike Hird, Dr Paul Hindmarsh, Dr Rob Lewis, Dr John Stanford and Mrs Aileen Partanen, giving a team with a vast experience of liquid crystals and general organic synthesis.

The company specialises in providing materials in niche areas not covered by the large, well-established liquid crystal producers, such as ferroelectric and antiferroelectric. However, the synthesis of all liquid crystals and related compounds is undertaken, including vital intermediates, in quantities from a few grams to a kilogram.

It has always been very difficult for researchers in the physics and device engineering areas to source certain materials essential for their research. Kingston Chemicals hopes to be able to assist in providing a source for vital research materials.

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Dr Mike Hird

'Holographic Imaging' DERA and FORD Joint Venture.

Ford Motor Company, Detroit and DERA have formed a joint venture called Holographic Imaging LLC aimed at accelerating the vehicle design process and improving quality. The joint venture is a research and development company which has been formed to create a three-dimensional, interactive imaging workstation prototype.

The technology, under development by DERA, will be used by Ford to create virtual digital models of prototype vehicles. The 3-D workstation is anticipated to streamline Ford's vehicle design processes, allowing for faster product development and quality process improvements. "The new company's focus is to develop a 3D design tool which can be used to accelerate and simplify Ford's product development and design processes," said Neil Ressler, vice president, Research and Vehicle Technology and chief technical officer, Ford Motor Company. "DERA's long history of innovation as the largest R&D organisation in Western Europe, including the development of proprietary liquid crystal display and flat screen display technology, makes this partnership a revolutionary step by Ford."

The 3D technology is based on computer generated holography (CGH). CGH is the only technique capable of producing 3D synthetic images having the full range of visual depth cues. Large pixel counts have precluded any practical application in interactive systems. However, advances in design algorithms, computing hardware and spatial light modulators now make it possible to anticipate the generation of reconfigurable, high quality, three dimensional images at interactive rates. A system based on this technology will enable true, three-dimensional virtual models of vehicles, components and fully interactive systems that can be used by design, engineering and marketing staffs. More information is available on the DERA web site at www.dera/news.

Holographic Imaging will have the potential to tap into other business and growth opportunities such as the ability to participate in new businesses in automotive and non-automotive fields as a licensor or equity partner. These include applying the technology to other fields such as aerospace, entertainment, medical imaging, oil and gas industry, industrial design and marketing. The technology may also have important military applications, for example in command and control, exercise planning, product design and simulators.

Dr. M. Stanley

CRL Opto

Research on displays has been carried out for more than 70yrs at CRL and on liquid crystal displays for over 15yrs. After several years successful operation within Central Research Laboratories (CRL), CRL Opto was established as a stand-alone business within the displays activities of Scipher plc in 2000. Scipher is the largest technology development and licensing company of its type in Europe and focuses on the key technology areas of Electronics, Optics and Magnetics. Scipher has launched many new businesses such as MicroPix (LcoS microdisplays), Sensaura (3D sound), Wavelength (short range high bandwidth radio), MediaTag (software tagging), TSSI (structured magnetic security devices), Monox (carbon monoxide sensors) and QED (IPR licensing and protection).

CRL Opto develops and licenses new LCD technologies and creates advanced optoelectronic products and solutions. CRL Opto offers specialist in-house optoelectronic expertise and technical support and has three main business areas: displays R&D, optoelectronic R&D and a range of products and services. The company's range of standard products and services include transmissive miniature LCDs, reflective LCoS microdisplays, fast switching ferroelectric shutters, and a specialist coatings and microfabrication service. Applications include 3-D display systems, micro lens array processing, head up displays, holography, printing, photography, ophthalmic and thermal imaging. Our team of experts have worked on many R&D and custom design projects over the years for various sized companies to many academic institutions worldwide. CRL Opto have a large team of graduate and PhD qualified engineers, a global customer base, and a purpose built facility near London Heathrow Airport.

Contacts
Sales. R West , 020 8848 6400, rwest@crlopto.com
R&D, P. Surguy, 020 8848 6637 psurguy@crlopto.com

CRL OPTO

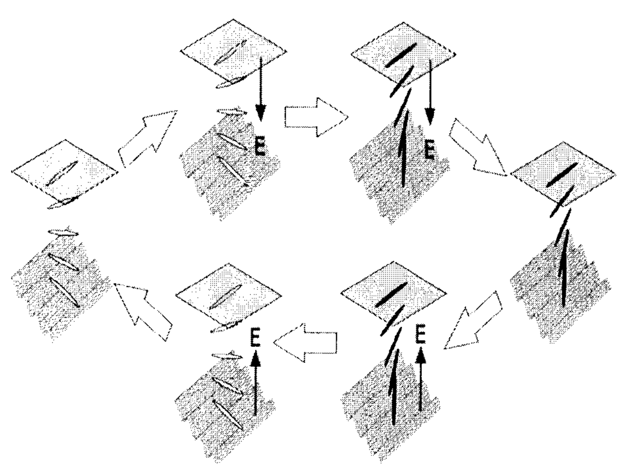
CRL Opto
Dawley Road
Hayes, Middlesex UB3 1HH
www.crlopto.com

ZBD Displays is borne:

There is a resurgence of commercial activity in displays in the UK at present, with the creation of several small companies over the past few years. One of the latest of these is ZBD Displays Ltd., founded last July to commercialize the zenithal bistable display mode, ZBD™.

ZBD is one of the more exciting new liquid crystal technologies to arise in the last few years since it allows images of unlimited complexity to be displayed using a simple low cost LCD (with tolerances similar to those of the twisted nematic watch display) and without drawing any power when the image is not changing. These attributes make it ideal for use in portable products such as mobile phone, portable digital assistants, electronic books and global positioning systems. Once the grating is fabricated by simple embossing techniques it will enable plastic LCD at low cost.

The basic principle of the technology is simple. Zenithal bistability uses a grating to provide a surface with either a high pre-tilt or a low pre-tilt configuration of the liquid crystal. A simple view of this is that the tops and bottoms of the grating prefer one orientation, and the sides prefer the other. This leads to distinct energy minima for both configurations over a range of grating shapes. Latching between the states occurs when an electric pulse of sufficient energy and the correct polarity couples to the flexo-electric polarization that occurs in the distorted region of the liquid crystal close to the grating. Although the flexo-electric effect is small, the polarization is concentrated at the surface region where switching occurs. Therefore, ZBD can switch with less than 10V pulses in a 4μm cell for a typical commercial nematic material.



Schematic of ZBD operation

The Founding members were all from the Displays Group at DERA: Pete Brett on ZBD fabrication, Alistair Graham on display electronics, Emma Wood on Module Design, Guy Bryan-Brown on grating production and Cliff Jones on Liquid Crystals and Intellectual Property.

£1.5M of funding was raised from Prelude Trust, TTP Ventures (both of Cambridge) and Dow Ventures (from the US). DERA has granted exclusive rights to the extensive patent portfolio on grating aligned nematic devices in exchange for an equity share of the company. The team have worked together on bistable LCD since the invention of ZBD in 1995 at DERA. Two of the three inventors (Guy and Cliff) are part of the Founding team. Since its formation, ZBD has recruited three new team members, and aim to grow quickly over the coming year. ZBD Displays is DERA's first venture-funded spinout. Its formation was part of DERA's move towards becoming a private company in July this year (from when the privatized part will be renamed QinetiQ).

For more information on ZBD Displays, please go to www.zbddisplays.com.

The Founding Team of ZBD Displays Ltd. (left to right) Alistair Graham, Guy Bryan-Brown, Cliff Jones, Emma Wood and Pete Brett.

Cliff Jones
Director or Research
ZBD Displays Ltd.

Intelligent Pixels Inc

Intelligent pixels embedded capability for processing of optical information. Depending on the application area these systems have additional embedded optical conversion capabilities. Because of these characteristics, Opto-VLSI systems are inherently capable of emulating optics without being purely optics-based. These systems have a broad range of applications in fiber optic communications, multimedia and wireless networks.

The Company's Opto-VLSI solutions are based on its novel Intelligent Pixel Array (IPA) architecture. Designs based on the IPA architecture are capable of localized intelligence, sensing and displaying of information. As a core technology, the IPA architecture is the enabler for the development of the Company's optical networking solutions. IPI's products consume very little power yet have very high computational throughputs. By combining existing technologies such as CMOS ICs, and LC microdisplays in novel ways, the Company is able to use a fabless semiconductor business model and outsource the manufacturing of its devices to subcontractors. The Company has filed a number of patents to protect its proprietary technology.

IPI introduces IROS, the Intelligent Reconfigurable Optical Switch which is being designed and developed by Intelligent Pixels Incorporation. IROS is an optical space switch which uses liquid crystal on Silicon technology. IROS achieves the desirable characteristics of an optical switch and has embedded processing capability to make it robust and adaptable, and provide the current and future functionality requirements of the network.

IROS makes scalable N x N optical switches possible with N in the order of hundreds, and if necessary thousands. The performance of the switch is very competitive with other technologies that can construct similar size switches but it has many intelligent features that are simply lacking in any other optical switch. The performance of IROS will still improve with further developments in fabrication technologies and liquid crystals, but it is the sheer level of flexibility, adaptability and intelligence available with IROS that is bound to startle the optical networking community.

Intelligent Pixels, Inc. (IPI)

www.intelligent-pixels.com

Cambridge 3D

Cambridge 3D Display Ltd was started in January 1999 as a spin-off from the Photonics and Sensors Group in Cambridge University's Department of Engineering. Their aim is to use ideas developed for optical telecommunications to make better electronic displays and vice versa.

A key project is their wedge display, which is a way of creating a flat panel display by projecting an image from a microdisplay into the edge of a tapered sheet of acrylic. The idea is to get a big, plastic screen which has the same size and quality as a plasma display, but whose performance/cost curve will follow that of other microelectronic devices.

www.cam3d.co.uk

Adrian Travis

MicroPix Technologies Ltd

MicroPix Technologies Ltd was established to design, market and licence high performance digital microdisplay systems for use in low cost, high definition video systems such as projectors, digital television and personal viewer applications. The systems are based on proprietary ferroelectric liquid crystal over silicon (LCOS) technology.

The Company brings together a unique set of technologies, skills and experience to meet immediate and anticipated needs of the display marketplace and to create next generation products.

Based in Scotland, alongside the spin-off microdisplay manufacturing unit of MicroVue plc, the Company has set up a facility which has all of the necessary resources for research, design and development to keep the product technology ahead of the market demand whilst continuing to add to the already large portfolio of Intellectual Property owned by the Company. MicroPix Technologies Ltd is part of the technology development and licensing company Scipher plc.

MicroPix

MicroPix Technologies Ltd.
1 St. Davids Drive, St. Davids Business Park
Dalgety Bay, Dunfermline, KY11 9PF
United Kingdom
www.micropix.com

MicroVue plc

In May 2000, MicroVue was created to initiate volume manufacturing and marketing to meet expanding customer demand for microdisplays. MicroVue, a joint venture between Scipher, plc (UK), PicVue Electronics, Ltd. (Taiwan), and two other Taiwanese companies, markets and manufactures microdisplays that are designed for a wide range of high-volume projection display applications. The microdisplays are well suited for compact and high-end projectors, HDTV, PC Monitors and high performance digital cinema, as well as for personal headsets and portable display systems.

The microdisplays manufactured by MicroVue were designed by MicroVue's sister company MicroPix Technologies Ltd. MicroPix is wholly owned by Scipher and has strong ties to CRL, Scipher's research laboratories. Backed by over 200 patents relating to display technology, MicroPix have extensive knowledge and experience of LCOS (Liquid Crystal On Silicon) microdisplays gained from over 15 years R&D.

MicroVue has now completed its manufacturing facility and is currently scaling up its production capacity. MicroVue markets its microdisplay chipset world-wide, both directly and through local agents.

MicroVue provides a full range of technical support and design-in services including optical and colour management component sourcing, up to and including reference engine designs. It can also, through MicroPix, provide contracted development and customisation services for product application projects.

Dr. Lewis Banks

MicroVue
Microdisplays

MicoVue Plc.
1 St. Davids Drive, St. Davids Business Park
Dalgety Bay, Dunfermline, KY11 9PF
United Kingdom
www.microvue.com

Screen Technology Ltd.

Screen Technology Limited are a high technology Research & Development and Licensing company set up in 1995 to develop and exploit Photoluminescent LCD (PLLCD), a new LCD architecture invented in the Cambridge University Engineering Department. The company has maintained close links with the University, funding complimentary research. Screen Technology has been funded throughout this time by private investment.

In a PLLCD display, narrow band collimated near UV light is modulated by a LCD. The near UV image formed is converted to visible light through photoluminescence from a red green blue pixellated phosphor screen on the front of the display.

Screen Technology Limited announced at the beginning of November 2000 that it has completed its new private equity financing, raising £2.5 million for the company. The company was funded since 1995 by Thomas Swan & Co. The new lead investor is MTI Partnership (Watford, UK) with funding also from TTP Venture Fund. The funding comes as Screen Technology is set to execute the next phase of its strategy for developing very large screen displays using its patented photoluminescent LCD (PLLCD) technology, prior to licensing for manufacture.

The funds will be used for the development of large screen PLLCD prototypes using seamlessly tiled LCDs from existing manufacturing lines. The funds will also support the company's strategic marketing initiatives, aimed at establishing medium-term partnerships to accelerate the transfer of the technology to production. Screen Technology's PLLCDs will target scaleable large screen video displays of 50 inch diagonal or greater. The technology is based on the 12 inch prototypes exhibited at the SID'00 Exhibition at Long Beach (May 2000).

Screen Technology Ltd
Unit D5, Button End, Harston
Cambridge, CB2 5NX

Cambridge Photonics Ltd

The Photonics and Sensors Group at Cambridge University Engineering Department is currently in the process of forming a new start-up company called Cambridge Photonics Ltd. This company will form an umbrella to cover recent technological developments in several photonics based areas.

Cambridge Photonics Ltd has been structured into three main areas, covering both applications and its enabling technology. Key to this technology is the development and low volume fabrication of customised liquid crystal over silicon spatial light modulators for specific applications. A recent example of such technology can be seen as the heart of the ROSES optical switch demonstrators.

Applications are also key to Cambridge Photonics Ltd and these include holographic switches and components for wavelength division multiplexed telecommunications networks and optical correlators and comparators for pattern recognition and machine vision systems.

Ian Bonas (Ian.Bonas@btinternet.com)

CPL

ILCC 2002 Edinburgh

30 June – 5 July, 2002.
Edinburgh International Conference Centre.

The 2002 ILCC meeting will br held in Edinburgh at the International Conference Centre. This meeting is to be combined with the 2002 annual BLCS meeting in order to allow a maximum number of participant to attend both meetings.

The organizing committee is formed with G. Gray (Conference Chairman), J.W. Goodby (Executive Chairman), D.W. Bruce (Executive Secretary), H.J. Coles (Honorary Secretary), I. Stewart (Treasurer), E.P. Raynes and G.R. Luckhurst (Scientific Conference Co-chairs).

Besides three parallel scientific sessions, all the posters will be displayed for the whole week. There will be also an exhibition by liquid crystals materials and device manufacturers involved in displays and photonic telecommunications applications. The conference Proceedings will be published in Molecular Crystals and Liquid Crystals. The conference fees will be about the same as for the present conference.

Conference web site: www.ilcc2002.slci.soton.ac.uk/.

<These details were taken from the last ILCC meeting minutes, dates may yet change – Ed>

British Liquid Crystal Society
Registered Charity (328163)

Balance Sheet at 16th March 2001

The balance sheet for 2001 contains far fewer items than usual because of the early date of the 2001 Conference. Hence the surplus from the Spring 2000 Conference at Strathclyde (£1365.64, some of which is for subscriptions), and the surplus for the December 2000 Winter Workshop at Hull (£669.47) have not yet been received.

The General Fund at the start of the financial year showed a healthy £15223.41 plus a further £6023.40 in the Sturgeon Fund, giving a total of £21246.81.

Income from subscriptions was £595 plus some to be included from the Spring 2000 Conference at Strathclyde.

Interest earned on the Society's funds is relatively poor, but still contributed £500 (plus an extra quarter due to the accounts being presented early this year). Interest was apportioned to the General Fund (71.65%) and the Sturgeon Fund (28.35%) based on the relative proportions of the total fund at the start of the financial year. The Society is a Registered Charity and so all interest is paid without the deduction of tax.

Expenses incurred for the forthcoming International Liquid Crystal Society Conference in Edinburgh in 2002 (£452.87) have now been refunded.

The capital value of the Sturgeon Fund has actually increased this year because the cost of the Sturgeon Lecturer for 2000 (Strathclyde Conference) has not been included in the accounts, however, this will amount to only £81.22.

Overall the income generated by the Society this year has increased only slightly on the previous year, but with the proceeds from the 2000 Strathclyde Conference and the 2000 Winter Workshop at Hull (see above) to be added the increase is once again quite substantial.

Description of Income (£)		
Cash at Bank		
General Fund	15223.41	
Sturgeon Fund	6023.40	
Total Cash at Bank		21246.81
Subscriptions		
General	595.00	
Total Subscriptions		595.00
Refund of ILCC 2002 Expenses		452.87
Interest (30/12/99 to 28/9/00)		
General Fund	357.83	
Sturgeon Fund	141.59	
Total Interest		499.42
Total Income		**22794.10**
Description of Expenditure (£)		
BLCS Secretarial Expenses		47.51
BLCS Young Scientist Award and Certificate 2000	216.99	
GW Gray Medal and Engraving 2000		240.47
GW Gray Medal and Engraving 2001		257.10
BLCS Logo Prize		100.00
BLCS Committee Meeting Expenses		116.84
Expenses in respect of Frank Leslie's Funeral	393.48	
Cash at Bank		
General Fund	15256.72	
Sturgeon Fund	6164.99	
Total Cash at Bank		21421.71
Total Expenditure	**22794.10**	

M. Hird
Hon. Treasurer
16th March 2001

Second Anglo-Japanese Seminar on Liquid Crystals

5th-7th September 2001

Novotel, York, United Kingdom

The first Anglo-Japanese Seminar on Liquid Crystals was held in Nara, Japan in May 1999 bringing together some of the leading scientists from the two communities. The Seminar proved to be extremely stimulating and so it was decided to repeat the Seminar in 2001. This second meeting of liquid crystal scientists from the United Kingdom and Japan is to be held in York in September of this year; it promises to be an equally exciting occasion. In addition to the Invited Lecturers there will be an opportunity for participants to present their work as posters.

Visit the website:
http://friedel.dur.ac.uk/~dch0mrw/blcs/anglo-japanese.html

If you would like to participate in the Seminar and wish to know more about it you should contact

Professor G R Luckhurst
Department of Chemistry and
Southampton Liquid Crystal Institute
University of Southampton
Southampton SO17 1BJ, UK

Tel: (0)23 8059 3795
Fax: (0)23 8059 3781
E-mail: gl@soton.ac.uk

The Seminar is sponsored by both the British and Japanese Liquid Crystal Societies

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The Ben Sturgeon prize.

The Ben Sturgeon prize is given for significant contribution in the field of liquid crystal displays.

Eligibility for the Award

1. Young Scientists or Engineers (under 40).
2. Must have made significant contributions to the displays field over the past 10 years.
3. Ideally the work they are nominated for should be in the liquid crystal display field (this includes all aspects of technology used in LCDs).
4. Under exceptional circumstances nominees from other display areas will be considered. In that case the international value of the work must be clearly demonstrated.

The Nominations

1. Letter of nomination clearly setting out the value of the nominees' work.
2. Additional letters of support are helpful but not essential.
3. CV for the nominee.
4. Publications (papers and patents) list.
5. Copies of key papers.

Previous recipients include

1992 Cliff Jones & Mike Towler
1993 Patrick Nolan & Martin Tillin
1994 Chris Booth
1996 Colin Waters
1998 Guy Bryan-Brown
2000 Ian Underwood.

Nominations for 2001 should be sent to the chairman of SID:

Mr. John Raines
15 Pond Lane
Baldock, Herts SG7 5AS,
jrsid@gardencitynet.co.uk
details at: http://www.sid.org.uk

The selection committee is formed jointly from members of SID UK & Ireland chapter & BLCS. Further details are available on the SID Web site.
http://www.sid.org.uk/Ben_Sturgeon.html

Materials Discussion 4
Molecular Topology in Liquid Crystals

Grasmere, UK, 11-14 September 2001

Scientific Programme

Molecular topology in liquid crystals covers a number of fascinating topics relating to self-organisation and self-assembly and mesophase formation. There is, of course, the characteristic self-organisation of rods, bananas, disks and spheres, all of which may be subjected to the touch of being handed. In addition, microphase segregation can be skilfully used to keep those things apart that we want to and at the same time to be used to recognise parts of molecules that we want to use to induce self-assembly.

These simple ideas being borne in mind, the conference will be split into four sessions, in each of which we will have two sub-group discussions. There will also be three keynote lectures:

Over the past 20 years molecular chirality has had a massive influence on the field of liquid crystals, therefore it is entirely appropriate that the opening session starts with the way in which helical macrostructures are formed in chiral liquid crystal phases. The first session entitled Twisting and Turning will move from theoretical modelling through to the practicalities of the induction of helical structures and inversions in their handedness.

We all know that chiral systems not only induce the formation of helical structures but they are also responsible for the induction of non-linear properties such as ferroelectricity and antiferroelectricity. In the second sub-group discussion entitled Poles Apart we will review new aspects of chirality, ferroelectricity, antiferroelectricity and their relationship to optical purity. Session two moves the field on from chirality at the molecular level to chirality in broken space. Here the focus will be on molecules that have bent molecular structures and which self-assemble to give mesophases with reduced symmetries. In this aptly titled third discussion group What is a Banana? we will focus our interest on the driving force for molecules that bend molecular shapes to self-assemble in novel ways.

Once having established what a banana is, the next and fourth discussion group will discuss the properties of self-assembled systems of molecules that have bent structures. This intriguingly named session called Working with Bananas! will probe the physical properties of these phases; the generation of ferroelectricity and antiferroelectricity; the defects that are formed and the structures that they possess.

We now move to the third major session of the meeting and, in the process, we go through a phase transition from chirality to microphase segregation. In the first discussion group we will investigate how we can make molecules with dichotomous and trichotomous structures so that when they self-assemble the liked parts will run away from the dissimilar parts of the molecules. This view on structural aspects of microphase segregation gives us our title for the session of Keeping Things Apart!

In an analogy with the session on microphase segregation, we now move on to working with such systems in novel ways so that the molecular shapes can be bent or curved. In this session called Bending and Shaping we will look at polycatenar systems where, if one chain can do it for you, we are sure that two or three chains would be better. Here we will also delve into the realms of materials related to biological systems.

Having set the ground for the shaping of molecules we now move on in the final session and examine the self-organisation of molecular disks, balls and spheres. In the first part of this session the focus will be on molecular disks from conventional discotic systems through to metal-containing and polyaromatic materials - Molecules on a Plate! will thus be the seventh discussion group.

In our final session we will examine how the liquid crystal environment determines the structure of spherical dendritic molecules from a theoretical through to a practical point of view. This session on Molecular Balls? will look at deformations of molecular structure by the liquid crystal environment from balls to disks to rods.

Rounding off these discussion groups will be a presentation by Professor G W Gray CBE FRS in which he will review the presentations at the conference.

Call for Posters

Offers of additional papers for poster presentation, are now invited. The title and a brief abstract should be submitted to Nicole Morgan at the address given on the Discussion home page no later than 28 July 2001.

Taken from: www.rsc.org/lap/confs/md4.htm