Conference report on the 2nd joint conference of the British and German liquid crystal societies

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This year it was the second time that a joint British and German liquid crystal conference took place. In the beginning of April, British and German liquid crystal scientists met in the stately Tuscany hall of the Residence of Würzburg, Germany, to present and discuss their latest findings in the fields of Chemistry, Physics, Biology and Technology. Matthias Lehmann, Professor for Organic Chemistry at the University of Würzburg, and Dr Philipp Hands, from the University of Edinburgh, organised this two and a half day conference with 120 national and international scientists. The participants were awaiting 37 oral, therefrom 7 invited, contributions and 53 posters. Generally, it was talked about the state of basic scientific knowledge in liquid crystals, whereas technical aspects of application were not missed out. Prof. Dr Matthias Bremer (Merck KGaA, Darmstadt) discussed, for example, the current development of nematic liquid crystals with a negative dielectric anisotropy. The topics of the oral contributions ranged from the synthesis of liquid crystals, their physico-chemical properties, to theoretical calculations and simulations, like, for example, the so-called ‘hybrid liquid crystals’ which are conjugated with nanoparticles. Furthermore, new results about lyotropic and chromonic liquid crystals, the twist-bend nematic phases and liquid crystalline metamaterials were reported.

The conference programme was inaugurated by the laureate of the Sturgeon Lecture. This prize is granted by the British Liquid Crystal Society, among which the most prominent awardee is the 2016’s Nobel prize laureate Ben Feringa. This year, Prof. Dr Bertrand Donnio (University of Strasbourg) was awarded with the Sturgeon Lecture and gave a talk about ‘Self-Assembly of Nanoparticles directed by Ligand Functionalisation’. His work shows that inorganic nanoparticles can be functionalised with organic ligands so that liquid crystalline phases with predictable properties can be obtained. Additionally, the British Liquid Crystal Society awarded Prof. John Lydon (University of Leeds) with the Georg W. Gray medal for his ground-breaking work on chemic liquid crystals.

The German Liquid Crystal Society (Deutsche Flüssigkristallgesellschaft, DFKG) awarded Prof. Wolfgang Weissflog und Prof. Gerhard Pelzl (both at the Marin-Luther-University in Halle) with the Alfred Saupe prize for their ground-breaking research about bent-core mesogens, which form twist-bend nematic phases (Figure 1). With their work, the two laureates established a new field of research in liquid crystal science.

The DFKG further awarded two Young Scientists Awards to Dr Markus Wahle (Paderborn University) for his talk on ‘ Electrode patterning by nanosphere lithography for switchable 2D blue phase gratings’ and to Clarissa Dietrich (University of Stuttgart) for her presentation on the ‘Observation of chiral structures from achiral micellar lyotropic liquid crystal under capillary confinement’. Summaries of their work are included in the following.

The poster prize was awarded to Michael Pfletscher (University of Duisburg-Essen) for his work on ‘Rationalizing the impact of subtle structural differences on the properties of hydrogen-bonded assemblies’. This prize was sponsored by Wiley-VCH. For her talk on ‘Measurement of Homotropic Surface Anchoring and Slip in Liquid Crystal Displays through Bistable Latching’, Sophie Jones (University of Leeds) received the Nikon camera prize.

Apart from the very well-organised scientific programme, the organisers offered the participants an outstanding social programme, which included a wine tasting in the historic ambience of the Residence cellar and a conference dinner in the Residence restaurant. Both occasions provided brilliant opportunities for the attendees to socialise and discuss science (Figure 2).

In 2018, the German Liquid Crystal Conference will be held in Luxembourg and is organised by Prof. Jan Lagerwall (University of Luxembourg). This conference is aimed to attract especially researcher from the Benelux; however, colleagues from the UK are more than welcome!
The spontaneous formation of chiral structures in a system of achiral components is known as spontaneous chiral symmetry breaking and of fundamental interest. A well-known example for this phenomenon is biomolecules, in nature the amino acids exist, for example, only in their L-form. Recently, research teams from the US observed that achiral chromonic liquid crystals show chiral configurations under capillary confinement.\(^1\) That phenomenon is explained in the way that chromonic liquid crystals have a very small twist elastic constant compared to thermotropic liquid crystals. A chiral twist of the director field costs therefore less energy than splay and bend.

Now I found similar chiral structures in a classical lyotropic micellar system containing a surfactant (cetyltrimethylammoniumbromide), a co-surfactant (Decanol) and water as solvent. The director of the disc-shaped micelles orients homeotropically to the inner glass surface of the capillary and obeys the boundary conditions. In a very slow process, chiral configurations are formed, like, for example, the twisted polar configuration in Figure 3. This configuration is interesting due to the fact that we have a double helix of two disclination lines twisting along the axis of the capillary and an additional twist along the diameter of the capillary which governs the sign of the axial twist. In total, the system is achiral, so there are regions with left- and right-handed double helices appearing with the same probability. Whereas when adding only a small amount of chiral dopant (1 out of 3000 molecules is chiral), the twist sense can be biased and a homochiral double helix can be observed.\(^2\) This high chirality sensitivity could be of use in future chiral detectors.

The fact that we were able to observe spontaneous chiral symmetry breaking in a capillary confinement with standard micellar lyotropic liquid crystals shows that this phenomenon seems to be more general and is therefore not restricted to the special case of chromonic liquid crystals. Given the structural similarities between micellar systems, vesicles and biological membranes, this observation could add to a further understanding of the spontaneous chiral symmetry breaking in nature.

\(^{[1]}\) J.Jeong, L. Kang, Z. Davidson, P. Collings, T. Lubensky, A. Yodh, \textit{PNAS} \textbf{2015}, 112, E1837-E1844.

\(^{[2]}\) C. F. Dietrich, P. Rudquist, K. Lorenz, F. Giesselmann, \textit{Langmuir} 2017, in press (DOI: 10.1021/acs.langmuir.7b01707).

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Electrode patterning by nanosphere lithography for switchable 2D blue-phase gratings

Electrically addressable optical gratings play a major role in modern communication systems and photonic circuits for multiplexing optical signals. In these areas, a high degree of integration is key in order to miniaturise optical systems. This restricts optical gratings to having large diffraction angles effectively decreasing the space needed to divide signals. Thus, optical gratings for these applications need regular structures with periodicities of a few microns. In our work, we use the self-assembly of poly-styrene spheres into hexagonal close packed monolayers (Figure 4(a)) to create such structures. Self-assembly-based processes are of great interest because they can be used to structure large areas on wafer scale in a fast and cheap fashion.

The spheres are deposited on a surface by using convective self-assembly, due to which a hexagonal monolayer is created. Subsequently, the spheres are shrunk by reactive ion etching to expose a larger fraction of the underlying substrate (Figure 4(b)). On the shrunk monolayer, a thin metal layer is deposited by physical vapour deposition. After removing the shrunk spheres, a periodically structured metal thin film remains on the surface (Figure 4(c)). The described process is known as nanosphere lithography (NSL). The prepared metal film acts as a structured electrode in our experiments. Together with a liquid crystalline blue phase, a periodic variation of the refractive index can be electrically induced leading to an optical

Figure 2. Group photograph of the conference participants in front of the Würzburg Residence.

Figure 3. Polarised optical micrograph of the twisted polar configuration of the achiral micellar lyotropic liquid crystal under capillary confinement.
phase grating. The index variation in the blue phase can be easily described by an extended Kerr model. Further, the blue phase (BP) provides sub-millisecond switching times, which gives BPs an advantage over nematic liquid crystals. The periodicity of the device is determined by the diameter of the polystyrene sphere utilised in the NSL process. In our case, the 2 µm spheres lead to a large diffraction angle of 21.4°. This can be increased further by choosing smaller diameter spheres. Standard lithographic procedures struggle with producing such small feature sizes.

Figure 4. (a) Scanning electron microscope (SEM) image of a poly-styrene monolayer on a microscope slide. (b) SEM image of a monolayer shrunk by reactive ion etching. (c) Atomic force microscope image of the structured metal electrode. (d) Photograph of the diffraction pattern of the structure shown in (c). The scale bars shown are 2 µm.