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Editorial

Liquid Crystals

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Liquid crystals were discovered by Friedrich Reinitzer in 1888 when he observed colors in cholesterol derivatives that are characteristic of highly birefringent materials [1]. Materials that today are classified as "liquid crystals" are typically composed of organic molecules and have phase structures that are between liquid and crystalline [2]. In particular, the simplest liquid crystal phase, the "nematic", is composed of highly prolate or oblate organic molecules (or other anisometric structures) that possess long-range orientational order, but no long-range positional order. At lower temperatures, one often finds various "smectic" phases in which the molecules arrange themselves in layers and exhibit a quasi-long-range translational order in one dimension, but are positionally liquid-like within the layer. For much of the next eight decades there was little activity beyond the characterization of their viscoelastic properties. However, the field took off in the 1960s, particularly after the first successful thermal model for the isotropic-nematic phase transition [3,4], followed by the invention of the "twisted nematic" optical display in the early 1970s [5,6]. Much of the work during the subsequent two decades involved understanding the transitions among the myriad liquid crystalline phases [7], especially in light of renormalization group theory and behavior in less-than-three-dimensions. Similar to a child's frame to make soap bubbles, it was discovered that the smectic phase of liquid crystals could form free-standing films [8] as thin as a single molecular layer across centimeter-sized frames, whose dimension ratio is comparable to a piece of paper stretched across a football pitch, either international football (i.e., soccer) or American football, as the dimensions of both playing fields are of the same order. During the past twenty years, the study of liquid crystals has continued to evolve and expand intellectually as research has broadened to include chiral effects; new technologies such as chemical and biological sensors, photovoltaic applications, "smart" materials, and optical communications; improved display technologies in which supersized displays have become high-quality, routine, and inexpensive; topological defects; dynamics and pattern formation; biaxial molecules and their phases; supramolecular structures including so-called "living nematics" in which the liquid crystalline structural unit is composed of more elementary units that self-assemble; polymers, elastomers, and gels; and mixtures of liquid crystals and colloids and/or nanoparticles. Research and development in liquid crystals is highly interdisciplinary as physicists, chemists, and engineers work together to develop new materials with novel behaviors. The effort is also international in scope, having spread from its early days in France, Germany, and Switzerland to every part of the globe, with many national societies operating under the umbrella of the International Liquid Crystal Society. My own work involves collaborators not only in the United States, but in Canada, France, Slovenia, and Israel. In fact, liquid crystal research has gone beyond the globe, with several experiments requiring microgravity having been performed aboard the International Space Station [9], and at least three more planned for the near future. In addition to the regular stream of liquid crystal-related papers appearing in **Crystals**, the section is organizing two exciting special issues. Prof. Helen Gleeson (University of Leeds, UK) is editing an issue dedicated to Rising Stars of the Past Decade, a collection of papers from young researchers who have made a tremendous impact and are shepherding the field in many new directions. I am editing a Special Issue in celebration of the 80th birthday of Prof. Noel Clark (University of Colorado, USA), gathering contributions from the most important names in the field over the past five decades. Noel Clark is arguably the world's most outstanding soft matter experimentalist, and has invented and/or made seminal contributions to many of the subfields studied today. This is truly an exciting time to be working in liquid crystals.

References

1. Reinitzer, F. Beiträge zur Kentiss des Cholesterins. *Mon. Chem.* **1888**, *9*, 421–441. [CrossRef]
2. DeGennes, P.G.; Prost, J. *Physics of Liquid Crystals*; Oxford University Press: Oxonia, UK, 1994.
3. Maier, M.; Saupe, A. Eines einfache molekular-statistische theorie der nematischen kristallinflussigen phase. Teil l1. *Z. Naturforsch. A* **1959**, *14*, 882–889. [CrossRef]
4. Maier, M.; Saupe, A. Eines einfache molekular-statistische theorie der nematischen kristallinflussigen phase. Teil II. *Z. Naturforsch. A* **1960**, *15*, 287–292. [CrossRef]
5. Helfrich, W.; Schadt, M. Lichtsteuerzelle. Swiss Patent 532 261, 31 December 1972.
6. Fergason, J.L. Display Devices Utilizing Liquid Crystal Light Modulation. U.S. Patent 3,731,986, 8 May 1973.
7. Anisimov, M.A. *Critical Phenomena in Liquid Crystals*; Gordon and Breach: Philadelphia, PA, USA, 1991.
8. Sonin, A.A. *Freely Suspended Liquid Crystalline Films*; J. Wiley & Sons: Chichester, UK, 1998.
9. Clark, N.A.; Eremin, A.; Glaser, M.A.; Hall, N.; Harth, K.; Klopp, C.; Maclennan, J.E.; Park, C.S.; Stannarius, R.; Tin, P. Realization of hydrodynamic experiments on quasi-2D liquid crystal films in microgravity. *Adv. Space Res.* **2017**, *60*, 737–751. [CrossRef]

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