Preface

Since their discovery in 1888, liquid crystals (LCs) have developed from a scientific curiosity to an interdisciplinary research field with broad commercial applications. LC displays (LCD) represent the most obvious and successful example for the practical application of LC, well know to a broad community. The light, flat and low power-consuming LCD is one of the key components of present mobile communication and data processing devices, which have changed our lives considerably. Nowadays, even the TV-market is dominated by LCD which allows incredible screens sizes and resolutions. However, beside the well known display technology there are many other applications of liquid crystals, for example polarized light reflecting and photonic band gap materials and light modulators. Liquid crystalline polymers are presently used for high strength fibres, for the encapsulation of microelectronic circuits and the construction of micro-electromechanical and micro-fluidic devices. Numerous new applications of LC are also approaching, such as organic light emitting diodes, photovoltaic devices, organic field effect transistors, tuneable lasers and many others. Besides the numerous technical applications there are also an increasing number of biomedical applications for drug delivery, gene delivery, sensors and as promising materials for artificial bones, tissues and actuators. In a more general sense, the combination of order and mobility in the LC state provides unique properties and is a basic requirement for self-assembly and structure formation in technical and bio-systems.

However, the LC displays are still based on the simplest mode of LC organization, the nematic phase, which comprises only an orientational order of the molecules, new applications, as for example in organic electronics also require the directed design of positional order in one, two or three dimensions as provided by smectic, columnar and cubic phases, respectively. In this way, through molecular design and synthesis of new LC molecules, the complexity of LC phases can be increased and this is the basis for the emergence of new materials properties, paving the way to new future applications. One recent example is provided by the so-called bent-core molecules, where ferroelectricity and spontaneous achiral symmetry breaking emerge in well ordered, but still fluid systems.

A number of fundamental aspects of liquid crystals chemistry were presented in volumes 94 and 95 of *Structure and Bonding,* edited by D. M. P. Mingos and published in 1999 and also in volume 128 of the same series, edited by T. Kato and published in 2008. Another monograph was published by Springer in 2007 (*Thermotropic Liquid Crystals,* edited by A. Ramamoorthy) and deals more with physical aspects of LC self assembly and methods of their investigation. This volume intends to shed light on a selection of different aspects of contemporary liquid crystal chemistry, focussing on molecular design carried out in order to influence the self-assembly behaviour of LC-forming molecules in a specific way.

The editor has intended to avoid duplications with subjects occurring in the previous volumes of the series *Structure and Bonding* and to provide the reader with most update information on design and self-assembly of LC materials. This volume in the *Topics in Current Chemistry* series combines eight chapters from different areas, starting with reviews on the current state in the fields of LCs with perfluorinated segments and LCs based on crown ether structures. The first one is focussed on nano-segregation as a basic tool for LC-design, leading to specific properties and new modes of self-assembly in liquid crystals. The second one provides a link to host-guest chemistry, a major area of supramolecular chemistry. The first chapter also gives a short introduction into the field of LC self-assembly and offers a brief description of the most important fundamental LC phase structures. LC phases formed by unusual molecules, namely three-arm-star molecules are reviewed in the third chapter. This is followed by a chapter presenting an overview of soft DNA-based structures, not only covering LC phases but also including other soft structures based on DNA nanotechnology, which provides some examples for the importance of LC self assembly in bio-systems and for the origin of life. As already mentioned above, another contemporary field of research is related to so-called bent-core mesogens. Two chapters are devoted to this subject, one reviewing complex phases with two-dimensional order and the other one focussing on spontaneous achiral symmetry breaking in bent-core LC and also in other LC phases. Another current research field deals with the combination of nano-particles and LCs. Nano-particles can either be combined with units promoting their mesogenity and enabling them to organize into well defined periodic LC structures, or the self assembly of nano-particles can be mediated by a LC host matrix. Finally, there is also an influence of the nano-particles on the phase structure of the LC host. The last chapter is devoted to the directed molecular design of photo-luminescent LC.

It is obvious that this volume cannot be fully comprehensive, but at least it should provide a rough overview, covering some of the important subjects in the field of liquid crystal design and self-assembly. Nevertheless, I hope the present volume will be highly informative and inspiring for chemists and physicists who are interested in developing new materials based on the unique combination of order and mobility provided by the LC state.

Halle, December 2011 Carsten Tschierske

Springer

http://www.springer.com/978-3-642-27590-6

Liquid Crystals
Materials Design and Self-assembly
Tschierske, C. (Ed.)
2012, XII, 412 p., Hardcover
ISBN: 978-3-642-27590-6