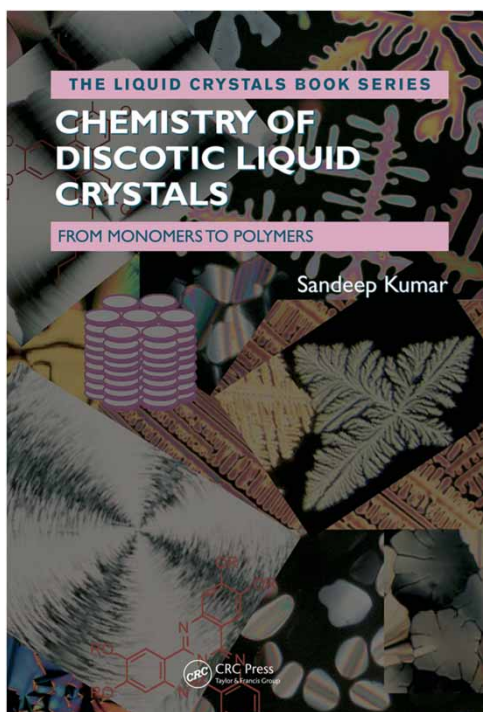


## BOOK OVERVIEW

### Chemistry of discotic liquid crystals: from monomers to polymers

Sandeep Kumar (Raman Research Institute, Bangalore, India), Boca Raton, FL, Taylor & Francis Group – CRC Press 2011, 519 pp., RRP: US\$ 220.00/£141.00 (hardback), ISBN 978-1-4398-1143-6



Liquid crystals (LCs) are ubiquitous in everyday life in the form of liquid crystal display (LCD) devices, which currently outnumber the people on earth. LCs are unique functional soft materials that combine both order and mobility on a molecular, supramolecular, and macroscopic level. Non-covalent intermolecular interactions such as hydrogen bonding,  $\pi$ -stacking, polar–nonpolar interactions, metal coordination, charge transfer and ionic interactions, etc., play a crucial role in the formation of LCs and in the determination of their mesomorphic properties. Shape anisotropy is the primary factor for any organic molecule to display mesomorphism. The phenomenon of liquid crystallinity in organic materials was discovered in 1888 and, until 1977, it was believed that only rod-like anisotropic molecules, having a much higher length than width, could show liquid crystalline properties commonly known as calamitic LCs. However, in 1977, it was realized that not

only rod-like molecules, but also compounds with a disc-like molecular shape are able to form liquid crystalline phases. These are referred to as discotic liquid crystals (DLCs).

*Chemistry of discotic liquid crystals: from monomers to polymers* is essentially a reference book which has covered the synthesis, mesomorphic behaviour and applications of DLCs. The book is organized into six chapters. The book opens with the description of self-organization of molecules in nature and its relevance to liquid crystalline phenomenon. After that, the molecular arrangement in classical states of matter (solid, liquid, and gas) and in liquid crystalline state is presented followed by a historical account of the discovery of LCs. Classification of LCs based on molar mass, occurrence, shape, mesophase types, etc., is presented in the next section. The lyotropic LCs part also covers the interesting chromonic LCs while the thermotropic LCs section focuses on the description of calamitic LCs and mesophases formed by calamitic LCs such as nematic phase, chiral nematic phase, various smectic phases, ferro-, antiferro-, and ferrielectric phases. A brief description of bent-core LCs has also been provided. After a brief general introduction of above-mentioned liquid crystalline topics, a comprehensive description of DLCs, various mesophases formed by DLCs and their characterization is presented. The final section of this chapter provides a comprehensive review of various alignment techniques of discotic nematic and columnar phases, an extremely important topic from an application point of view.

Chapter 2, which is about 60% of the total book, deals with the chemistry and mesomorphic properties of various monomeric DLCs. It consists of 25 sections which are organized by the discotic core structure. Sections 2.1–2.14 of this chapter deal with the chemistry and thermal behaviour of LCs derived from aromatic cores, namely, benzene, naphthalene, phenanthrene, anthraquinone, pyrene, triphenylene, perylene, dibenzo[g,p]chrysene, dibenzo[fg,op]naphthacene, truxene, decacyclene, hexabenzocoronene, tribenzocyclononatriene, tetrabenzocyclododecatetraene, metacyclophane, phenylacetylene macrocycles, indene and pseudoazulene (discotics without flexible aliphatic chains), benzo[b]triphenylene, tetraphenylenes, tetrabenzo[a,c,h,j]anthracene, helicene and tetrahedral, and other low aspect ratio organic materials. DLCs generated from heterocyclic cores such as triazene, phenazines, hexaazatriphenylene, heterotruxenes, tricycloquinazoline, porphyrin, porphyrin-

zine, phthalocyanine, etc. are covered in Sections 2.15–2.24. Section 2.25 presents the chemistry and mesomorphism of DLCs derived from saturated cores, such as cyclohexane, glucopyranose, and azamacrocycles.

Chapters 3–5 are structurally similar to Chapter 2 and cover the chemistry and mesomorphism of discotic dimers, oligomers, and polymers. Each chapter begins with a general description, which provides the necessary background and context for the uninitiated reader to understand the concepts involved. The remainder of the section is a comprehensive review of work. The book elegantly describes the synthetic routes to all the DLCs. More than 300 schemes and figures have been used to cover the synthesis and molecular structures of about 3000 DLCs. Transition temperatures of all described compounds are provided in tables with references.

Chapter 6 presents some applicable properties of DLCs. Though the field of DLCs is at a relatively nascent stage, many significant advances have been achieved in a short span of time and products derived from DLCs have reached the market. A typical example is the optical compensation films for wide viewing LCDs. This topic is discussed in the first section of this chapter followed by the use of discotics for thin film polarizer and high quality carbon

products. The unique geometry of columnar mesophase formed by disk-shaped molecules is of great importance to study the one-dimensional charge and energy migration in organized systems. There are a number of potential applications of these materials, such as one-dimensional conductor, photoconductor, photovoltaic solar cells, light-emitting diodes, and thin film transistors. All these aspects have been discussed at length in the later part of this chapter.

This book is a comprehensive, up-to-date source of work on DLCs. Researchers working on DLCs need to have an up-to-date source of reference material to establish a solid foundation of understanding. It is extremely important that researchers in the field of LCs have ready access to what is known and what has already been accomplished in the field. This book will be helpful not only to students and researchers but also to the directors and principal investigators working in this field in designing new materials and conducting various physical studies. About 2400 references have been cited in this book. The extensive reference list may help the reader to pursue further investigations.

Discotic liquid crystals are nanostructured materials, usually 2 to 6 nm size and have been recognized as organic semiconducting materials. Recently, it has been observed that the dispersion of small concentration of various functionalized zero-, one- and two-dimensional nanomaterials in the supramolecular order of mesophases of DLCs imparts negligible impact on liquid crystalline properties but enhances their thermal, supramolecular and electronic properties. This article primarily summarizes recent advancement in the field of discotic liquid crystal (DLC) nanocomposites. Discotic liquid crystals are nanostructured materials, usually 2 to 6 nm size and have been recognized as organic semiconducting materials.

15. Kumar S (2011) Chemistry of discotic liquid crystals: from monomers to polymers. CRC Press, Boca Raton, FL. 16. Bushby RJ, Kawata K (2011) Liquid crystals that affected the world: discotic liquid crystals. *LiqCryst* 38: 1415-1426. 17. Bisoyi HK, Kumar S (2011) Carbon-based liquid crystals: art and science. *LiqCryst* 38: 1427-1449. 18. Kaafarani BR (2011) Discotic liquid crystals for opto-electronic applications. *Chem Mater* 23: 378-396. Liquid crystalline polymers (LCPs) are a class of polymers that show liquid crystal phase, they show both anisotropic properties which originate from mesogenic units and good mechanical properties.

Sabine L, Angelika B, Nelli S, Frank G (2007) Discotic liquid crystals: from tailor-made synthesis to plastic electronics. *Angew Chem Int Ed* 46:4832-4887. Saez IM, Goodby JW (2005) Supermolecular liquid crystals. Phases - Phase transition - QCP. v. t. e. Liquid crystals (LCs) are a state of matter which has properties between those of conventional liquids and those of solid crystals. For instance, a liquid crystal may flow like a liquid, but its molecules may be oriented in a crystal-like way. There are many different types of liquid-crystal phases, which can be distinguished by their different optical properties (such as textures). The contrasting areas in the textures correspond to domains where the liquid

The first reference book to cover DLCs, *Chemistry of Discotic Liquid Crystals: From Monomers to Polymers* highlights the chemistry and thermal behavior of DLCs. Divided into six chapters, each with a general description, background, and context for the concepts involved, the book begins with a basic introduction to liquid crystals, describing molecular self-assembly and various types of liquid crystals. It outlines their classification, covers their history and general applications, and focuses on DLCs and their discovery, structure, characterization, and alignment. The bulk of the book covers the chemistry and mesomorphism of discotic dimers, oligomers, and polymers and concludes with a look at some applicable properties of DLCs.