Preface

Liquid crystals are a soft material formed through molecular assembly. The liquid crystalline state is unique because it combines molecular order and dynamic properties. Nematic liquid crystals have been widely used in display devices because of their anisotropic nature and responsiveness to electric fields. Generally, nematic liquid crystals consist of rod-like molecules and they form no nano-segregated structures. Recently, intensive studies have focused on liquid crystals forming nano-segregated structures such as smectic, columnar, and cubic phases to develop new functional materials. These nanostructured liquid crystals are expected to show enhanced or anisotropic properties in the following applications: electrooptics, photonics, transportation of electrons, ions, or molecules, sensory, catalysis, and bioactivity properties. To induce these functions in nanostructured liquid crystals, control of the nano-segregated structures of the molecular assemblies as well as the design of the structure of each molecule is of great importance.

A number of fundamental aspects of liquid crystals were presented in volumes 94 and 95 of *Structure and Bonding*, published in 1999 and edited by Prof. Mingos. The present volume reflects recent aspects in the development of functional liquid crystals which form nano-segregated structures. The editor has intended to provide readers with the most up-to-date information on the design of liquid crystalline materials. In conventional liquid crystalline compounds, the shapes of the mesogens were basically rod-like or disk-like molecules with covalent bonds. On the basis of their molecular weights, the materials were classified simply into low molecular weight liquid crystals and polymer liquid crystals. The polymer liquid crystals were categorized as main-chain and side-chain types. The design of new molecular architectures based on liquid crystals involves the syntheses of polymers with well-defined structures such as dendrimers and molecules with block structures. Moreover, supramolecular architectures based on liquid crystals have been intensively studied. Supramolecular liquid crystals form well-defined structures through non-covalent bonding including hydrogen bonding and ionic interactions. The present volume covers these new aspects of design and functionalization of liquid crystals.

In Chapter 1, Saez and Goodby describe unconventional liquid crystals having “supermolecular” structures that are more complex than those of conventional liquid crystals. They focus on dendritic liquid crystals with monodispersed and discrete molecular structures. These materials can incorporate functional moieties in the self-organized states. In Chapter 2, Lee reports on the self-assembly of rod–coil molecules consisting of a rod-like mesogenic part and flexible coils. They have block structures inducing a variety of liquid crystalline phases that form the nano-segregated structures.

Chirality is also an important aspect of liquid crystals. The introduction of chiral moieties into the chiral smectic phases induces functions such as ferroelectricity and antiferroelectricity. A few of the unconventional chiral liquid crystals are described in Chapter 1. The blue phase is one of the exotic chiral liquid crystalline phases. In Chapter 3, Kikuchi introduces the basic aspects and recent progress in research of the blue phase. Recently, the materials exhibiting the blue phases have attracted attention because significant photonic and electro-optic functions are expected from the materials.

In Chapters 1, 2, and 3 unconventional liquid crystalline molecules with complex structures based on covalent bonding are described. In Chapter 4, Rowan and Mather demonstrate that non-covalent bonding such as hydrogen bonds may be used for the design and construction of liquid crystalline materials.

Polymeric materials have advantages because of their stability and structure-forming properties. Electron- and ion-active organic polymeric materials have attracted attention for new devices. In Chapter 5, Kato and co-workers focus on polymeric liquid crystalline materials that are used for the development of functional materials transporting ions and electrons. The nanostructures such as smectic and columnar phases exhibited by side-chain, main-chain, dendritic, and network polymers may exhibit one- and two-dimensional transportation properties.

Thermotropic liquid crystals and also lyotropic liquid crystals generate functional molecular assemblies. Lyotropic liquid crystalline phases are exhibited by amphiphilic molecules in appropriate solvents. They form nano-segregated structures because the molecular structures consist of hydrophilic and hydrophobic components. In Chapter 6, Gin and co-workers describe how lyotropic liquid crystals may be used to form functional materials. Lyotropic liquid crystals can act as templates for inorganic materials, ion conductors, catalysts, drug delivery systems, and nanofilters.

I hope the present volume will be very informative and inspiring for scientists and engineers who are interested in developing new functional materials based on the molecular order formed in liquid crystals and their nanostructures.

Tokyo, January 2008 Takashi Kato

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