Abstracts

Basic Concepts of Liquid Crystals in Soft Matter

Akihiko MATSUYAMA

Soft matter includes a vast range of materials that cannot be classified as simple liquids or hard solids. The partial ordering with respect to viscoelastic properties, long relaxations associated with broken symmetries and self-assembly are the main features of these systems. Soft matter systems include polymer solutions, liquid crystals, gels, biological membranes, colloidal suspensions, protein solutions, surfactant solutions etc. Most soft matter forms liquid crystalline states which have spontaneous broken symmetries of translational and orientational symmetries. In this review, the basic concepts to understand liquid crystals in soft matter such as structural interactions, order parameters, and the role of the entropy are discussed.

Keywords : Soft matter, Liquid crystal, Structural interaction, Order parameter, Entropy, Liquid crystal composite, Mean field theory

Diversity and Universality of Mesoscopic Orders in Soft Matter

Takao OHTA

A recent study on the formation and transitions of mesoscopic structures in soft matter focusing on microphase separation in block copolymers have been described. The reduction theories suitable for mesoscopic scale are explained together with their limitations. Recent investigations of the transition kinetics based on one of the reduction theories are given.

Keywords : Soft matter, Microphase separation, Block copolymer, Kinetics

Microrheology of Soft Matter

Yasuyuki KIMURA

Most soft matter such as liquid crystals, polymers and colloids are complex fluids that show viscoelasticity. Soft matter is a suitable targets for applications in "rheology" and thus their macroscopic mechanical properties have been extensively studied. Recently, the properties and functions of soft matter in a micrometer-scaled system such as cells have attracted much attention. The study of "nanorheology" which measures the mechanical properties of a single polymer and that of "microrheology" which deals with the mechanical property of soft matters on a mesoscopic scale have progressed greatly. In this paper, we discuss the basic methods of microrheology and present our study on the transport of nano-sized particles in the lyotropic smectic phase as an example of microrheology.

Keywords : Soft matter, Microrheology, Particle tracking, Optical tweezers, Electrophoretic microrheology, Lyotropic lamellar phase, Colloidal dispersion

Hydrogels Containing Immobilized Lyotropic Liquid Crystals

Kaoru TSUJII

Polymer hydrogels that contain lyotropic lamellar liquid crystals have been synthesized and characterized as novel hybrid materials. The hybrid gels show some unique properties which cannot be obtained from the individual polymer gels and the liquid crystals. Iridescent color resulting from Bragg diffraction of visible light by the periodic structure of bilayer membranes in the liquid crystal can be changed by controlling the swelling degree of the gel. Introduction of bilayer membranes strongly affects the volume phase transition behavior of the gel. An anisotropic gel has been synthesized by polymerizing a gel while shear flow is imposed upon the solution to be gelled. The hybrid gels show more than a seven times larger elastic modulus compared to the simple polymer gel, and can be extended by more than three times before fracture. An anisotropic gel shows anisotropic swelling and mechanical prop-

erties. Hydrogels containing immobilized polymeric micelles which show a rapid phase transition are also studied and discussed.

Keywords : Surfactant, Lamellar liquid crystal, Bilayer membrane, Hydrogel, Micelle

Visualization of The Dynamic Property of Two-Dimensional Liquid Crystal Membranes

Takehiko INABA, Akihiko ISHIJIMA, Kingo TAKIGUCHI and Hirokazu HOTANI

Lipids assemble into bilayers in aqueous solution and behave as two-dimensional liquid crystals. The lipid bilayer edge spontaneously closes and forms a membrane vesicle called the liposome. The liposome has the ability to transform into various morphological shapes. To investigate the dynamic properties of lipid membranes in morphogenesis, we constructed an imaging system that can manipulate liposomes and measure the forces required to transform their shapes. Spherical liposomes transformed into a lemon shape with increasing tension, and tubular membrane projections were subsequently generated at the tips of either end. In the elongation stage of the lemon-shaped liposomes, more force was required for the transformation as the end-to-end length increased. Just before the tubular membrane projection was generated, the force required reached its maximum strength. However, immediately after the tubular membrane projection developed, the force exerted suddenly decreased and remained constant independent of further tube elongation or shortening. These results indicate that the two-dimensional liquid crystal membrane has the unique properties of forming tubular membrane projection depending on the application of mechanical force and that the lipid bilayer itself has the ability to buffer the membrane tension.

Keywords : Liposome, Two-dimensional liquid crystal, Membrane projection

Lipidic Cubic Phases Confining Proteins in the Water Channels

Shinpei TANAKA

Lipidic cubic phases have been interwoven and periodic water 'channels' formed with bilayers. This paper introduces several phenomena taking place in the cubic phase when protein molecules are confined to the water channels. The strong confinement of proteins in the water channels leads to both enhanced crystallizations of proteins and structural transitions of the cubic phase. A simple concept of the 'available volume' in the water channels is proposed to explain this behavior.

Keywords : Lipidic cubic phase, Protein crystallization, Structural transition

Chiral LC Molecular Motor

Yuka TABE

Tilted liquid crystalline thin films composed of chiral compounds exhibit coherent precession motion under the transmembrane water transfer. The inversion of molecular chirality or water transfer direction can reverse the precession direction, whose angular velocity is linearly dependent on the amount of water flow per unit of time. The result indicates that molecular chirality can work as a propeller driven by transmembrane water transfer, which gives rise to the coherent collective precession of the entire molecules via the liquid crystalline molecular interaction. We also discuss possible nanomachines using the LC cooperative force.

Keywords : Chirality, Molecular motion, Collective precession, Water flow, Motor function

Formation of Chiral Liquid Crystal as a Soft Self-Assembly of Amino Acid Based Chiral Surfactants and Imprinting the Structure on Mesoporous Silica, a Hard Entity

Kazutami SAKAMOTO

The evolution of self-organization of amino acid based chiral surfactants from soft assembly to hard mesophase are investigated. Chiral micelles and lyotropic cholesteric liquid crystals were brought together to produce a soft assembly material. Those soft self-organized chiral structures were utilized as templates to create chiral mesoporous silica.

Keywords : Acylamino acid, Chiral surfactant, Chiral self-organization, Template, Chiral mesoporous silica