Abstracts

Zero Zero-Birefringence Polymers

Yasuhiro KOIKE and Akihiro TAGAYA

Polymers tend to exhibit large birefringence because polymer molecules tend to be oriented in processes such as extrusion, drawing and injection molding. Therefore, it has been thought that polymers are highly birefringent material. However, we proposed zero-birefringence optical polymers that exhibit no birefringence with any orientation of the polymer main chains based on detail investigation of the relation between their chemical structures and birefringence property, and synthesized them. Furthermore, we demonstrated, for the first time, that it is possible to synthesize a polymer that exhibits no orientational birefringence and no photoelastic birefringence in a system that is composed of more than three components, and named it a zero zero-birefringence polymer.

Keywords : Zero-birefringence optical polymers, Zero zero-birefringence polymers, Orientational birefringence and Photoelastic birefringence, Photonics polymers

Photo-Rubbing Method : A Practical Photo-Alignment Solution

Masayuki KIMURA and Hiroshi YOKOYAMA

A normal-incidence single-exposure scheme to obtain a stable pretilted alignment of nematic liquid crystals on photo-alignment polymer layers is proposed. The new scheme consists in periodically modulating the intensity of the normally incident linearly polarized near-ultraviolet light and unidirectionally scanning it on the photosensitive alignment layer. By properly choosing the relative directions of scan and polarization, this scheme works for any types of photo-alignment materials regardless of the resultant alignment direction relative to the polarization direction of the UV light. The pretilt appears in such a way that the nematic director is lifted up in the scan direction, similar to the case of the conventional cloth rubbing. This "photo-rubbing" method allows a fairly accurate control of the pretilt angle by way of the scan speed and the light intensity.

Keywords : LCD, Liquid crystal, Photo-alignment, Pretilt angle, Rubbing

Structure and Tribological Properties of Liquid Crystals

Shigeyuki MORI, Hidetaka NANAO and Ichiro MINAMI

Tribology is science and technology for controlling friction and wear by lubrication. Elasto-hydrodynamic lubrication and boundary lubrication properties of liquid crystals (LC) are described. Tribological properties of LC are discussed on the basis of molecular structure and molecular orientation of LC by shear. The application of LC mixture as a lubricant and friction control by electric field is also described.

Keywords : Liquid crystal, Elasto-hydrodynamic lubrication, Boundary lubrication, Molecular orientation, Friction control

Photoalignment of Chromonic Liquid Crystals

Takashi TAMAKI

The chromonic mesophases are a well-defined family of lyotropic liquid crystalline phases distinct from those of conventional amphiphiles. They are characteristic of aqueous solutions of some drugs, dyes or nucleic acids, which have disc-like or plank-like aromatic structures with polar units at the peripherals to form isodesmic columnar aggregates by face-to-face stacking in solutions.

Recently, some efforts have been made toward the practical application of chromonic mesophases to optical elements such as optical compensators. They were produced by using mechanical methods like stretching

or shearing to align mesogens. These conventional methods are uniaxial alignment techniques and cannot be applied to multi-mode alignment which means to align individual pixels in any required orientation. This can only be achieved by the photoalingment approach named 'command surface'. It has been revealed that this technique is quite useful for the photoalignment of a chromonic dye, C.I. Direct Blue 67 to fabricate a micro-patterned polarized film for high-presence 3D displays.

Keywords : Lyotropic liquid crystal, Chromonic liquid crystal, N and M phases, Photoalignment (command surface), Micro-patterned polarized film

A Progressive Challenge for Development of a Liquid Crystalline Polyolefin

Naofumi NAGA and Shigemitsu MURASE

A liquid crystalline phase of polyolefins was discovered in poly(methylene-1,3-cyclopentane) (PMCP), which was obtained with cyclization polymerization of 1,5-hexadiene (HD) using zirconocene catalysts, under the ambient conditions. PMCPs clearly showed birefringence and the texture indicates the nematic liquid crystalline phase. The high cyclization selectivity of inserted HD units and high *trans*-content of the 1,3-cyclopentane unit were necessary to induce the liquid crystalline phase. The transition temperature from the liquid crystalline phase to the isotropic phase (T_i) was controllable by precise control of PMCP microstructures, and increased with the increasing of *trans*- content of 1,3-cyclopentane unit in PMCP. The wide-angle X-ray diffraction patterns of oriented fiber sample showed clear diffraction below the T_i, indicating certain existence of lateral inter-chain packing structure of liquid crystalline phase.

Keywords : Polyolefin, Liquid crystal, Metallocene catalyst, 1,5-hexadiene, Cyclization polymerization, Poly(methylene-1,3-cyclopentane)

Organic-Inorganic Hybrid Liquid Crystals : Development of Functional Materials by the Induction of Liquid Crystallinity into Inorganic Nanoparticles

Kiyoshi KANIE and Atsushi MURAMATSU

Novel organic-inorganic hybrid thermotropic liquid crystals (LC) are developed by the hybridization of organic LCs having a mesogenic core and monodispersed TiO_2 or α-Fe_2O_3 particles with different shapes through the specific adsorption of the LCs to the surfaces parallel to the *c*-axis of the particles. The hybrid LCs shows thermotropic mesophases in wide ranges of temperatures. Variable-temperature small angle X-ray measurements reveal that the spontaneous formation of periodic structure by the hybridization induces the thermotropic liquid crystallinity. This technique would lead development of novel-type of dynamic functional materials with multi-responsively to magnetic and electric fields.

Keywords : Organic-Inorganic hybrid, Fine particle, Nanoparticle, Titanium oxide, Iron oxide

Video Rate Intracellular Calcium Imaging with High Power Light Emitting Diodes and Ferroelectric Liquid Crystal Shutters

Takashi FUKANO and Atsushi MIYAWAKI

Dual-excitation ratiometric dyes permit quantitative measurement of Ca^{2+} concentration, by minimizing the effects of several artifacts that are unrelated to change in Ca^{2+}. These dyes are excited at two different wavelengths, and the resultant fluorescence intensities are measured sequentially. Therefore, it is difficult to follow fast Ca^{2+} dynamics or Ca^{2+} changes in highly mobile cell samples. To overcome this drawback, we have developed a fluorescence microscope with two high-power light emitting diodes and two high-speed liquid crystal shutters for dual-excitation ratio-imaging. The open/close operation of the two shutters is synchronized with the on/off switching of the two LEDs. We demonstrate the effectiveness of this microscope by monitoring changes in Ca^{2+} in cardiac muscle cells loaded with Fura 2 at video rate.

Keywords : Bio-imaging, Light emitting diodes, Ferroelectric liquid crystal shutter, Intracellular calcium, Ratiometry