LIQUID-CRYSTAL TECHNOLOGY

Cholesteric LCDs

P.105: Improvement of 2 + 2 Dynamic Drive Schemes for Cholesteric Displays

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The addition of segments into each selection stage of a 2 + 2 dynamic drive scheme (DDS) for cholesteric LCDs shortens the update time by 30–35%. The influence of additional segments on the peak/effective voltage ratio during different addressing stages and on the driving pulse frequency as well as the potential for gray-scale implementation of this method will be discussed.

P.106: Single-Layer Multicolor Reflective Cholesteric Displays

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The optical response of a single-panel multicolor cholesteric reflective displays made by polymer-stabilized cholesteric liquid crystals was studied. It is shown that the polymer-stabilized cholesteric cell has an asymmetric structure. One side of the cell reflects a specific wavelength that is tunable with the electric field while the other side scatters light.

Fast Response

P.107: A Very-Fast-Response TN-Type TFT-LCD

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A very-fast-response TN-type TFT-LCD has been developed. The panel can reach response times of 2 msec and gray-to-gray response times below 2 msec. The fastest cell and an advanced overdrive system were combined for an MPRT to be 4 msec.

P.108: WITHDRAWN

P.109: Fast-Response-Time Reflective NBB Display and Its Application to LCOS

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A fast-response-time reflective LCD was designed. By making use of nanostructure alignment surfaces, a stable high-pretilt-angle NBB mode was implemented. The pretilt angle and cell gap were optimized for a high-reflectivity low-driving-voltage display. The experimental result shows a very fast average response time at around 0.7 msec.

P.110: Electroclinic Effect in Chiral Smectic-C (SmC*) Phase

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The electroclinic effect can explain the mechanism of layer rotation in SmC*. The soft mode in the SmC* phase for three different experiments was investigated.

P.111: Novel Electrowetting Displays

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Novel displays have been developed by moving a droplet by electrowetting. This approach enables bistable and high-reflective monochrome and color displays which could also be made on plastic substrates. Prototypes show promising performance in terms of contrast ratio, gray scale, and color.

Ferroelectric LCDs

P.112: Low Driving Voltage with Clean Aligned Ferroelectric Liquid-Crystal Devices

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A low-driving-voltage FLC material, R3206, with V_{sat} at 3.5 V, and its mixtures were investigated for potential TFT-display application. Poor alignment was overcome by using longer-pitch R3206 mixtures and assembly in asymmetrical hybrid alignment cells. Contrast and alignment quality were improved by using a mixture with a pure compound in pre-made cells (1.8 ± 0.1 µm). In particular, the 70% R3206 mixture showed the best results, having a low driving voltage below 5 V and a fast response time (t_{on} + t_{off}) less than 270 µsec. The horizontal defects can be successfully suppressed by using the hybrid alignment cell. These results provide promising FLC materials with low driving voltage, good alignment, and fast switching for TFT-LCD application.

P.113: Ferroelectric LC Aligned on SiO_2 Thin Films Using Ion-Beam Deposition and Its Applications

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The uniform alignment of ferroelectric LCs (FLCs) on inorganic thin-film surfaces was obtained using oblique ion-beam sputtering deposition on substrates. A large deposition angle from 60 to 80° was used for thin SiO_2 alignment layer whose thickness was adjustable from 5 to 40 nm. Two types of uniform alignment (chevron, before electrical treatment) and (quasi-bookshelf, after electrical treatment) were studied. The applications using this unique technology in low-power-consumption displays, fast-switching color displays, future LCD-TVs, and fiber optics will be discussed. The high-quality alignment on large-sized substrates was also easily achieved because of the linear design of the ion-beam sputtering source, which was previously a big challenge for FLC-on-SiO_x layers.

P.114: Effect of the Surface-Alignment Layer on Analog Switching of Ferroelectric Liquid Crystals

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The effect of the alignment layer on the properties on analog switching of ferroelectric liquid crystals was investigated. By using a liquid crystal that does not exhibit a nematic phase in its phase sequence, allowed for the alignment of the smectic layers independent from the surface alignment layer used. This has widened selections of alignment layer materials and provided greatly improved performance.

P.115: Novel PSV-FLCDs Exhibiting High Response Time, High Optical Throughput, and High Contrast Ratio with Temperature-Dependence-Free Operating Voltages: Application to Field-Sequential Full-Color LCDs

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By doping newly synthesized photocurable monomers into FLC media and performing appropriate photocuring, novel polymer-stabilized FLCDs exhibiting V-shaped switching (PSV-FLCDs) with t = 400 μsec and with a small temperature dependence on operating voltage within 3 mV/°C from -5 to 50°C was fabricated. A field-sequential full-color LCD with a 4-in. diagonal and 254 ppi capable of displaying video images without blurring was demonstrated.

Films

P.116: Up-Grading of LCD Panels with Novel Pressure Sensitive Adhesives

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Pressure-sensitive adhesives (PSAs) suitable for attaching polarizers and compensation films in high-performance LCD panels will be described. When PSAs with a high storage modulus were used, light-leakage through the panel caused by temperature- and humidity-induced expansion and shrinkage in the films could be greatly reduced.

P.117: O Films with Variable Tilt of Optical Axis for Display Application

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A method to make O films where the tilt axis of the optic axis can be continuously controlled over the full range of 0–90 is proposed. The method uses reactive mesogens and alignment materials providing a wide range of pretilt-angle control. These O films can be used to widen the viewing angle of LCDs.

P.118: Alignment and Optical Properties of Retarder Film Made of Photoreactive Calamitic Liquid Crystals

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Liquid-crystal polymer (LCP) retarder films were prepared by the photopolymerization of reactive liquid-crystal mesogens. It was found that the quality of the orientation in the films strongly depends upon the alignment method, with rubbed alignment layers providing films with better optical quality than photoalignment methods.

Flexible Displays

P.119: The Stabilized Bistable LC Mode for Flexible Displays from Multi-Rubbing on the PILC Structure

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The bistable LC mode for flexible displays based on a micro-structure was investigated. The display has dynamic and memory modes simultaneously on a flexible substrate. The driving scheme guarantees low power consumption for portable applications. The bistable LC mode was realized in a pixel-isolated LC structure for flexible LCD applications. In order to keep the permanent memory time, a 90° twist domain in each subpixel by using a multi-rubbing method was developed.

P.120: Fabrication of Flexible LCD Based on a Micro-Structure and Micro-Contacting Assembling Technique

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S-I. Kim
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A technique to maintain a constant cell gap for a flexible display under various external forces was developed. By the use of a rigid pillar spacer array and a micro-contact printing method, two flexible substrates were tightly assembled.

P.121: Direct Formation of Polymer Walls by Wettability Patterning for Flexible LCDs

J-H. Hong, Y-T. Kim, S-D. Lee
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A new technique for fabricating a flexible LCD with a photopolymer/spacer composite by using the wettability patterning process have been developed. The composite walls defined on patterned regions provide a uniform cell gap as well as improved mechanical stability.

P.122: Fabrication of Single-Substrate Flexible LCDs by a Laminated Functional Polymer Cover Film

K-S. Bae, H-R. Kim, J-H. Kim
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A lamination process of a polymer-covered film with a photo-curable polymer for fabricating single-substrate flexible LCDs is proposed. In the structure, the cover film was tightly attached to the polymer wall structure of the bottom plastic substrate after lamination, and LCs were uniformly aligned by grooves imprinted on the surface of the laminated cover film.

Image Sticking

P.123: Image-Sticking Analysis of Different Q-Time LC Cell by Machine Vision

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A 2-D/CCD and an automatic machine were used to measure image-sticking phenomenon that can be analyzed by a simple model. The image sticking of different que-time panels were measured and analyzed for comparison.

P.124: Analysis of Image Sticking on a Real LCD Cell

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Micro Analysis Lab., Inc., Shiga, Japan

Microanalysis methods such as infrared micro-spectroscopy (μ-IR) and micro-sampling mass spectrometry (μ-MS) were used to investigate image-sticking phenomena on LCDs, indicating that aromatic carboxylic acid condensed at the interface of the CF side induced residual dc voltage.

P.205L: *Late-News Poster:* The Study of the Correlation between Surface Anchoring Energy and Activation Energy on Patterned Vertical-Alignment (PVA) Mode

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It is well known that adsorption and desorption of the ions are closely related to the image sticking of LC cells. An effort was made to measure a fixed quantity of ion concentration by measuring the residual dc voltage in the LC cell and the surface anchoring energy in the PVA cell. To understand the mechanism of image sticking, the adsorption and desorption activation energy was studied, and the desorption activation energy was found to increase as the surface anchoring energy increases. This observation led to the conclusion that a smaller anchoring energy is required to reduce the image sticking of LC cells.

LCD Color

P.125: Sequential Color LCD Using No-Bias-Bend Mode

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Hong Kong University of Science & Technology, Kowloon, Hong Kong

A nano-structured alignment layer capable of producing any pretilt angle was used to make a π-cell with pretilt angles ~ 50°, ensuring bend alignment with no bias voltage. A total response time of less than 1.3 msec enables a color-sequential display without color filters.

P.126: Advanced Image-Processing Method for Hybrid Color LCDs

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A hybrid color LCD can display the RGB primary colors by using only two subpixels of green and magenta. An advanced image-processing method uses a continuous hue change in the magenta subpixel to reduce the degradation of the display resolution, allowing effective portrayal of the human face or skin.

LC Material

P.127: Synthesis and Mesomorphic Properties of Bent-Core Mesogens with Isomeric Naphthylene Central Units

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Y-C. Kim, S-H. Paek
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New bent-core mesogens that possess only ester linking groups between the aromatic rings and 1,6-, 1,7-, 2,3-, or 2,7-naphthylene unit as a central aromatic ring were synthesized. The bent-core ester mesogens with unsymmetrical or highly bent central unit can form a banana-phase in a wide temperature range.

Liquid-Crystal Allignment

P.128: Orientation of a Reactive Mesogens on Photosensitive Surface

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Reactive mesogens are polymerizable liquid crystals produced by photopolymerization. Their application requires homogeneous orientation of the optical axis over the film's surface. A high-quality photoalignment of reactive mesogens on surfaces of cellulose-cinnamates will be reported. Unique photoaligning properties of cellulosecinnamates make them promising for producing birefringent polymer films by using roll-to-roll technology.

P.129: Rejuvenated Photoalignment of Liquid Crystal on Cinnamoil-Containing Polymers

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Université Montpellier II, Montpellier, France

S-K. Park
NDIS Corp., Asan, Korea

Easy-orientation-axis alternation in new photoaligning polymers (PG materials) based on cellulose-backbone-containing photosensitive cinnamoil groups was reported. These materials have strong application potential due to their high aligning quality, low photosensitivity, strong anchoring energy, and weak sticking effect. Rejuvenation of the polymer after UV irradiation makes the PG materials attractive for various applications.

P.130: Plasma-Beam Alignment of Reactive Mesogenes

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Plasma beam processing of commonly used LCD substrates, such as glass, silicon, and plastics, provides excellent alignment of reactive mesogenes was demonstrated. Roll-to-roll alignment can be also obtained on flexible plastic substrates. The developed method is an advancement in the technology of optical films based on reactive mesogenes.

Modeling

P.131: Three-Dimensional Modeling of Liquid-Crystal Pixels

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Stress Engineering Services, Houston, TX, U.S.A.

A commercial finite-element modeling package (ANSYS) was used to solve director electrostatics problems. The algorithm crucially depends on a scaling of the LC material properties to lower the aspect ratio of the problem. This information is used to calculate transmission through the pixel using a ray-tracing algorithm.

P.132: Real-Time Simulation Software for Electro-Optical Calculation of LC Cells

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Fast algorithms for solving differential equations permit users to see changes in the electro-optical response immediately after changing any liquid crystal or cell-configuration parameters. The software is useful for fitting the measured parameters related to LC materials and devices as well as dynamic driving simulations and overdrive optimization.

Transreflective LCDs

P.133: A Novel Portable LCD with New AFFS (i-LCD) Technology for High Transmittance and Superior Sunlight Readability

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A 10.4-in. XGA tablet demonstrates improved indoor and outdoor images through the implementation of a novel Advanced Fringe-Field-Switching (AFFS) pixel design featuring high aperture ratio, a reflective metal gate area, and data bus lines without a black matrix. An anti-reflective front polarizer and a DBEF back polarizer have been developed.

P.134: New Optical Configuration of a Transflective LCD at Low-Voltage (2.5 V) Driving

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J-S. Yi
Information and Communication Devices Laboratory, Kyunggi-do, Korea

An ultra-low-voltage transflective LCD without high-dielectric liquid-crystal material uses a new LC configuration. By adjusting the cell gap, retardation, and film angle (polarizer, retarder), a driving voltage of 2.5 V has been achieved, thereby reducing power consumption by 50%.

P.135: 4.3-in. Transflective OCB LCDs with a Response Time of 2.4 msec in the Reflective Mode

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A 4.3-in.-diagonal transflective optically compensated bend (OCB) LCD with a dual-gap structure has been developed. Because of the fast response in both the transmissive and reflective modes, transflective OCB LCDs are promising as a multimedia displays for outdoor-use applications.

P.136: Highly Efficient MVA-Mode TR-LCD

C. Lo, T-C. Yang, C-J. Hu, C-S. Cheng, C-M. Chang, F-Y. Gan
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A novel transflective LCD uses a specific MVA pixel structure for normally black operation with a single cell gap. This structure provides individual driving gammas for transmissive and reflective modes, simplifies the fabrication process, and increases contrast ratio. The square pixel structure improves the alignment.

P.137: Photoaligned Transflective LCD with a Single Cell Gap Using OCB and Low-Twisted-Nematic Modes

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Transflective LCDs utilizing OCB and low-twist nematic modes has been studied. A double-cell-gap structure is not required, so only one more UV exposure step is needed to produce domains. High brightness and a reflective contrast of 31 were obtained.

Vertically Aligned LCDs

P.138: Axially Symmetric Domain Formed by Soft-Lithographically Patterned LC Alignment Layers

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An axially symmetric multi-domain liquid-crystal (LC) structure formed by soft-lithographically patterned LC alignment layers was demonstrated. Homeotropic LC alignment layers were periodically patterned on a uni-directionally rubbed homogeneous LC alignment layer. The field-induced LC reorientation produces axially symmetric multi-domains.

P.139: New Multi-Domain Vertically Aligned LCD with High Contrast Ratio

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A new multi-domain vertically alignment (MVA) LCD with a high contrast ratio was developed and fabricated. This new MVA structure can realize a stable alignment without protrusions by fabricating a concave structure on the color-filter substrate. The concave structure creates a fringing field to create an MVA LCD.

P.140: Optical Compensation of a High-Transmittance MVA-LCD with Uniaxial Films

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A compensation method that uses uniaxial films was developed for widening the viewing angle of high transmittance multi-domain vertical-alignment LCDs (MVA-LCDs). Based on this design, a complete 80° viewing cone with a contrast ratio greater than 100:1 was achieved. Potential application as a mobile display is emphasized.

P.141: Pretilt-Angle Effects on Liquid-Crystal Response Time

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Analytical expressions for correlating LC response time with a pretilt angle were derived. The theoretical analysis was confirmed experimentally using vertically aligned LC cells. This study improves the understanding of the liquid-crystal dynamic process that is helpful for optimizing liquid-crystal response time.

P.142: Multi-Domain Alignment Technology by Ink-Jet Printing

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An ink-jet-printing method capable of producing multi-domain-alignment LCDs was developed. Two applications of this technology, a wide-viewing-angle display and a single-cell-gap transflective display, will be demonstrated. A 2.4-in. 170-ppi prototype was built to demonstrate this technology.

P.143: Wide-Viewing-Angle LCD Based on a Multi-Patterned Electrode

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A new geometry for an electrode pattern in the patterned vertical alignment (PVA) mode was proposed. An eight-domain LC alignment in a simple fabrication process was obtained. This multi-patterned electrode technique enlarges the viewing angle of the LCD by about 10% compared to that of the conventional PVA mode.

P.144: Control of Liquid-Crystal Director through Defined Pretilt Angle in Vertical-Alignment Mode Surrounded by Polymer Walls

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An improvement in vertically aligned liquid-crystal displays (VA-LCDs) in which the LC is surrounded by polymer walls, called the locked-super homeotropic (LSH) device, is proposed. To improve the switching speed, a pretilt angle was fixed by using the polymerization of a reactive mesogen with a bias voltage.

Wide Viewing Angle

P.145: A Systematic Optimization of Normally White STN-LCDs

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A systematic study to optimize the performance of a normally white STN-LCD is reported. Computer simulations to optimize the polarizer and analyzer angles, as well as cell thickness and drive voltage, and compensation film parameters, were used. Prototypes were developed and the experimental results were compared with theoretical results.

P.146: π-Twist Cell Stabilized by Pixel-Isolation Polymer Walls without Chiral Dopants

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A liquid-crystal cell that is initially in the π-twist state stabilized by pixel isolation walls without any chiral dopants was fabricated. In comparison with a conventional π-cell, the fabricated cell does not need any nucleation for the transition from splay to bend state and exhibits enhancement of contrast as well as reduced driving voltage.

P.147: Novel Electrode Structure for the Super-IPS LC Cell Resulting in a High Aperture Ratio

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J-H. Lee, T-W. Ko
Pusan National University, Busan, Korea and LG.Philips LCD, Kyungbuk-do, Korea

Generally, the transmittance of the super in-plane-switching (S-IPS) liquid-crystal (LC) cell is not superior to other LC modes using the multi-domain effect because of the low aperture ratio. The black-matrix (BM) area was minimized by applying a novel electrode structure that can move the disclination from the active area.

P.148: Viewing-Angle Switching in VA-LCDs by Optimizing the Pixel Structure and Controlling LC Orientation

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In conventional VA modes, the LC director tilts down in four directions 45° to the crossed polarizers. By dividing the pixel into two regions, or RGBW structure and controlling the LC director to tilt down to the polarizer axes, the image quality in oblique directions can be controlled without distorting the image quality at the normal direction.

P.149: Multi-Reflection Effects of the Compensated Black State of LCDs

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The effect of multi-reflection on a perfectly compensated black state of a LCD was studied. The previously unexplained wavelength dependence of light leakage was found to be caused by the interference of ordinary and extraordinary waves, and they could place a limit on the performance of liquid-crystal devices used as displays and optical switches.

P.150: Dynamics of Electro-Optical Switching Processes in Surface-Stabilized Biaxial Nematic Phase

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The dynamics of electro-optical switching processes in the biaxial nematic phase of an oxadizole-based bent-core liquid crystal (LC) is reported. This LC exhibits optical biaxiality in the lower temperature range of the nematic phase and optical uniaxiality in the higher temperature range. The dynamics of switching will be presented.