The 2005 Kyoto Prize Workshop: Symposium of Advanced Technology Category

New Developments of Liquid Crystal Displays

1:00 pm - 5:10 pm, November 12, 2005 (Sat.)

Kyoto International Conference Hall

Coordinators

Tisato Kajiyama (President, Kyushu University)

Shohei Naemura (Manager, Atsugi Technical Center, Liquid Crystals Division, Merck Limited)

1:00 **Opening Address**
Tisato Kajiyama

1:05 **Introductory Talk**
Shohei Naemura
"Electronic Display Applications of Crystals, that flow"

1:25 **Introduction to Laureate**
Hiroyuki Sakaki (Chairman of Kyoto Prize Committee, Professor, Institute of Industrial Science, the University of Tokyo)

1:30 **Laureate Lecture**
George H. Heilmeier (the Laureate in Advanced Technology)
"Liquid Crystal Displays: Reminiscence of the Early Days"

2:30 **Intermission**

2:45 **Session I**
Chairperson: Hiroshi Yokoyama (Director, Nanotechnology Research Institute, National Institute of Advanced Industrial Science and Technology)
Lecture
Katsumi Kondo (Senior Chief Researcher, Hitachi Research Laboratory, Hitachi, Ltd.)
"R&D for Liquid Crystal Display Modes Based on Research on Physical Properties"

3:20 **Lecture**
Tatsuo Uchida (Associate Dean, Graduate School of Engineering, Tohoku University)
"Progress of the Liquid Crystal Display and its Future Trends"

3:55 **Session II**
Chairperson: Yutaka Ishii (Group Deputy General Manager, Display Technology Development Group, Sharp Corp.)
Lecture
Hideo Takezoe (Professor, Graduate School of Engineering, Tokyo Institute of Technology)
"Chirality in Bent-Core Mesogens"

4:30 **Lecture**
Hirotsugu Kikuchi (Professor, Institute for Materials Chemistry and Engineering, Kyushu University)
"Advanced Liquid Crystals by Hybridization with Polymers"

5:05 **Closing Remark**
Shohei Naemura

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[The Laureate Lecture]

Dr. George H. Heilmeier
U.S.A. / born in 1936
Electronics Engineer;
Chairman Emeritus, Telcordia Technologies, Inc.

Liquid Crystal Displays: Reminiscence of the Early Days

While the field of liquid crystals emerged in the late 19th century, liquid crystal display technology was a product of an interdisciplinary research effort that took place in the 1960s. This lecture is based on my personal reminiscences of those years in which four new electro-optic effects in liquid crystals were discovered and prototype applications of liquid crystal displays were developed. There was excitement, frustration, failure and success during those years at RCA Laboratories where the full potential of nematic liquid crystal displays was discovered. For me, it began with the completion of my dissertation on organic semiconductors and ended in my departure in frustration from RCA Laboratories. What happened between those years is the subject of this lecture along with the lessons that I learned from the experience.

[Lecture]

Katsumi Kondo
Senior Chief Researcher, Hitachi Research Laboratory, Hitachi, Ltd.

R&D for Liquid Crystal Display Modes Based on Research on Physical Properties

Since the first liquid crystal display prototype was introduced in the late 1960's by Heilmeier et al., active developments for a new display mode have been underway. This continuous activity may be due to many varieties of both molecular alignment states and pixel structures. Together with active developments of components, such as the back light system, color filter, polarizing film, etc., the quality of the liquid crystal display has been significantly improved. The display quality will be developed further for new applications.
Recently, requirements for qualities of large flat TVs and mobile displays have been increasing. For the future, research on physical properties is becoming more important in order to invent new materials and display modes.
In this presentation, our experiences of the R&D for a new display mode based on the research of physical properties will be reviewed and future possibilities discussed.

[Lecture]

Tatsuo Uchida
Associate Dean, Professor, Graduate School of Engineering, Tohoku University

Progress of the Liquid Crystal Display and Its Future Trends

Liquid crystal displays (LCDs) started from black-and-white numeric displays, and have progressed to computer monitor, liquid crystal television, etc. In this process, significant improvement of temperature range, contrast ratio, resolution, viewing-angle, response speed and display size has been made.
In future electronics, the image will be more and more important. According to it, further improvement in display quality will be required to the LCDs, and they will progress as vivid image displays, information displays and wearable displays.
In this presentation, details of the development of the high performance LCDs mentioned above and their future trends will be reviewed.

[Lecture]

Hideo Takezoe
Professor, Graduate School of Science and Engineering,
Tokyo Institute of Technology

Chirality in Bent-Core Mesogens

Bent-core mesogens opened a new world of science in view of polarity and chirality. Focusing on chirality, the mysterious world will be presented including very recent results. Chirality is a very important property related to life science and function. Bent-core mesogens exhibit variety of phenomena originated from chirality, despite being composed of achiral molecules. One of the most interesting phenomena is spontaneous chiral resolution of achiral molecules. Two chiral domains are clearly recognized under a polarizing microscope and are of millimeter size. This is a very unusual example of the famous Pasteur's experiment in the sense that it occurs in a fluid system. We are trying to control the chirality. The molecules are inherently achiral, so that two chiral domains appear in equal probability. However, we succeeded in obtaining large unbalance of two chiral domains using external fields. Producing chiral molecules is possible only by creatures. The present experiment explodes this established idea.

[Lecture]

Hirotsugu Kikuchi
Professor, Institute for Materials Chemistry and Engineering,
Kyushu University

Advanced Liquid Crystals by Hybridization with Polymers

Hybridization of liquid crystals with polymer yields novel properties which are never observed in pure liquid crystals. In this presentation, unique functions and exotic phenomena of liquid crystals induced by hybridization with polymers will be summarized and the future prospects will be stated.

1. Light scattering of liquid crystals induced by polymers

Forming polymer networks with appropriate mesh-size in a liquid crystal produces liquid crystal poly-domains among which the directors are random, resulting in strong light scattering under zero electric field. This state, may be called “static” light scattering in contrast to the dynamic light scattering which was discovered innovatively by Dr. Heilmeier, can be switched into the light transmitting state upon application of an electric field. The function has been applied to the large area and flexible light valve.

2. Molecular orientation of liquid crystals memorized by polymers

By in-situ polymerization of peculiar monomers in a chiral nematic phase with distributed helical pitch being subject to a temperature gradient, the distributed helical structure of the chiral nematic is preserved after removal of the temperature gradient. The memory effect allows photonic crystals of chiral nematic phase with broad band-gap.

3. Liquid crystalline “phases” stabilized by polymers

The temperature range of a blue phase which appears in a small temperature range can be expanded by in-situ polymerization of a small amount of monomer in the blue phase. This stabilization of the blue phase could be due to the stabilization of natural disclinations (line defects) by resultant polymers. The polymer-stabilized blue phase is a candidate for the next-generation display materials with high-speed response and without the need for rubbing process during fabrication.