ALCOM Update

NSF Science and Technology Center for Advanced Liquid Crystalline Optical Materials | Consortium of Kent, Case Western Reserve, and Akron

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AlphaMicron begins development of LC variable transmission eyewear

The vision of three Kent State University scientists to create a high-technology company to research and manufacture liquid crystal variable transmission eyewear has become a fast-growing reality.

Dr. Tamas Kosa, Professor Peter Palffy-Muhoray, and Dr. Bahman Taheri started AlphaMicron, Inc. in 1997 to carry out research and development in the area of ambient light control for helmet-mounted displays. The company has moved from its initial research into the development of a liquid crystal variable transmission device for eyewear applications.

AlphaMicron group in front of their recently expanded clean room.

AlphaMicron has seen steady growth since its inception. Due to the success of its research during the initial Air Force SBIR grant, the company has subsequently received two additional military contracts. The founders envision that the company's growth will eventually lead to the manufacture of their product for the military sector. They have also recently entered into a joint development agreement with a major company to commercialize their product for the private sector.

> *"We see the transfer of liquid crystal technology onto flexible and curved plastic substrates as a challenging area with great potential growth."*
>
> Peter Palffy-Muhoray

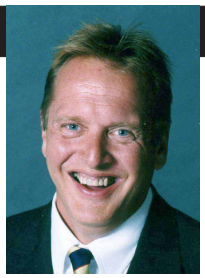
AlphaMicron is focusing on expanding its plastic pro-cessing facility with emphasis on flexible and curved plastic displays. "We see the transfer of liquid crystal technology onto flexible and curved plastic substrates as a challenging area with great potential growth," Peter Palffy-Muhoray, AlphaMicron's President said.

AlphaMicron's clean room has been expanded and is completely operational, allowing all work to be done in-house. The facility also has significantly increased floor space to include plastic processing and electro-optic testing facilities. The company currently has twelve full and part-time employees and plans to increase the number in the near future.

Although AlphaMicron's R&D facilities are essentially self-sufficient, the use of the Liquid Crystal Institute's Research Facilities at Kent State was a great asset during the start-up phase of the company. AlphaMicron continues to interact with the ALCOM Center through membership in the Industrial Partnership Program. The company uses the Liquid Crystal Institute synthesis facility to fabricate some materials used in its device development.

AlphaMicron also closely interacts with the Chemical Physics Interdisciplinary Program (CPIP) at Kent State University. In the field of liquid crystals, fundamental scientific issues are closely linked to device applications. AlphaMicron employs CPIP doctoral students who gain hands-on experience by applying the theoretical knowledge learned in the classroom to practical applications in a commercial setting. AlphaMicron helps the University by providing financial support for students during the final stage of their doctoral research and in turn, the company benefits by having

AlphaMicron, *continued on page 2*



Spring is almost here. I can smell it in the air. This spring is bringing many new initiatives. I'm particularly pleased with the progress of some of the local liquid crystal companies. AlphaMicron is demonstrating effective ways to move technology from the laboratory to the marketplace (see the cover story in this newsletter). Hana Microdisplay Technologies has received local attention for its plans to produce liquid crystal devices to be included as a key part of the headset computer that IBM plans to launch sometime this year. One of the reasons Hana decided to locate in Northeast Ohio was to have rapid access to ALCOM scientists, students and facilities. ALCOM is demonstrating how our basic and applied research and effective outreach programs can support the industry and economy of the region.

This winter everyone in the ALCOM center worked hard to prepare a proposal to continue our funding through the National Science Foundation Materials Research Science and Engineering Centers (MRSEC) program. The process clearly demonstrated the effective collaboration we have established by joining three major universities in Northeast Ohio.

I want to thank all the ALCOM participants for the great amount of time and energy they put into this proposal. We will learn how the proposal fared by early spring. Wish us luck!

With spring shaping up so well, I'm already looking forward to summer.

AlphaMicron, *from page 1*

access to potential employees with a thorough knowledge of the science of liquid crystals.

Through the Industrial Partnership Program, ALCOM Center scientists work with industry and provide research to help move liquid crystal technologies into the marketplace. AlphaMicron scientists provide industrial insight and future direction for the ALCOM Center by membership on the Resource Facility Advisory Board.

AlphaMicron, together with representatives from Kent State University, Northeast Ohio Universities College of Medicine (NEOUCOM), Kent Regional Development Board and the City of Kent, is active on the committee supervising the development of a local high tech incubator. One of AlphaMicron's goals is to help pave the road for other startup companies in this area by acting as an example.

For more information on AlphaMicron, please contact Dr. Bahman Taheri, telephone: (330) 676-0648; fax: (330) 676-0649 or email: bahman@alphamicron.com.

ALCOM

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BerremanInternet server ready to perform LCD simulations

by Jon Ruth, Industrial Partner Liaison

ALCOM researchers now have access to the latest liquid crystal device simulation tools via the internet. Completed under the direction of IPP Liaison, Dr. Jon Ruth, a collaboration between Dr. Phil Bos' research group and Dr. Dwight Berreman makes the computational strength of Dr. Berreman's LCD simulation programs available to IPP members. An internet connection and a PC running Win9x/NT is all that is required to benefit from these valuable tools.

Dr. Berreman wrote one of the first liquid crystal director modeling programs and invented the 4x4 method of modeling optics. His efforts brought quantitative understanding to the study of the electrooptics of liquid crystals, as well as precision and predictability to the design of liquid crystal devices. His methods have been widely employed by others, and his original code has been used extensively. With over 20 years of testing and verification, Dr. Berreman's code is the standard of LCD simulation programs.

The collaboration with Dr. Berreman grew out of DARPA sponsored liquid crystal device research in Dr. Bos' group. It became clear to DARPA that a standardized modeling program would be of tremendous benefit to the U.S. LCD development effort. Dr. Berreman was invited to be a consultant on this project with two goals: 1) Make Berreman's simulation programs easy to use and 2) make them readily available to the LCD R&D community.

Dr. Berreman's modeling programs originally employed a "no-frills" command line interface and used input files created with a separate text editor. Ease of use was achieved with the creation of the *BerremanGUI* (graphic user interface). This graphical front-end performs all the tasks necessary to use the stand alone modeling programs on Pentium based PCs running Win9x/NT. It was created by CPIP graduate students Jim Anderson, Chad Hoke, Salman Saeed, and Phil Watson.

Ready availability came about with the creation of *BerremanInternet*, a limited-feature, internet client version of *BerremanGUI*, and the development of a reliable server to run the director and optics modeling programs. Only *BerremanInternet* is distributed. The modeling programs stay on the server, thereby maintaining their integrity and reliability. Internet access assures that everyone benefits from improvements in the client, server, and modeling programs. *BerremanInternet* is the work of Jim Anderson and Salman Saeed. The server, a Linux-powered PC located at the LCI, was developed by Dave Watson, a pre-admission student at Kent State, and Dr. Ruth.

How does *BerremanInternet* work? The GUI (see figure) allows the user to generate the input files for the simulation programs, upload them to the server, and retrieve the output files. The server continually scans for new input files and processes them as soon as they are recognized.

BerremanInternet is a valuable research tool and an excellent introduction to LCD simulation. A user can specify the material parameters of the liquid crystal, the configuration of the cell, a 30-layer optical stack, and the drive waveform. Configurations can be saved to files and retrieved. The director simulation program returns a file of director configurations that can be plotted with *DDraw*, a 1-D director drawing utility. The optical simulation program returns files containing the optical reflectance and transmittance as a function of wavelength and time.

BerremanInternet graphic user interface (GUI)

Utilities to plot the calculated reflectance/transmittance versus voltage, time, and wavelength are available in the full-featured BerremanGUI, which is free to buyers of Dr. Berreman's stand alone executables.

BerremanInternet (Version 3.1) can be downloaded for free at the newly updated LCI/DARPA LCD Modeling Software web site <www.lci.kent.edu/boslab/modeling>. A PDF version of the *BerremanGUI* manual is also available and provides detailed instructions for using *BerremanInternet.*

A *BerremanInternet* account is required to perform any modeling calculations. Accounts are available for free, with approval, to members of the ALCOM Industrial Partnership Program, to individuals at educational institutions, and to DARPA contractors. Application details are found on the LCI/DARPA LCD Modeling Software web site.

CALENDAR

SID '00, Society for Information Display
May 14-19, 2000, Long Beach, CA
http://www.sid.org/conf/conf.html

3rd SIAM
Society for Industrial and Applied Mathematics
Conference on Mathematical Aspects of Materials Science
May 21-24, 2000, Philadelphia, PA

ILCC 2000, International Liquid Crystal Conference
July 24-28, 2000, Sendai, Japan
www.ecei.tohoku.ac.jp/~ilcc2000/

Research

Ultra-high resolution liquid crystal images and gratings

Charles Rosenblatt's group at Case Western Reserve University has developed a technique to create ultra-small, gray-scale pixels of micron-size or smaller. Using the stylus of an atomic force microscope as a "writing" instrument, a polymer-treated substrate is rubbed unidirectionally within each pixel, although the rubbing direction may be varied from one pixel to another. A second substrate is treated for uniform alignment, where the registration between the two substrates plays no role in device operation and performance.

When used with crossed polarizers but without electrodes, a static gray-scale image may be created. With uniform semitransparent electrodes (e.g., indium-tin-oxide) at the substrates, the brightness may be controlled continuously

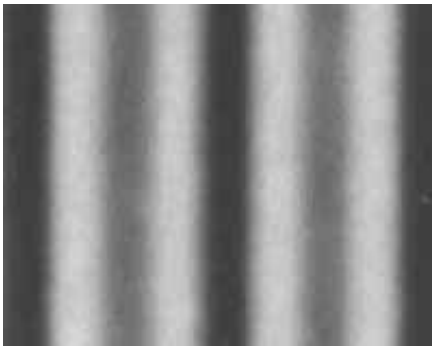

Fig. 1. Cell with 3μm stripes

from a bright image to completely black. An example of a cell with 3 μm-wide stripes is shown in Figure 1.

A recent modification to this technique allows two images or gratings of micron or sub-micron sized pixels to be overlaid in the same physical space, with rapid switching (<10 nanoseconds) from one grating to the other. An example of the two states of overlaid images, an "X" and an "O" comprised of 8 μm pixels, is shown below.

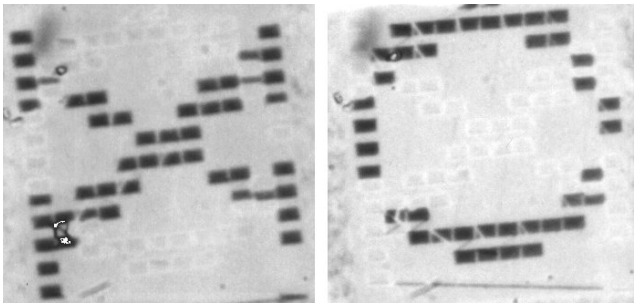

Fig. 2. Two states of overlaid images comprised of 8μm pixels.

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Publications continued on page 5

Photo-polymerized discotic films with uni-axial and twisted optical axis configurations

Chien and Kelly's groups (KSU) studied alignment of discotic molecules on different alignment layers and developed conditions for fabrication of negative retardation films. Alignment of the optic axis was fixed during the photo-polymerization process.

The simultaneous action of processes during photo-polymerization and anchoring forces provide three types of film structures. The most common is the splayed configuration of the optic axis featuring pretilt angles of 30° and 90° near the film-air and film-substrate interfaces, respectively. The fast rate of photopolymerization leads to a homeotropic alignment of the optic axis (negative C-plate). The relatively strong anchoring of rubbed polyimide layers yields uniaxial films with optic axis perpendicular to rubbing direction (negative A-plates).

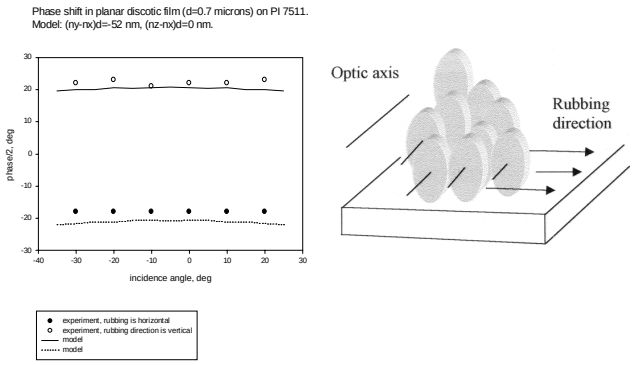

Fig. 1. (a) Measured and modeled φ versus θ curves for discotic planar films (negative A-plates) and (b) distribution of discotic molecules in planar film.

Figure 1(a) shows typical φ versus θ curves for the discotic films on modified polyimides. The curve fitting revealed the following relationship between the three principal indices of refraction: $n_y=n_e<n_x=n_z=n_o$ and $(n_e-n_o)d$= -50 nm. (negative A-plate) (Fig. 1b). The cured planar films have birefringence of n_o-n_e= 0.05-0.1.

Figure 2 shows the polarized fluorescence study. For all discotic films an emission peak was observed at 494 nm with excitation wavelength of 349 nm. The calculated order parameter for a discotic film with a planar alignment layer is S~0.55.

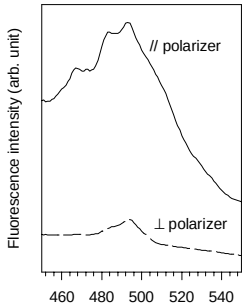

Fig. 2. Fluorescence spectra for planar aligned discotic film.

The ability of certain alignment layers to provide planar alignment in combination with the use of discotic cholesteric materials allowed the group to fabricate a negative film

Discotic, *continued next column*

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Discotic, *from previous column*

with a twisted optical axis configuration. The twist angle in a planar film of a particular thickness is determined by the twisting power of the chiral dopant. For example, to produce a 10 μm thick film with a 90° twist that matches the birefringence of the first minimum twisted nematic cell, the concentration of dopant should be in the range of 1.1-1.5%. The group obtained films with thickness up to 8 mm and twist angles 45°-90°.

Koenig elected to Nat. Academy of Engineering

Jack Koenig was recently elected to the National Academy of Engineering in recognition of his pioneering applications of FTIR and NMR spectroscopic methods to understand and control structure-processing-property relationships in polymeric materials. Prof. Koenig was the only one chosen this year from Ohio and one of a select few elected because of their great contributions in material science.

Koenig is the J. Donnell Institute Professor in the Department of Macromolecular Science at Case Western Reserve University. He serves ALCOM as associate director and Operations Committee member.

Cheng receives Mettler-Toledo Award

During the September 1999 annual meeting of the North American Thermal Analysis Society, Stephen Z.D. Cheng received the 1999 Mettler-Toledo Award, the highest academic award the society bestows upon its members. Professor Cheng received the award for his advancement of the understanding of solid state polymer liquid crystal materials through thermal analysis.

Professor Cheng is the University of Akron Trustees Professor in the Institute of Polymer Science and a principal investigator in the ALCOM Center.

Web Sites

ALCOM Home Page
http://www.lci.kent.edu/ALCOM/alcom.html

Liquid Crystal Institute, KSU
http://www.lci.kent.edu

Dept. Macromolecular Science, CWRU
http://k2.scl.cwru.edu/cse/emac/

Department of Physics, CWRU
http://erebus.phys.cwru.edu/phys/physdept.html

Polymer Science, University of Akron
http://www.polymer.uakron.edu/

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ALCOM Update newsletters with color photos
www.lci.kent.edu/newsletters.html

Heterogeneous Structures Project Database
http://hsp.kent.edu

KSU Office of Technology Transfer
http://www. techtrans.kent.edu

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