May, 2009

Our featured LCI Faculty this month is Professor Deng-Ke Yang. His Profile can be found at the end of the newsletter, following LCI NEWS. Student CVs can be accessed on the IPP website, http://ipp.lci.kent.edu by clicking the “LCI Connection” tab.

This month’s newsletter also provides a “how to” section about a method to build a driver for a multipixel liquid crystal device.

CLEANROOM NEWS

This summer, LCI cleanroom staff will continue with room reorganization plans and attempt to return several pieces of equipment to proper working condition.

The MRC sputter coater located on the 1st floor (“MRC Room”) has undergone routine maintenance to tune the RF power supply output, and to clear blockages in the cooling water lines. The unit is currently running using a slightly undersized mechanical pump while the larger pump is rebuilt. This pump is expected to be returned in June, but the MRC is completely operational now, for the usual nickel or SiO2 coatings.

The new high end assembly area has been completed, in the alcove next to the cleanroom air shower. The Asymtek A402 XY Dispenser has been reinstalled in this space (the A403 Dispenser is still in the original assembly area), and the Fusion UV Source and Dymax UV Source have been moved to this area as well. This area will initially be used by one of the IPP member companies for more complicated assembly tasks.

Parts are expected in the next 1-2 weeks to complete installation of an Ocean Optics Spectrometer in the standard assembly area. This would allow for quick cell gap measurements during and immediately after cell assembly efforts. Completion of this setup is expected in June.

The Brewer GX100 Large Area Spincoater has been shipped back to Brewer for repairs and upgrades, and is expected to be completely reinstalled in the next 2-3 weeks. The unit will be returned to operating condition, but will continue to operate with some components that are obsolete. At this time, the cost of completely upgrading the unit to supported hardware is not justified, especially with the Headway Research IT22 Spincoater also available.

The GenVac Aerospace SC1 ion-assisted e-beam coater is currently operational for metal or insulator coatings, but not for ITO. GenVac has agreed to help troubleshoot and repair the custom ion gun. One of the turbo pump controllers requires repair as well. The ion gauges have been replaced, and staff will continue to look at upgrading the safety interlocks, likely in late June or early July, depending upon interest in the machine.
If there are particular pieces of equipment that are of interest to you, or if you would like to see particular capabilities added to the room, please contact Doug Bryant.

**MULTI-PIXEL LIQUID CRYSTAL DEVICE DRIVER**

To drive an LCD requires a RMS voltage, which from the viewpoint of the torque on the liquid crystal director could be a straight DC voltage from a battery. But there are ions present in the liquid crystal material that migrate under the influence of a DC voltage and cause problems. (may be the subject of another note). So the drive voltage requirement is typically a balanced AC square wave. The value of the RMS level can be changed by changing the amplitude of the square wave, or by adjusting its duty cycle. For fast responding devices, this second method can cause a ripple in the optical response, so it is not the method we will consider here.

As a result of the above considerations, to drive a typical LCD pixel requires an AC balanced square wave with a variable amplitude that typically covers the range from 0 to 5 or 10 volts. The frequency is not too critical, but a value of 1kHz is generally fast enough to eliminate most ion problems, and also is not too high to run into RC time constant issues associated with the capacitance of the cell and the resistance of the driver, the connection to the LC device, and the transparent conductive electrodes on the device.

To drive a single pixel, it is convenient to use a lab signal generator, but if many pixels are needed to be driven with different voltages, this is not a convenient solution.

Merrill Groom, our EE at the LCI, has found that analog output cards are available from National Instruments or UEI can provide a good solution for a multi-pixel driver.

We used National Instruments hardware and software because we are familiar with it. Their analog output hardware can seen by logging onto [http://www.ni.com](http://www.ni.com) and going to Products & Services -> (Shop Hardware) -> Data Acquisition -> (Analog Output Channels). Next, search their product matrix for the desired Form Factor, Analog Output Range, Operating system etc. For example, selecting a “PCI” form factor on the parametric search turned up six analog output cards that may work in our application. Another analog output board manufacturer to consider is United Electronics Incorporated (UEI). They sell several high channel count analog output boards and may be found at [http://www.ueidaq.com](http://www.ueidaq.com). Searching under Products -> I/O Type -> Analog Output -> PCI/ISAS Bus turns up seven boards. Go to specifications and accessories for a list of support hardware and software.

For software, we used the National Instruments LabVIEW graphical programming suite to control our NI analog card. But, as long as the appropriate driver module is available, LabVIEW can control any manufacturer’s hardware. Mathwork’s Matlab is another object oriented software packages, running in the Windows, Unix or Linyx environment, that can be used to control NI, UEI or other manufacturer’s hardware. Go to [http://www.mathworks.com](http://www.mathworks.com) and navigate to Products and Services -> Test & Measurement -> Supported Hardware for a list of manufacturers of hardware that they support. The National Instruments page at the Matlab site is: [http://www.mathworks.com/products/daq/supportedio14005.html](http://www.mathworks.com/products/daq/supportedio14005.html)

For a recent application, we used a National Instruments 32 channel Digital to Analog board with a PCI form factor. All of the code necessary to drive the analog board is supplied with the board and we used the LabVIEW development suite to generate the user interface. Once the user interface is written and compiled, the development suite is not needed and the display driver can be operated with only the runtime engine installed a personal computer. Small DA boards are available for use with laptop computers but typically they only have 16 channels of output.
Specifically, we used a National Instruments NI 6723-68 DAQ board. This board offers 32 channels of analog output and a variety counter/timers and digital I/O. Because of this board’s two high density connectors (68 pins per), cabling was difficult. Such high density connectors are designed for machine crimping flat ribbon cable. Factory made cables for this board have 68 signal wires, plus shielding, gathered into a relatively large and stiff bundle. This analog board has two 68 pin connectors with output and input lines distributed over both connectors thus requiring two such cables. In our application, we chose to manually crimp individual wires with the aid of a microscope. Using the high density connectors but manually crimping allowed the use of a single lightweight flexible ribbon cable with the exact numbers of wires needed. Interconnects are one of the least considered and most frustrating aspect of such driver system. When planning such systems, interconnects should be considered early on in the design process.

In a subsequent newsletter, we will cover an approach to connecting the driver to an LCD.

Details of this unit along with the software that we developed to run it, will be available in the next month on from our website under the “Publications and Tutorials” tab.

**LCI NEWS**

**Li secures research funding from AFOSR to develop light-driven chiral molecular motors and novel functionalized hybrid gold nanorods**
LCI Senior Research Fellow, Dr. Quan Li, has secured research funding from the Air Force Office of Scientific Research for two five-year projects. A $625,000 award will support a project on the development of light-driven chiral molecular motors and an additional $750,000 will support the development of novel functionalized hybrid gold nanorods.

**The Light-Driven Chiral Molecular Motors Project**
Dynamic control of molecules by light is an important area of modern nanoscience. The team will focus on synthesis and characterization of effective light-driven molecules that can be added to cholesteric liquid crystals to create optically tunable materials and devices.

**The Novel Functionalized Hybrid Gold Nanorods Project**
As compared to their spherical counterparts, metallic nanorods offer a number of new opportunities, ranging from materials science to biomedical applications. Assemblies of nanorods are considered as an attractive pathway to prepare optical metamaterials, i.e. artificially engineered materials with unusual optical properties and applications ranging from sub-wavelength imaging to cloaking. This project contributes greatly to the expansion of LCI research into the new areas.

**Fontana Awarded University Fellowship**
Jake Fontana, CPIP graduate student, has been awarded a University Fellowship for the academic year 2009-2010.

**Recent Events**

**KSU Spring 2009 Science Symposium**
The Center for Materials Informatics hosted a science symposium on May 13 in the Samsung Auditorium at the Liquid Crystal Institute. This interdisciplinary symposium focused on synthesis, processing, characterization and applications of materials. The symposium consisted of 8 invited talks,
with presentations from each of the participating science departments, programs, institutes, and centers. [http://cmi.kent.edu/events/may_13_2009/event.php?i=1](http://cmi.kent.edu/events/may_13_2009/event.php?i=1)

**Recent Publications**

Professor Jonathan Selinger and CPIP Student Lena Lopatina recently published "Theory of Ferroelectric Nanoparticles in Nematic Liquid Crystals," in Physical Review Letters, and it was selected by the journal as an "Editors' Suggestion." The abstract states: “Recent experiments have reported that ferroelectric nanoparticles have drastic effects on nematic liquid crystals—increasing the isotropic-nematic transition temperature by about 5 K, and greatly increasing the sensitivity to applied electric fields. To understand these effects, we develop a theory for the statistical mechanics of ferroelectric nanoparticles in liquid crystals. This theory predicts the enhancements of liquid-crystal properties, in good agreement with experiments. These predictions apply even when electrostatic interactions are partially screened by moderate concentrations of ions.” PRL 102, 197802 (2009)

**Recent LCI Seminar Videos Available**

(Note: To see video recordings of these presentations, go to the IPP web site: [http://www.lci.kent.edu/ipp/07/lciconnection.htm](http://www.lci.kent.edu/ipp/07/lciconnection.htm) and click on the “Access Videos” link and enter your login and password.)

- **April 29, 2009** - **Prof. Royce Zia**, Department of Physics, Virginia Tech University, "New Surprises in Driven Systems with Two Species"
- **April 22, 2009** - **Prof. Michael Hu**, Department of Marketing, Kent State University, "Artificial Neural Networks, Strategic Alliances and Consumer Research"
- **April 15, 2009** - **Prof. Hyuk Yu**, Department of Chemistry, University of Wisconsin - Madison, "Polymer Surface Functionalization and Endovascular MRI Applications"
- **April 13, 2009** - **Prof. Rajeswari Kasi**, Polymer Program, Institute of Materials Science & Chemistry Department, University of Connecticut, "Self-Assembling Polymers: Ordering on Multiple Length Scales"
- **April 6, 2009** - **Prof. Wim H. de Jeu**, Polymer Science & Engineering, University of Massachusetts, Amherst, "On the Subtleties of Smectic Layer Ordering"
- **March 30, 2009** - **Prof. Changhuei Yang**, Bioengineering and Electrical Engineering, California Institute of Technology, "Novel Optical Approaches for Biomedical Applications"

**Upcoming Events and Conferences**


The 5th International Liquid Crystal Elastomer Conference will be held at the Liquid Crystal Institute on September 24-26, 2009. [http://ilcec2009.lci.kent.edu](http://ilcec2009.lci.kent.edu)

**FACULTY PROFILE**

Deng-Ke Yang
Statement of Interest
My research interest is in liquid crystals and liquid crystal/polymer composites, particularly interested in developing liquid crystal electro-optical devices, investigating interaction between liquid crystal and polymer and exploring chiral liquid crystals.

Current Lab Activities
- Developing liquid crystal switchable goggles
- Developing liquid crystal switchable windows for privacy and energy flow control
- Developing cholesteric liquid crystal from biological materials
- Developing compensation films for large viewing angle LCDs

CV/website
- http://www.lci.kent.edu/PI/DkYang.htm

Research Interests
- Electro-optical liquid crystal devices
- Liquid crystal/polymer composites: physics and applications

Application interests
- Liquid crystal goggles
- Reflective liquid crystal display
- Flexible liquid crystal display
- Switchable window
- Large viewing angle liquid crystal display: compensation films and liquid crystal modes

Interests in potential industrial interactions
- Research / Development topics
  I would be glad to collaborate with industrials in the following areas:
    o Switchable liquid crystal goggle
    o Switchable liquid crystal light shutter and window
    o Reflective liquid crystal display
    o Flexible liquid crystal display
    o Modeling electro-optical properties of liquid crystal devices
    o Lab facilities of potential interest to IPP members.
    o My lab has capabilities for most aspects of the characterization of LC devices.
    o Topics that could address as consultant

Current Postdoctoral Fellow and Graduate Students
- Young-Cheol Yang (Postdoc.)
- Shawn Hurley
- Sarah Hicks
- Rafael Zola

Awards
Information Display Society Special Recognition Award
For pioneering work on polymer stabilized devices and reflective displays, 2005.
Information Display Society Fellow
For significant scientific and technological contributions to bistable, reflective cholesteric displays and to polymer-stabilized cholesteric devices, and for his outstanding contributions to education in the field of liquid crystal technology, 2007.

Recent publications

Books

Chapters in books

Papers

**Patents**


**Recent Short course and Talks**

7. July 13-18, 2006, JiaoTong University, Shanghai, China, 32 hours lecture, “Liquid crystal displays”
13. October 8, 2007, Beijing University of Science and Technology, “Polymer stabilized liquid crystals,” invited
17. February 27, 2008, Applied Materials, San Jose, Ca, “Reflective displays, liquid crystal reflective displays and cholesteric display”, invited.
18. March 12, 2008, Shanghai, China, China annual flat panel display conference, “Polymer stabilization and encapsulation in liquid crystal displays”, invited.
Sarah Hicks
Ph.D Candidate
Liquid Crystal Institute &
Chemical Physics Program
Kent State University
Kent, OH 44242-0001
(330) 990-6792
shicks@lci.kent.edu

Long Term Interests
Conduct research in liquid crystal/polymer composites and their use in display technology. Teaching physics at a university and aiding undergraduate and graduate students in their research in liquid crystals.

Current Research Projects
Detecting polarization freezing in nematic liquid crystal/polymer network systems. Polymer stabilized vertical alignment mode displays.

Interest in short term projects for a company
I am interested in collaborating with a company by characterizing novel materials. I am open to on-site as well as off-site internships.

Shawn Hurley
Ph.D Candidate
Liquid Crystal Institute &
Chemical Physics Program
Kent State University
Kent, OH 44242-0001
shurley@lci.kent.edu

Shawn is working for Dr. Yang on polymer stabilized liquid crystal displays and is in his 4th year of the CPIP program. His experience ranges the entire gamut from modeling, to fabrication, to characterization. He is a member of SPIE, SID, Sigma Xi and IEEE.

Rafael Zola
Ph.D Candidate
Liquid Crystal Institute &
Chemical Physics Program
Kent State University
Kent, OH 44242-0001
rzola@lci.kent.edu

Long Term Interests
I’m interested in developing knowledge from basic liquid crystal science until the applied results by this works. I’m interested in studying elastic properties as well as surface effects of liquid crystals. As my field of experience is theory, in particular analytical calculation, I would like to try analytical results in the laboratory, in particular if I could use computer simulations to improve my measured results. I also have interest in using and learning more about applications of liquid crystals such as the areas where polymer science is involved. Other fields of interest are adsorption-desorption of particles and memory effect, anchoring effects in liquid crystals and mathematical problems for the liquid crystalline area.

Current Research Projects
At this moment, I’m working with defects in cholesteric liquid crystals and “natural” chiral dopant. For the defects research, I’m interested in studying the propagation and the reasons for the formation of defects, in particular the Oily Streaks defects. The thermal annealing process is one of my main focus, due to the many variables involved and a possibility of surface effects due to this kind of treatment. Further, I’m also interested in other methods for getting rid of these defects and I’m currently doing some Monte Carlo simulation about these defects. For the “natural” chiral dopant, I’m studying chiral molecules that can be used in the liquid crystal field, since they can reduce costs a lot once these new dopant might cost even 1000 times less than the well known chiral dopants. Also, I am interested in the main change made by these elements, such as response time, viscosity, etc., for cholesteric phases, TN’s and STN’s.