CLEANROOM NEWS

Process Spotlight: Introduction to Vacuum Deposition Technologies: Physical Vapor Deposition
Deposition techniques requiring moderate to high vacuum levels are commonly used for thin film deposition in the display industry. Thin film transistors are deposited exclusively with vacuum methods (other than some recent research into organic TFTs), and ITO or metal electrodes are similarly deposited. Deposition techniques can be generically described as physical vapor deposition (evaporation, sputtering) or chemical deposition (CVD, ALD). Physical methods rely on phase transitions and collisions, but do not generally change the composition of materials, whereas chemical methods typically involve chemical reactions in the gas phase or at surfaces.

Deposition by evaporation is the simplest of the physical vapor deposition methods. A material is heated to its melting point under high vacuum, and the evaporated molecules travel to and are then adsorbed onto the surface of the substrate, gradually growing a thin film. There are two primary methods to heat the material being evaporated: thermal, in which a large current is passed through the material to evaporate it, and e-beam, where a focused electron beam is directed at the material to heat to evaporation. Evaporation techniques require high vacuum (typically 10^-6 torr range) in order that the mean free path in the chamber is large. This makes evaporation a “line of sight” process, with films good for patterning by lift-off processes. However, evaporation is a low energy process (since the evaporated molecules have little kinetic energy), and leads to lower density films. E-beam evaporation is commonly used for metals (Al, Cr, Ni, etc.) or insulators (SiO2, Al2O3), whereas thermal is used in displays for SiOx alignment layers (more on this in a future Process Notes).

Sputter coating is the other main class of physical vapor deposition (we will not discuss techniques such as pulsed laser ablation, since they are not commonly used in the display industry). In its most common form, magnetron sputtering, a plasma is formed from a noble gas (typically argon), and a set of magnets is used to accelerate the ions toward the “target” material, which is the material to be deposited. The high energy ions knock molecules free from the target material surface, and these molecules are directed toward the glass substrate. Although chambers are pumped to 10^-6 range high vacuum initially, the gas introduced for plasma raises pressures to millitorr ranges. This means short mean free paths for target molecules, which encounter multiple collisions before reaching the substrate surface. This makes sputtering less directional than evaporation, giving good step coverage on multilayer coatings. The low temperatures necessary for sputtering make it a good technique to deposit mixtures or alloys that might otherwise disassociate with temperature. Power supplies for sputtering can use DC or RF power—DC is useful for conductors, but insulators like SiO2 must be deposited with RF power (ITO is a special case, and is usually deposited using pulsed DC power). In some instances, it is useful to add other gases to the chamber for reactive sputtering, which can be used, for instance, to deposit an oxide film from a metal target.
In LCDs, sputtering is used to deposit ITO, as well as some metals and insulators in thin film transistors.

The LCI has several tools available for physical vapor deposition. The **Kurt Lesker Thermal Evaporator** system is dedicated primarily to thermal evaporation of SiOx layers for liquid crystal alignment. The **GenVac SC1 Coater** is an e-beam evaporator for large substrates (up to 24”), and is also equipped with an oxygen ion gun for ITO deposition. The **MRC 603III Sputter Coater** is capable of RF or DC sputtering, and is currently configured for SiO2 and Ni coatings.

Please feel free to forward any suggestions for future “Process Notes” topics. If you are interested in learning more about our capabilities, or reserving time in the facility, please contact Doug Bryant.

A few useful physical vapor deposition links:
http://www.cerac.com/ (materials supplier, also has “Tech notes” section)
http://vtmag.com/ (Vacuum Technology and Coating, a trade magazine)

Books:
**Thin-Film Deposition: Principles and Practice**, Donald Smith, 1995
**Handbook of Thin Film Deposition Techniques**, Krishna Seshan, 2001

**Equipment Update**
The AZLCD vacuum bagger is currently under repair due to a crack in the chamber. Repairs are expected to be complete by the end of August.

Representatives from Oxford Systems will visit the LCI in September to complete installation and training on the reactive ion etcher system. The date is not yet firmly scheduled. Any IPP members interested in taking part in this training should contact Doug Bryant.

**Surplus/Under-utilized Equipment**
As with any laboratory environment, the LCDRF is continually bringing equipment in and out of service based upon the needs of its users. As a result, there are a number of pieces of equipment being stored, that are not in immediate need. If you have need for any of these tools, please contact us.
http://www.lci.kent.edu/usedequipment/thumbnails.htm

**Cleanroom Fall Schedule and Staffing**
Two new undergraduate students are being hired to help with cleanroom operations. They will primarily help with routine cleaning and supplies, which will help to free up more of Doug’s time for training and prototyping.

With the arrival of a new group of graduate students in Chemical Physics, Doug will again be scheduling formal training sessions on cleanroom access and safety for the month of September. Due to process training, it is likely that the cleanroom will be unavailable for several half-days in late September. Users will be alerted to specific dates when they are scheduled. In addition, a one to two day shutdown will occur in late September or early October for in depth cleaning, and equipment movement.

**LCI News**

**LC Day set for October 12, 2007**
On October 12, the LCI will host the third Liquid Crystal Day which is sure to bring excitement to the liquid crystal field, showcasing the many achievements of local students and industrial partners. We are in the final planning stages, but as of today, invited speakers include Dave Walba, University of Colorado; Jim Yuan, CoAdna Photonics; and Mary Neubert, Emeritus Senior Research Fellow, LCI. The event will
be held from 9am – 5pm in the Liquid Crystal and Materials Sciences Building, Samsung Auditorium. To find out more, please visit: www.lcd.kent.edu. If you would like to sponsor this event, please contact Jim Maxwell at 330-672-7770, Maxwell@lel.kent.edu. An industrial exhibition will be held that afternoon and we would like to see your company’s exhibit.

**Palermo Defends Master Thesis**

**New CPIP Students for Fall 2007:**

- **Volodymyr Borsch**, Kyiv National Shevchenko University, Ukraine
- **Nicholas Diorio**, The Ohio State University
- **Wilder Iglesias**, University of Carabobo, Venezuela
- **Jun Geng**, University of Science & Technology, Beijing, China
- **Vianney Gimenez**, University of Carabobo, Venezuela
- **Liwei Li**, Nankai University, China
- **Lu Lu**, Wuhan University of Technology, China
- **Rafael Zola**, State University of Maringá, Brazil

**Fall 2007 Seminars**

**Sept. 12:** Christopher Gorman, Department of Chemistry, North Carolina State University: Dendrimers and Patterned Surfaces: *Electron Transfer 'to' and 'through' for Molecular Electronics*

**Oct. 3:** Randall D. Kamien, Department of Physics, Univ. Pennsylvania: *On the Stability of Large Angle Grain Boundaries*

**Oct. 10:** Lorenzo Marrucci, The National Institute for Nuclear Physics, Naples: *T.B.A.*

**Oct. 31:** Ting Zhu, Department of Mechanical Engineering, Georgia Institute of Technology: *Modeling Hyperelastic Crystals*

**Dec. 12:** L. Jay Guo, Univ. Michigan: *Nanoimprint technology and its application in polymer based photonic devices*