CNST Center for Nanoscale Science & Technology

NanoFab News

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We are pleased to distribute the *NanoFab News* for current and potential users of the NanoFab at the NIST Center for Nanoscale Science and Technology (CNST). This quarterly newsletter is intended to keep users up to date on our fabrication process development, tool installations, safety and access policies, and other notable news. This newsletter is for you, so if you have suggestions for improving it, please let us know via email.

Tool News

The CNST's Newest E-beam Lithography Tool - Now Operational!

After several months of specification trials and testing, the CNST's second state-of-the-art electron beam lithography system is now fully online and available for customer use. The JEOL JBX-6300FX, first delivered in mid-January 2009, is located in building 216 immediately outside the NanoFab cleanroom. The JEOL's beam deflection unit employs a 19-bit DAC unit for accuracy, scans and writes at 12 MHz speeds, and can operate with beam voltages of 25, 50, and 100 kV and a 2-nm minimum spot size. The new system supplements the CNST NanoFab's first e-beam nanolithography tool, a Vistec VB300 located in the cleanroom, which scans and writes at 50 MHz at 50 to 100 kV. Both units can write to better than 25 nm stitching and overlay accuracy. The two systems are cornerstones of the NanoFab's nanolithography capabilities, complementing the laser pattern generator, nanoimprint lithography tool, and dual-beam focused ion beam system.

Oxford ALD/RIE Systems Coming Online Soon

The NanoFab team reports it is doing the last few tasks to get our new cleanroom-based Oxford FlexAL atomic layer deposition and Plasmalab 100 reactive ion etch systems online. Technician Bill Young reports the installation team has completed most of the plumbing and electrical work necessary to bring the three machines online, and he expects to begin vendor acceptance trial work in mid-September. Simultaneously, Lei Chen is developing a number of new processes to take advantage of the new systems' capabilities, all of which are the product of participant surveys collected at past NanoFab meetings. All three machines should be available for use in early October.

24/7 Access to Many NanoFab Resources/Out of Hours Access

The NanoFab is experiencing tremendous growth - both in the number of participants and in the number of hours each tool is used. For example, the dual beam FIB is seeing a large increase in hourly use, and advance bookings are becoming more difficult. For your convenience, the NanoFab allows 24/7 access to any tool outside the cleanroom, especially those in building 216 (subject to NIST site access restrictions). These tools include the new JEOL e-beam, the dual beam FIB/SEM system, and the wide-field microscope, the wire bonder, and wafer dicing saw in the sub-Fab. In addition, those with access to NIST during off hours may access the cleanroom 24/7 with the NanoFab Manager's approval. (The buddy system is mandatory at all times!)

Miscellaneous Tool Notes

The NanoFab has arranged for regular maintenance for its optical microscopes. Electronic MSDS sheets will soon be available at most of the computer work stations in the Nanofab with the NIST-wide installation of the CISPro (Chemical Inventory Software) package. The thermal evaporator is being converted to an e-beam evaporator, so a second e-beam evaporator will soon be online. The cleanroom's Heidelberg laser patter generator now has a 4 mm write head that will allow for shorter write times for geometries one micrometer and larger; the 2 mm write head is still available for higher resolution writing.

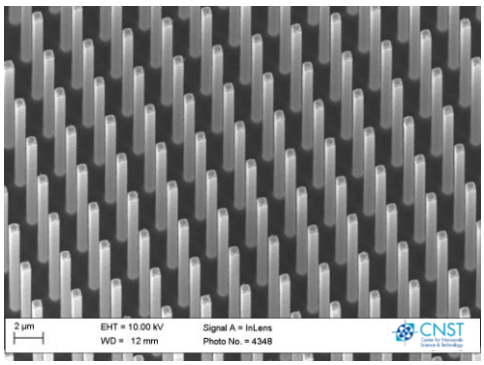
Processes and Process Development

Thin Film Processes with Stress Level Characterization

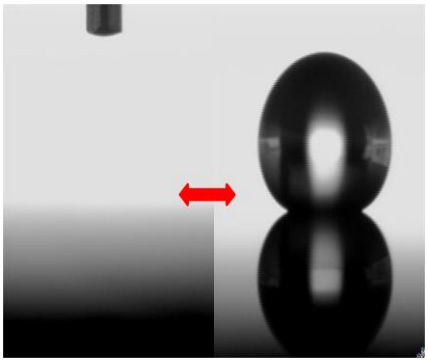
The NanoFab staff has completed work on building a comprehensive list of more than 30 thin films, including metals, oxides, and nitrides, all of which were characterized for stress level using our Flexus wafer curvature analyzer. Our staff deposited the films via electron beam evaporation, sputtering, LPCVD, and PECVD using standard recipes and a common thickness of 100 nm for consistency. The data is available next to the respective tools in the cleanroom. Controlling and/or minimizing the stress in a film is important to ensure proper adhesion to the substrate during subsequent process steps (such as lift-off); it becomes especially crucial when the substrate is very thin, such as a membrane or a cantilever where buckling or tearing may occur otherwise. For additional information, contact Gerard Henein.

NanoFab Process Engineers Marc Cangemi and Gerard Henein with thin film nitride membranes. (Holmes/NIST)

High Aspect Ratio Etching



The NanoFab staff has also developed a series of new processes involving high aspect ratio etching for a wide variety of applications, including electromechanical, biotech, and filtering devices. The new processes reduce the sidewall scallop size in "Bosch" deep Si etching, which can be used to make high aspect ratio Si structures with sub-micron features. Used in concert with the NanoFab's deep Si etcher, the technique is ideal for making MEMS/NEMS and microfluidic devices. In one of the initial research applications using deep silicon etching, NanoFab Process Engineer Lei Chen worked with a group from Massachusetts General Hospital to create a high aspect ratio Si pillar array inside a microfluidic channel for separating different particles by size.



Hydrophobicity

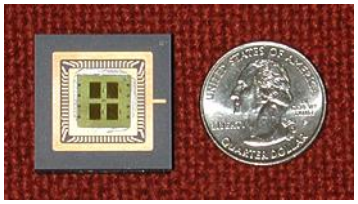
A novel plasma-based surface modification technique has been developed by the NanoFab staff with a variety of industrial applications. The approach, recently presented at the Nanotech 2009 Conference in Houston, allows scientists to easily switch between super-hydrophobic and super-hydrophilic surfaces over large areas by simply changing the plasma chemistry. Using a stencil mask to selectively modify areas on the surface with different gases, a hydrophilic array can be created on a super-hydrophobic surface. Some of the potential applications include coatings on marine vessels, contact lenses, cooking appliances, and biomimetics. For additional information, contact Lei Chen.

Recognition

NanoFab News, Broadcast Style

The Associated Press sent a crew to Gaithersburg in early July to produce a television news story on the annual International RoboCup Games, which NIST organizes with the RoboCup Federation, an international organization dedicated to fostering innovations and advances in artificial intelligence and intelligent robotics. Craig McGray from NIST's Electronics and Electrical Engineering Laboratory was featured on camera explaining how the groundbreaking 'Robosoccer' competition works - nanobots are operated by remote control and move in response to changing magnetic fields or electrical

signals transmitted across the micrometer-sized arena. The 2009 demonstration consisted of two qualifier events and one competition event: the two-millimeter dash in which nanobots seek fast times for a goal-to-goal sprint across the playing field; a slalom course where the path between goals is blocked by polymer post "defenders," and a final ball handling "shootout" exercise that requires robots to move "nanoballs" into the goal. The television crew visited the NanoFab to watch staff members create the Si wafer-based soccer field (right) the games use in the competition. To see Craig and various members of the CNST NanoFab staff in the short video, click here. (Please note this is an external Associated Press video site and not connected to NIST.)



Student Profile

A Summer of SURFing in the NanoFab

If not for one professor's persistence and eye for talent, NIST probably would have welcomed one less Summer Undergraduate Research Fellowship (SURF) student to campus this summer, and the world, one less physicist. You see, Aaron Cochran didn't start out with a passion for physics or nanotechnology.

The CNST's ten SURF students, with Aaron Cochran, center, in brown. (Holmes/NIST)

"I originally went to school in 2000, and I didn't know what I wanted to do," said Cochran. "I started out as a psychology major, and I did that for three years."

And then, somewhat demoralized, he walked away.

"After a while, the head of our chemistry department talked to me, and I found out we had a nanotechnology program starting, so I went back," explained Cochran. "I've always been interested in science, and it's a small technical school." Cochran, now a physics major, has spent the last few semesters working as a electron microscope technician at the University of Wisconsin-Stout.

One thing led to another, and Cochran found himself at NIST in June as a Summer Undergraduate Research Fellow.

"I'm figuring out how effectively low energy plasma, in the 50 eV range, cleans thin film samples, specifically cobalt palladium thin films," said Cochran, "because they have out of plane magnetization, which in terms of recording on hard drives and whatnot, will allow a lot more density, a lot more bits per square inch."

Cochran went to work in the CNST's SEMPA (Scanning Electron Microscope with Polarization Analysis) laboratory under staffer John Unguris, but he also spent about 40% of his 11-week study in the NanoFab cleanroom. "It's a tremendous resource," said Cochran. "In part, because of the equipment, but especially the minds at work there."

That exposure seems to be going somewhere big. UW-Stout is preparing to open its own class 1000 cleanroom sometime in the next year. Because of his NIST experience, Cochran is a candidate to manage the facility.

"It's still up in the air right now, but at this point, I would be the most qualified undergraduate, at least in my opinion, and I've started discussing it with my professors," said the young student. It's a prime example of how

NIST's SURF program not only leads students to an academic career in science, but also provides them with real-world experience they can apply to getting ahead in nanotechnology.

"I've been in other summer programs," said Cochran, "and not to diminish them in any way, this is the best."

Cochran plans to continue his education to earn a Ph.D. in either nanoscale physics or materials science — whichever will give him more time and access to a cleanroom like the CNST's.

The CNST welcomed ten SURF students for 11 weeks this summer. All ten visited the NanoFab to perform experiments related to their assignments, along with three other SURF students from other NIST Laboratories.

Safety Notes

As always, working safely is of paramount importance in the NanoFab and the staff is always looking for ways to improve safety. We have a couple reminders for you this quarter:

- Do not store chemicals in your personal storage bin. Place them in a chemical cabinet, properly labeled.
- Wear the right size nitrile gloves, all sizes are available. If you need to turn them inside out to get them off, they are too small. We throw away gloves that are found inside out.

Outreach Campaign

The NanoFab's outreach campaign has exhibited at nine venues to date, and has additionally provided literature at NIST booths in five other venues. Visit us at the following upcoming conferences:

September	8-11	NanoBusiness Alliance	Chicago
September	8-11	Society for the Study of Nanoscience and Emerging Tech.	Seattle
September	21-23	MicroNano Breakthrough Conference	Portland
October	22-25	American Society for Nanomedicine	Potomac, MD
November	8-13	AVS-56 International Symposium and Exhibition	San Jose
November	30-Dec. 4	Materials Research Society	Boston

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