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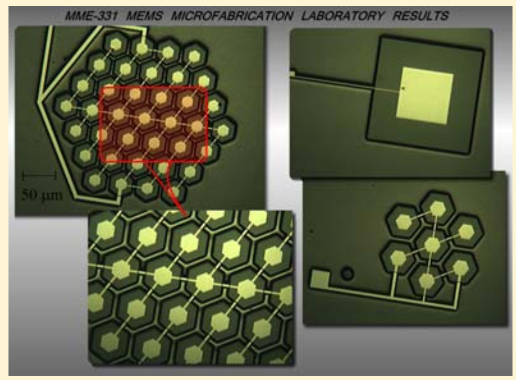
Nanotechnology News from the University of Minnesota

Summer 2009

National Nanotechnology Infrastructure Network Featured User

As a member of the NNIN network, the Nanofabrication Center (NFC) has a charge to provide facilities access to both internal and external users. This year St. Cloud State University dedicated a portion of their MME-331 Engineering Materials Processing II course to microfabrication for the first time. As part of the new curriculum, two 3.5 hour laboratory sessions were prepared to show students the basic processes for MEMS microfabrication. These sessions were conducted in the NFC of the University of Minnesota in April. The introductory level microfabrication laboratory sessions involved all of the key processes in microfabrication including photolithography, thin-film dielectric deposition, thin-film metallization, wet and dry plasma etching and deep reactive ion etching (DRIE) of silicon. An efficient timeline was created to allow these tasks to be accomplished in just two visits. Six SCSU undergraduate students majoring in the Mechanical and Manufacturing Engineering Department and two faculty members (Dr. Kenneth Miller and Dr. Jay Byun) were present during the sessions. The sessions were instructed by Dr. A. Serdar Sezen. Before the sessions began, a tour of the NFC was given and the basic operation of a cleanroom was described to the students. The experiments started with a blank silicon wafer, the basic element in microfabrication and in the end a 3-dimensional array of microfabricated hexagonal pillars with top metalized regions were successfully fabricated. The students were then given a tour of the Advanced Controls and Microsensors Laboratory (ACML) at the University of Minnesota (access provided by Dr. Rajesh Rajamani) where the MEMS transducers fabricated by using similar methods have been shown in operation.



The experience proved an extremely effective way to introduce microfabrication to students. Despite the rather long drive and long laboratory sessions, students showed appreciation for being able to see firsthand a real cleanroom environment and all the basic equipment and manufacturing methods for MEMS microfabrication and utilizing these to create a microstructure.

Reminder: If your work uses the Nanofabrication Center please add the following in the acknowledgements section of any publication: “Parts of this work were carried out in the University of Minnesota Nanofabrication Center which receives partial support from NSF through the NNIN program.”

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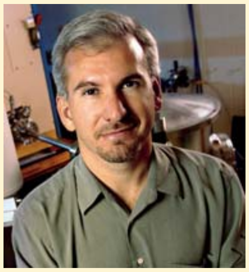
CHARACTERIZATION FACILITY NEWS

CHARFAC DIRECTOR'S MESSAGE



CharFac Director, Greg Haugstad

New funding for instrumentation and newly installed systems are among recent developments in the charfac.

A grant-in-aid has been awarded to fund the purchase of a micro-contact angle meter. Contact angle is the angle at which a liquid/vapor interface meets a solid surface. It relates to the interface/surface tensions between liquid and solid (surrounded by vapor). Measuring the contact angle of a water droplet on a given surface has many practical uses, such as a quick and easy way to evaluate cleanness or assess the wettability of solid surfaces. It is also used in research on adhesion and repellency. The advancement of micro-electro-mechanical systems (MEMS) often requires contact angle measurements at much smaller scales, thus using water droplets less than 0.01 µL in volume and a few microns in size. The MCA-3 system to be purchased from Kyowa Interface Science enables microscale positioning and viewing of microdroplets and continuous image capturing from the moment the droplet adheres to the surface. The capability is also attractive to examine microscale biomedical devices such as the struts of stents. Given the small size of the droplet, evaporation can occur over a short time frame to further

(continued, top right)

examine contact angle hysteresis, which is sensitive to surface molecular mobility.

Several monetary contributions from PI's, deans and other sources have enabled the purchase of a new temperature- and humidity-controlled X-ray powder diffractometer. We hope to have this system operational by mid to late summer. The Bruker D8 system to be purchased has the following specs:

- Two circle goniometer: theta / 2 theta reproducibility to +- 0.0001 degree
- Rotating reflection sample stage
- Detector: compound silicon strip detector (much faster than point detectors; count rate of 10^8 cps max, energy resolution 25%, spatial resolution 75 micron)
- Heating/cooling stage: TTK 450, -170 to 450 C (to 1200 C with attachment)
- Temperature/humidity controller (simultaneous programmatic control)

New WinXP data acquisition computers have been installed on scanning probe microscope stations 1-2. Compared to the 10-year old systems replaced, these computers allow for faster data processing and network transfer, USB file transfer, and higher data density in special acquisition routines like force volume. For example the ability to collect force measurements throughout a 64 x 64 x 512 data cube (in X-Y-Z) provides improved lateral resolution while at the same time allowing finer resolution of distance dependent forces, compared to the old systems. Custom software developed in-house can be used for post processing these large data sets, for example to produce histograms of stiffness or tip-sample adhesion measurements over 4096 locations.

Special data collection software was recently installed on the F30 cryo FEG TEM in Nils Hasselmo Hall. It features automatic tracking and focusing for use in 3D reconstruction maps. This enables efficient electron tomography (ET) data collection. ET has become a powerful tool for studying the structures of non-uniform biological specimens including cells and viruses, and generally macromolecular complexes. The 3D maps are computed from a series of TEM images recorded within ±70-degree tilt-angles.

The CharFac home page has begun to highlight recent journal publications that use some of the newer CharFac instrumentation, such as the cryo FEG TEM, or newsworthy applications of older instrumentation. Please contact me if you would like to see a particular paper highlighted on our home page.

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Greg Haugstad, Director

NANOFABRICATION CENTER NEWS

NFC DIRECTOR'S MESSAGE

NFC Director,
Steve Campbell

Over the spring I polled NFC faculty users of the types of equipment that would be most helpful to research activities. There was a broad response. After removing suggestions for characterization equipment that is outside our charter and systems primarily used by individual faculty groups, a short list developed. One clear need is a state of the art electron beam lithography tool. I am pursuing this and hope to have more information later. The second most common request was for better optical lithography. I also found that many of the leading schools provide optical steppers for their users. We were able to locate, test, and purchase a used Canon i3-2500 i-line stepper for the lab using National Nanotechnology Infrastructure Network (NNIN) funds. This 4" system is capable of 400 nm lines and spaces with overlay accuracy of about 150 nm. Furthermore, our current mask making system will be able to make the Canon reticles since the new system is a reduction stepper. We expect the system to ship in June with set up in July. Training will follow soon after.

THIN FILM DEPOSITION TECHNIQUES

An important aspect of many micro- and nanofabrication processing sequences is the deposition of thin films. The films may be conductors, insulators, semiconductors or magnetic materials. At the Nanofabrication Center we have several different process tools for deposition of a wide variety of thin films using the techniques of evaporation and sputtering. We currently have 3 different electron beam evaporation systems in our facility. Two of these evaporators, the CHA system and the Temescal system, are inside the cleanroom. The CHA is a newer tool with complete automation capability, a six pocket gun, fixturing for both planetary and lift-off deposition, and heated deposition capability. The Temescal is an older, manual operation system with a four pocket gun and lift-off fixturing. Both systems can support four to six inch wafers and smaller. Commonly deposited films include Cr, Ti, Ni, Al, Au, Pt, Pd, Ag, Mo, Cu, and Ge. NFC sputtering capabilities are centered around the AJA International system. This tool has both RF and DC guns (2 each), load lock loading, single wafer deposition up to 8 inch diameter, and heated deposition. Common materials include Al, Al_2O_3, Au, Cr, Cu, Ge, ITO, Ni, SiO_2, Ta, Ti and W. If thin film deposition is needed for your project, consider having the work done at NFC on these excellent systems.

The Nanofabrication Center's
AJA Sputter System

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Steve Campbell, Director
Greg Cibuzar, Lab Manager

SAFETY TRAINING

NFC is offering safety training for new users twice each month. On the first Thursday of every month, the training sessions begin at 1:00PM, and on the third Thursday of the month sessions begin at 10:00AM. The training includes watching our safety video and taking a brief quiz. Also, a NFC staff member provides a tour showing some of the safety related equipment and the gowning process used for the NFC cleanroom. Finally, there is training on using the Coral lab software. The safety training takes about two hours to complete, and must be done before users will be granted access to NFC facilities.

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Comments and suggestions are welcome! Would you like to be added to or removed from our distribution?
Contact: Becky von Dissen at vondi001@umn.edu or 612-625-3069

Center for Nanostructure Applications

The primary mission of the Center for Nanostructure Applications is to seed interdisciplinary nano research projects that will go on to attract external support. Active nanostructures include applications of nano as diverse as energy conservation and production, large area displays and lighting, printed electronics, smart fabrics, electronic noses, drug delivery, cancer therapy, and new types of medical imaging.

These applications often require significant participation across traditional disciplines and the Center is designed to foster the cross-disciplinary research necessary to bolster the nano applications area at the University.

The Center also organizes workshops, speaker series, and short courses, as well as serving as a focal point for nano at the University.

For more information, visit http://www.nano.umn.edu/

The National Nanotechnology Infrastructure Network

The National Nanotechnology Infrastructure Network (NNIN) is an integrated networked partnership of user facilities, supported by the National Science Foundation, serving the needs of nanoscale science, engineering and technology. The mission of the NNIN is to enable rapid advancements at the nano-scale by efficient access to nanotechnology infrastructure. The NNIN supports the Nanofabrication Center at the University of Minnesota. As a node in NSF's National Nanotechnology Infrastructure Network (NNIN), the NFC provides access to advanced multi-user facilities to both industry and academic researchers, the latter at a subsidized rate.

For more information, visit www.nnin.org