CORNELL

NanoMeter

The Newsletter of Cornell NanoScale Science & Technology Facility

Volume 15 March 2004 Number 1

Director's Column

The year 2003 ended with many major accomplishments for CNF.

In November, our physical move from our prior space to Duffield Hall was completed and we started functioning exclusively in our new space. And in December, we heard of our success in the NSF infrastructure competition that assures a continuing and vibrant CNF for the coming years. The support we received from our users, the Cornell administration, and the hard work of our staff was vital in these successes. Coming years will be exciting years for science and technology at nanoscale at Cornell because of the capabilities, the ideas, and the interactions that CNF provides and catalyzes.

Our new laboratory has started providing a major upgrading in the resources—a nearly $35M in toolset improvements over the previous space. Users, whether of electron beam lithography, or of silicon-related materials growths and depositions, or pattern transfers, or new chemistry- or biology-based techniques, or advanced characterization, should see these benefits in their work.

I wish everybody a fruitful year.

Sandip Tiwari
Lester B. Knight Director of CNF

Cornell to Lead NNIN Consortium

NSF creates National Nanotechnology Infrastructure Network, forming coast-to-coast, shared open laboratory

The National Science Foundation (NSF) has designated a 13-member national consortium as the National Nanotechnology Infrastructure Network (NNIN), creating the world's largest and most accessible nanoscale laboratory.

The consortium will enable university students and researchers, as well as scientists from corporate and government laboratories, to have open access to resources they need for studying molecular and higher length-scale materials and processes, and applying them in a variety of structures, devices and systems.

Named to lead NNIN is Sandip Tiwari, director of the NSF-funded Cornell NanoScale Facility (CNF), a national user facility on Cornell campus. NSF funding to the new network is expected to be $70 million or higher for five years, beginning in January 2004, with the possibility of a five-year renewal.

Other consortium members who will share their specialized facilities are Georgia Institute of Technology, Harvard University, Howard University, Pennsylvania State University, Stanford University, Triangle National Lithographic Center (operated by North Carolina State University and University of North Carolina), University of California at Santa Barbara, University of Michigan, University of Minnesota,

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University of New Mexico, University of Texas at Austin and University of Washington, Seattle.

Nanoscale and nanotechnology refer to work on small-size systems approaching the molecular level.

NSF Engineering Advisor Lawrence Goldberg says the new network is a significant expansion of the capabilities of the decade-old, five-university National Nanofabrication Users Network (NNUN), which it replaces. "NNIN will implement, on a national scale, innovation in education that will impact all levels from professional through K-12, include outreach efforts to non-traditional users, reach underrepresented groups, and disseminate knowledge to the wider technical community and public. It will also develop the intellectual and institutional capacity needed to examine and address societal and ethical implications of nanotechnology," he says.

Tiwari, an ECE professor at Cornell, notes, "By assembling and offering to share our specialized resources with any and all qualified users, we have created the world's largest, most comprehensive and accessible laboratory for research and development at extremely small dimen-sions. Networking America's very best talent and tools for research, development and training will ensure this nation's leadership in nanotechnology for the future."

Stanford Nanofabrication Facility Director Yoshio Nishi, a professor of electrical engineering, says the user network, "together with Stanford Nanocharacterization Facility, will provide strong resources across a broad range of disciplines in nanotechnology: in fabrication, robust and reproducible synthesis, characterization, and prototyping of complex nanostructures, devices and systems."

At Georgia Tech, James Meindl, director of the institute's Microelectronics Research Center, says educational outreach to college undergraduates—and even to K-12 students—is an important part of the new network. Among the resources Georgia Tech will be sharing nationwide, Meindl says, is a $4 million electron beam nanolithography system to etch patterns at the nanoscale. "This critical tool, which is funded by the Georgia Research Alliance, and our specially trained staff will facilitate advances in bioelectronics, nanotechnology and advanced microelectronics."

Venkatesh Narayanamurti, dean of the Division of Engineering and Applied Sciences and dean of physical sciences at Harvard, says the network "provides users across the nation with access to leading-edge fabrication and characterization tools and instruments in support of nanoscale science and engineering research and education." Pledging full access to the Center for Imaging and Mesoscale Structures at Harvard, Narayanamurti notes that Harvard's specific responsibilities in the network include: soft lithography and assembly of nanoparticle and molecular electronics, theoretical simulations of electron states and transport in nanoscale systems, and the establishment of core computational resources to assist users in understanding and visualizing new device structures.

Social and ethical issues raised by nanotechnology cover "an incredible range," according to Bruce Lewenstein, an associate professor of science communication at Cornell. "They range from the ethical implications of doing research on human enhancement to the privacy implications of having tiny and very powerful computers widely accessible."

Lewenstein and other researchers of social and ethical issues plan to examine, for example, the effects on the workforce of changes in manufacturing processes that nanotechnology will bring, as well as the complications of intellectual property ownership when new ideas are built with government money at academic institutions and then are developed by industry. "Our goal," Lewenstein says, "is to build the capacity of NNIN users, as well as students and others throughout the country, to deal with these issues in informed and critical ways."

Cornell Vice Provost for Research Robert C. Richardson says the new network builds on the pioneering success of NNUN. "The new network will greatly expand the open-facilities culture to new geographic regions and to new research disciplines," Richardson predicts. Opening resources of the 13 consortium members, he says, "will meet new experimental and computational needs and will accommodate a much broader set of under-served researchers and students nationwide."

Among the Cornell-based facilities participating in NNIN, besides CNF, are three NSF-funded facilities: the Cornell Center for Materials Research, the Center for Nanoscale Systems (CNS) and the Nanobiotechnology Center.

Cornell's Robert Buhrman, director of CNS and the John Edson Sweet Professor of Engineering, recounts the university's tradition of open access to specialized resources: "Beginning with the National Submicron Facility that NSF established at Cornell in 1977, and which has evolved so very successfully into what is now the Cornell Nanoscale Facility, Cornell and its partnering institutions have been at the forefront in enabling research and education in nanoscale science and engineering." He adds, "New and expanded capabilities, such as nano-imprinting and molecular assembly, will now be available to researchers in this exciting nanotechnology infrastructure network, and will definitely have a major impact on revolutionary nanoscale solutions to meet the needs of future information technologies."

Noting the need for discovery-driven research at a time when most industry research is mission- and profit-oriented, and the need for finding a balance, Tiwari observes, "In the experimental science and engineering research at the nano- and micro-scale, exciting interdisciplinary research depends on sharing the diverse resources, techniques, tools and knowledge from various disciplines and institutions so that researchers can follow their own interests. This network brings together these resources for the overall good of the nation and is critical to the success of research in this new environment."

Roger Segelken
Cornell News Service

A New Cornell 'NanoGuitar,'

played by a laser, offers promise of applications in electronics and sensing

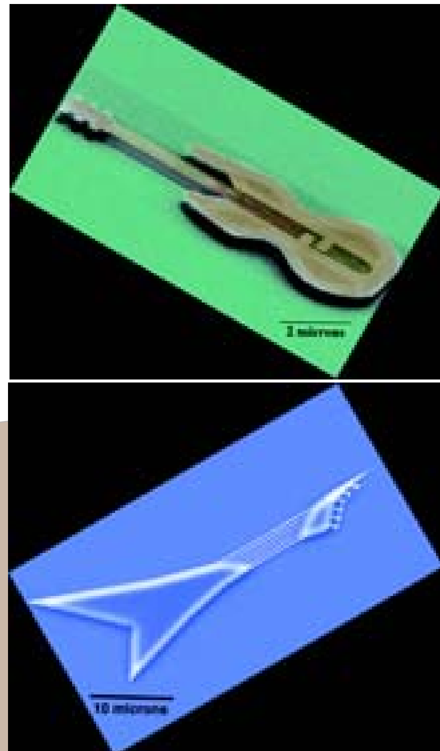
Six years ago Cornell University researchers built the world's smallest guitar—about the size of a red blood cell—to demonstrate the possibility of manufacturing tiny mechanical devices using techniques originally designed for building microelectronic circuits.

Now, by "playing" a new, streamlined nanoguitar, Cornell physicists are demonstrating how such devices could substitute for electronic circuit components to make circuits smaller, cheaper and more energy-efficient.

Lidija Sekaric, who built the new, playable nanoguitar while an Applied Physics graduate student at Cornell, described the project, along with other materials and device research in nanoelectromechanical systems (NEMS), at the 50th International Symposium and Exhibition of the American Vacuum Society, November 2 to 7, 2003, in Baltimore, MD. At the same meeting Harold Craighead, professor of applied and engineering physics at Cornell, presented a plenary talk reviewing the uses of NEMS in biology. Sekaric worked in the Craighead Research Group, as part of the Cornell Center for Materials Research study of NEMS systems.

NEMS usually refers to devices about two orders of magnitude smaller than MEMS (microelectromechanical systems). Craighead prefers to define NEMS as devices in which the small size is essential for the job, such as those that respond to very small forces or biosensors so small that they can measure the mass of a single bacterium.

Sekaric, now a researcher at IBM's Watson Research Center in Yorktown Heights, NY, worked with Cornell graduate student Keith Aubin and undergraduate researcher Jingqing Huang on the new nanoguitar, which is about five times larger than the original, but still so small that its shape can only be seen in a microscope. Its strings are really silicon bars, 150 by 200 nanometers in cross-section and ranging from 6 to 12 micrometers in length (a micrometer is one-millionth of a meter; a nanometer is a billionth of a meter—the length of three silicon atoms in a row). The strings vibrate at frequencies 17 octaves higher than those of a real guitar, or about 130,000 times higher.



The original nanoguitar (top) was made to resemble a Fender Stratocaster. The new, "playable" version is modeled on the Gibson Flying V. Both were made by electron beam lithography, which can create far smaller shapes than earlier methods, at the Cornell Nanoscale Facility. (Although both are shown at about the same size here, the playable guitar is actually about five times larger than the original.) Craighead Group Copyright © Cornell University

The researchers recently observed that light from a laser could cause properly designed small devices to oscillate, and this effect underlies the nanoguitar design. The nanoguitar is played by hitting the strings with a focused laser beam. When the strings vibrate they create interference patterns in the light reflected back, which can be detected and electronically converted down to audible notes. The device can play only simple tones, although chords can be played by activating more than one string at a time. The pitches of the strings are determined by their length, not by their tension as in a normal guitar, but the group has "tuned" the resonances in similar devices by applying a DC voltage.

"The generations of researchers to come can aim to play more complex pieces," says Sekaric. "This goal would indeed improve the science and technology of NEMS by aiming for integrated driving and detection schemes as well as a wide range of frequencies produced from a small set of vibrating elements."

Most of the devices the group studies don't resemble guitars, but the study of resonances often leads to musical analogies, and the natural designs of the small resonant systems often leads to shapes that look like harps, xylophones or drums. The guitar shape was, Craighead says, "an artistic expression by the engineering students." Sekaric notes that "a nanoguitar, as something close to almost everybody's understanding and experience, can also be used as a good educational tool about the field of nanotechnology, which indeed needs much public education and outreach."

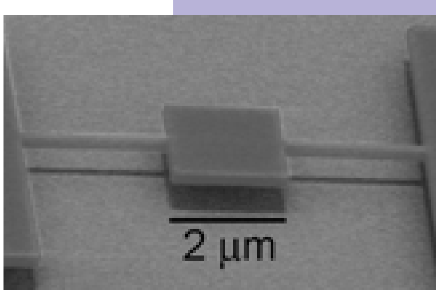
The ability to make tiny things vibrate at very high frequencies offers many potential applications in electronics. From guitar strings on down, the frequency at which an object vibrates depends on its mass and dimensions. Nanoscale objects can be made to vibrate at radio frequencies (up to 100s of megaHertz) and so can substitute for other components in electronic circuits. Cell phones and other wireless devices, for example, usually use the oscillations of a quartz crystal to generate the carrier wave on which they transmit or to tune in an incoming signal. A tiny vibrating nanorod might do the same job in vastly less space, while drawing only milliwatts of power.

Research by the Cornell NEMS group has shown that these oscillations can be tuned to a very narrow range of frequencies—a property referred to in electronics as "high Q"—which makes them useful as filters to separate signals of different frequencies. They also may be used to detect vibrations to help locate objects or detect faint sounds that could predict the failure of machinery or structures.

As the nanoguitar shows, NEMS can be used to modulate light, meaning they might be used in fiber-optic communications systems. Such systems currently require a laser at each end for two-way communication. Instead, Craighead suggests that a powerful laser at one end could send a beam that would be modulated and reflected back by a far less expensive NEMS device. This could make it more economical to run fiber-optic connections to private homes or to desktop computers in an office.

Current Cornell research, Craighead says, still focuses on understanding what materials work best for making NEMS, how such small devices work and what they can do, gathering understanding that can be used in building future applications.

The Craighead NEMS Research Group also includes graduate students Rob Reichenbach and Scott Verberage, research associate Maxim Zalalutdinov and physics professor Jeevak Parpia. Aubin, Reichenbach and Zalalutdinov recently received the 2003 Collegiate Inventors Prize (see page 6) for an ultra-small oscillator. The group is part of the Cornell Center for Materials Research, funded by the National Science Foundation, and performs particular research at the Cornell NanoScale Facility.



For laboratory NEMS research, Cornell physicists use less musical devices like this nanopaddle, which can be set into motion by laser light.

Related World Wide Web sites: The following sites provide additional information.

The original nanoguitar story: http://www.news.cornell.edu/releases/July97/guitar.ltb.html

Craighead Research Group: http://www.hgc.cornell.edu/index.html

CNF Research Accomplishments: http://www.cnf.cornell.edu/cnf/cnfra.html

Bill Steele
Cornell News Service

The 2004 NNIN REU Program

Application Deadline: February 28, 2004
Award Process Begins: March 21, 2004

The 2003 NNUN REU Convocation at the University of California Santa Barbara, Augsut 2003

Dear Colleagues:

The National Nanotechnology Infrastructure Network* will be hosting a Research Experience for Undergraduates Program (NNIN REU) during the summer of 2004 and invites you to share the following information with your undergraduate interns.

All undergraduates are eligible for the NNIN REU Program if they do not graduate before the end of the program in August 2004. Applicants must be USA citizens or permanent residents. Minority and female candidates are especially encouraged to apply.

Seventy-two undergraduates will be chosen to take part in this ten-week program, receiving hands-on nanoscience and technology experience through research with applications to bio-engineering, chemistry, electronics, materials science, optics, optoelectronics, physics, and the life sciences. Students interested in the biological application of nanotechnology are also encouraged to apply. REU projects are designed using the unique resources offered at each award site and are supervised by faculty, graduate students and technical staff. *(Applicants can indicate a preference for a particular NNIN site; however, internships will be awarded according to faculty choice and project compatibility.)*

Research opportunities will be available at: Cornell University, Georgia Institute of Technology, Harvard University, Howard University, Pennsylvania State University, Stanford University, University of California Santa Barbara, University of Michigan, University of Minnesota, University of New Mexico, University of Texas Austin, and the University of Washington.

A three-day scientific conference, the network-wide NNIN REU Convocation, is held in August to allow each intern the opportunity to present their work to their peers in the form of a concise scientific presentation. In doing so, interns learn from each other as well as from leaders in the field of nanofabrication. Full participation in the site program and the network convocation is mandatory. For the program to be complete, each intern must submit a written report on their investigations.

The NNIN REU Program is supported by the National Science Foundation, by NNIN sites and industrial sponsors. Participants receive a $3,800 stipend, plus housing and round trip travel expenses to their research site and the convocation site.

Information and the online application for the 2004 NNIN REU Program are available at: www.nnin.org

If a paper copy is preferred, an application packet can be requested from:
Ms. Melanie-Claire Mallison
NNIN REU Program Assistant
CNF, 250 Duffield Hall
Ithaca NY 14853-2000
mallison@cnf.cornell.edu

Information on past programs can be found on the web at www.nnin.org

** Successor to the National Nanofabrication Users Network*

CNF User Profile:

Nicole Schilling

The Research Experience for Undergraduates (REU) program is an important element in the overall mission at CNF. It gives undergraduate students the extraordinary opportunity to apply the knowledge they have gained in science and engineering courses to interesting projects in the laboratory, involving several advanced fabrication techniques.

The CNF REU Program interns accomplish this by closely interacting with faculty members, graduate students, and CNF technical staff members on projects covering many aspects of nanoscale fabrication. In many cases, CNF senior technical staff members have served as the principal investigator(s), giving direction and focus to an REU student. Projects such as these are mutually beneficial since they enable our facility to expand and develop new fabrication capabilities while giving hands-on experience to the intern.

An example of this is a project under the direction of CNF staff members Vince Genova and Mandy Esch titled "Low Temperature Wafer Bonding and Bonding of Unconventional Materials", involving 2002 REU student Nicole Schilling. Nicole began her CNF REU internship after grad-uating from Corning Community College in 2002 with a major in physics. This research was very successful in the summer of 2002 (see www.cnf.cornell.edu/2002reu/2002cnfreu.html for her pdf report), and in fact continued at Genova's request with Nicole's return for the summer of 2003, after completing her junior year in physics at Rensselaer Polytechnic Institute (RPI).

The implementation of silicon wafer bonding in the fabrication of sensors, actuators, and many other microelectro-mechanical structures is increasing rapidly. Traditional silicon direct bonding involves a high temperature final anneal exceeding 1000°C to complete the reaction process and increase the interface bond energy. However, the need for lower temperatures (~400°C or less) is becoming more urgent. Low temperature processing reduces the detrimental thermal mismatch effect, as well as the degradation of metal and polymer structures. Furthermore, it enables the integration of temperature sensitive CMOS circuits with complex MEMs structures. This project addresses these concerns with conventional materials such as silicon and silicon dioxide, but also less conventional materials such as silicon nitride, gallium arsenide, and silicon carbide. In addition to direct bonding methods, we also studied anodic bonding schemes for these materials.

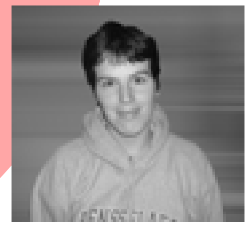
Successful wafer bonding is not only dependent on surface roughness (less than 5Å), but is also dependent upon the chemical composition at the wafer surface and the bonding interface. Traditionally this is influenced by the application of an RCA1 chemical pretreatment which yields a favorable Si-OH bond configuration at the interface, and makes the surface hydro-phyllic. After the application of force in the EV501 bonder, the bond reaction is then completed by an 1100°C/1hr. anneal in N_2, which forms a network of Si-O-Si bonds at the interface. However, to enable the bond reaction to proceed at lower temperatures, we must alter or "activate" the surface.

Our approach uses chemical and/or plasma pre-treatments to compositionally and structurally modify the bonding surface. As for chemical treatments, we have examined both hydrophyllic and hydro-phobic approaches. Our plasma pre-treatments have centered on the application of low energy RIE oxygen plasmas to influence both the bond and chemical structure. We have discovered that with certain combinations of chemical and/or plasma pre-treatments, we are able to successfully bond many of the above mentioned materials with a thermal budgeting approach involving lower anneal temperatures for longer times, or with the application of force and temperature within the bonder itself.

In addition, we have investigated and compared bonding strategies with unpatterned and patterned wafers for both direct and anodic bonding. Our approach to bonding of dissimilar materials has focused on the use of both patterned and unpatterned PECVD intermediate layers such as TEOS, oxynitride, and BPSG to influence the chemical makeup of the surface making it favorable for bonding. The work during the summer of 2003 has focused intensely on the bonding of silicon nitride, which is inherently difficult and has not received much attention in the scientific community.

We have been extremely successful by applying many of the above approaches and this work is expected to continue. In fact, Nicole may return to CNF in the summer of 2004 for an unprecedented third term as a summer intern as she approaches the completion of her B.S. in physics at RPI.

Vince Genova
CNF MEMS Exchange Engineer
genova@cnf.cornell.edu



***Nicole Schilling** is currently a senior physics student at RPI. She has recently been hired by the Center for Automation Technol-ogy to work on BCB / glass substrate wafer bonding. Nicole plans to do her graduate work at either Cornell or RPI. She enjoys gardening, reading, playing video games, baking and plays French Horn in a small brass group.*

EV501 Manual Bonding System

Features:

- Anodic, silicon direct and pressure bonding
- Supports 3" and 4" wafers and materials for all wafer bonding applications
- Compatible with the EV 620 contact aligner, enabling optically aligned bonding
- Independent temperature control (up to 500°C) for top and bottom wafers
- Manual and automatic process execution
- Contact force of electrode up to 10 kN
- Full support for fragile or bowed wafers

Collegiate Inventors Competition 2003 Finalists

Keith Aubin, Robert Reichenbach, Maxim Zalalutdinov

Cornell University, Graduate Category

Micromechanical Device for Telecommunications

The ever-increasing drive to make electronic circuits smaller and smaller is increasingly frustrated by certain types of components that refuse to shrink. These elements, known as oscillators and resonators, grant the ability to fish out a desired signal from a sea of many. Engineers have struggled unsuccessfully to find a way to miniaturize and integrate these components.

Thanks to three student inventors from Cornell University, the barriers have been overcome.

Keith Aubin, Robert Reichenbach and Maxim Zalalutdinov found a solution by building a novel type of micromechanical oscillator: one shaped like a dome. Their oscillator resonates like a bell in response to light or heat. The dome is tiny and can be built on a chip. That makes it perfect for a wide range of electronic applications, especially in the field of telecommunications. Microscopic domes could replace many of the largest, most expensive parts contained in cells phones, among other devices.

Aubin, 27, is working on his doctorate in applied physics. Reichenbach, 25, is earning his doctorate in electrical engineering. Zalalutdinov, 39, is doing post-doctoral research in the field of microelectromechanical systems. The trio conceived of their novel oscillator as a solution to the long-standing problem in electronic miniaturization.

Aubin said he was inspired to become a scientist by the career of Nobel Prize-winning scientist Richard Feynman. Ironically, he was especially moved by Feynman's famous 1959 lecture, "There's Plenty of Room at the Bottom," which is considered to be the first description of what is now called nanotechnology. Aubin and his wife Tamar Segal live in Freeville outside Ithaca. His parents, Richard and Florence Aubin, reside in Coventry, Rhode Island, where Aubin was raised.

Reichenbach is a son of Bruce and Sharon Reichenbach of Shoreview, Minn. He said his interest in electronics began when he was a teenager playing with stereo equipment. The birth of the Internet fueled his interest in science. He said he especially enjoys working in the field of nanotechnology. "I like the mind-boggling part of this. It's so small you can barely see it. And it vibrates 15 million times a second. I can't fathom that. It's so small, so fast, and it has such a huge impact. It's fun to come into work every day."

Zalalutdinov, a native of Russia, said he doesn't remember a time when he didn't want to be a scientist. He said he especially enjoys working with such tiny structures, and that he hopes to contribute to the ongoing effort to find technological ways to invent devices that mimic biological systems. It might be possible, he said, to use these new oscillators to build new types of circuits capable of artificial intelligence. "That's the most interesting thing to me," he said.

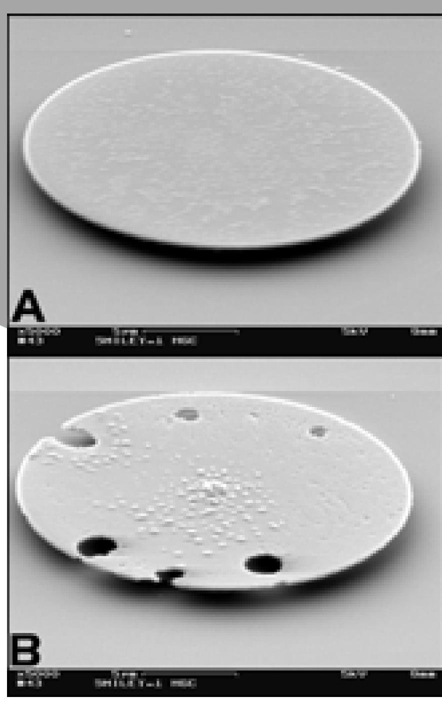


Figure A: SEM of disk type Si oscillator. Figure B: SEM of a damaged disk type Si oscillator after multiple high power (10 mW) laser exposures. http://www.cnf.cornell.edu/2003cnfra/2003cnfra160.pdf

CNF Celebrates 25 Years

On October 5th and 6th, 2004, the Cornell NanoScale Facility will celebrate over 25 years as a leading research facility to the sciencific and engineering communities.

Two days of events will include presentations from CNF users, panel discussions with noted members from the CNF's history along with representatives from the science world. There will also be tours of our new clean room in Duffield Hall.

Participants in this silver anniversary celebration will hear about current successes in nanotechnology, but also get a glimpse at the future of nano research.

In addition to the 25th anniversary events, on October 7th, Duffield Hall will be celebrated with an official dedication from Cornell's President Jeffrey Lehman. During this Grand Opening, technology will meet theatre with red carpets, trumpets and a keynote speech by Jeff Hawkins on Neuroscience. There will also be self-guided tours of the many innovative labs and spaces contained in this $?? million dollar building.

To be part of this extravaganza of nanotechnology, please save the dates of October 5-7, 2004, and contact Ms. Melanie-Claire Mallison, CNF Corporate & Public Relations, to receive the official invitation in July. (607-254-4858, mallison@cnf.cornell.edu)

Tuesday, October 5th, 2004
CNF Annual Meeting, 8:30 a.m. to 4 p.m.
Poster Session & Reception, 4:30 p.m.
Dinner, 7 p.m.

Wednesday, October 6th, 2004
CNF 25th Anniversary
Panel Discussions, 8:30 a.m. to 6 p.m.
Reception, 6 p.m. to 7 p.m.
Dinner, 7 p.m.

Thursday, October 7th, 2004
CNF Career Fair, 9 a.m. to 1 p.m.
Duffield Grand Opening Events, 2 p.m.
Keynote Address, 4 p.m.
Public Reception in Atrium, 5 p.m. to 6 p.m.

New Equipment at CNF

Heidelberg DWL 66 Laser Pattern Generator

Manager: Rob Ilic
ilic@cnf.cornell.edu

The DWL is an extremely high-resolution imaging system where over half a million dpi is achieved using a 40 nm writeable address grid for exposing chrome plates or wafers and accommodating media up to 8 x 8 inches. Design data is produced on any program using DXF, HPGL, Gerber, GDSII, or CIF files and is converted into a LIC format that is outputted into the DWL system through a CONVERT workstation.

The DWL uses raster technology to image on various substrates like silicon, glass, film, or other photosensitive type plates. It can be used for semiconductors, mask and direct writing, integrated optics, lead frames, flat panel displays, shadow mask, MEMS and any application where high precision, high resolution images must be produced.

The DWL offers an interchangeable write head with a selection of two lenses. Each lens offers a different resolution and feature size to meet the needs of the application.

DWL System Specifications:

- Write lens = 2mm, 10mm (0.6 µm and 2 µm nominal spot sizes)
- Stage = 8", linear motors, and 2-axis interferometer
- Laser Source = He-Cd laser: 442 nm
- Autofocus = Air pressure autofocus
- Electronics = VME-processor running OS9

Additional DWL Features:

- Metrology and alignment system for multi-layer exposures and metrology measurements, including front to backside alignment for direct write. The backside alignment uses a third camera for image recognition and registration on the substrate backside.
- Active write area: 170 mm x 185 mm
- Interferometric resolution: 10 nm
- Grey-scale Exposure Mode: This mode enables the system to perform grey-scale exposures into photoresist. The intensity of the laser beam can be varied per pixel to achieve different exposure depths.
- Number of grey scale levels: 32

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CEE Model 100 Spinners

Manager: Garry Bordonaro
Bordonaro@cnf.cornell.edu

CNF has two bench-top mounted Cee Model 100 spinners for resist coating of wafers. Each unit has 10 available recipes for up to 10 step programming of acceleration, speed and time.

- Up to 200 mm round or 6" square substrates
- 0-6000 rpm spin range
- 1-20,000 rpm/sec acceleration
- Repeatability is ±5 rpm with a res. of 1 rpm

JBX-9300FS Electron Beam Lithography System

Manager: Daron Westly
westley@cnf.cornell.edu

The JBX-9300FS is an electron beam lithography system featuring a spot beam, Vector scan, and a step and repeat stage. Capable of varying the beam size widely, the system is versatile in its applications from basic research of elements to test production of optical elements to research and development for masks for high accelerating voltage exposure. Its dynamic correction system eliminates defocusing resulting from beam deflection.

Specifications:

Beam Shape = Spot

Accelerating Voltage = S100 kV / 50 kV

Gun Emitter = SZrO/W (Schottkey)

Workpiece Dimension = Sup to 178 mm^2

Beam Size = S4 to 200 nm (100 kV)
7 to 200 nm (50 kV)

Substrate Size = S300mm

Check http://www.cnf.cornell.edu/Equipment/EquipmentIndex.html for a list of all CNF tools.

The NanoMeter is published four times a year by the Cornell NanoScale Facility, Cornell University, 250 Duffield Hall, Ithaca, New York, 14853-2000.

Your comments are welcome!

To be added to our mailing list please email: information@cnf.cornell.edu
Find the NanoMeter in pdf at: http://www.cnf.cornell.edu/

The CNF has been serving the Science and Engineering Community since 1978, and is a member of the National Nanotechnology Infrastructure Network, supported by the National Science Foundation.

Cornell NanoScale Science & Technology Facility

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