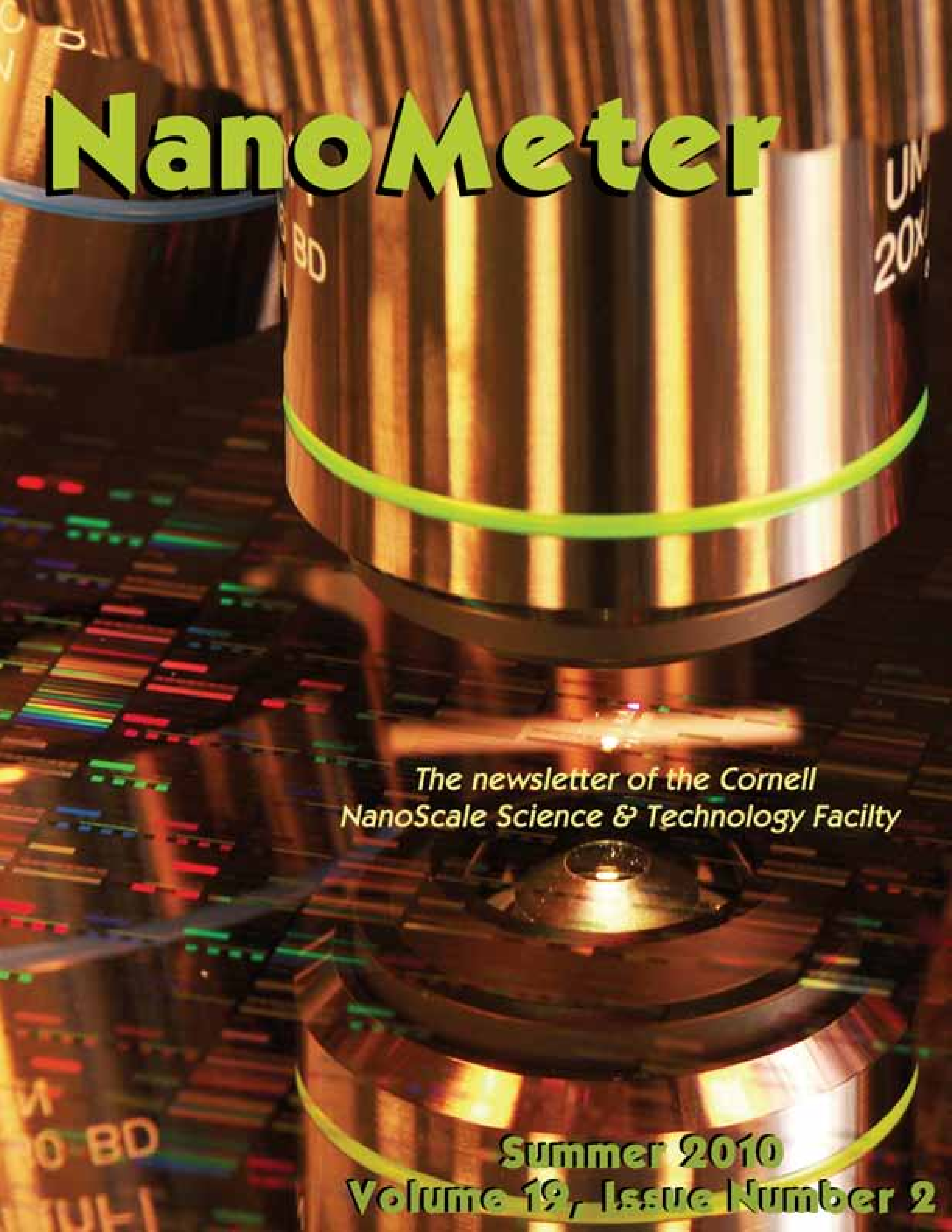

NanoMeter

The newsletter of the Cornell NanoScale Science & Technology Facilty

Summer 2010
Volume 19, Issue Number 2

In This Issue....

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http://www.nature.com/nphys/journal/v5/n7/full/nphys1301.html.
Submitted by Jared Hertzberg, jbh237@cornell.edu

All other images are credited within the article.

CNF Cornell NanoScale Science and Technology Facility

The CNF is a member of the
National Nanotechnology Infrastructure Network
(www.nnin.org)

And is supported by:
The National Science Foundation,
New York State Office of Science, Technology
& Academic Research, Cornell University,
Industry & Our Users.

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Daniel C. Ralph Named

May 6, 2010
Blaine Friedlander, Anne Ju
Cornell Chronicle

Daniel C. Ralph, the Horace White Professor of Physics, has been named the Lester B. Knight Director of the Cornell NanoScale Science and Technology Facility (CNF), starting July 1, 2010.

"Dan will bring years of CNF user and leadership experience to his new role as director," said Robert A. Buhrman, senior vice provost for research.

Prof. Ralph first started working in the CNF in 1987, when he was a graduate student investigating electrical transport and quantum defects in metallic nanostructures as small as 15 atoms in diameter.

Dan receives the ultimate CNF welcome — ice cream cake!
Staff photo

After a postdoctoral appointment at Harvard during which he continued to use the CNF for sample fabrication, Ralph joined the Cornell physics faculty in 1996 and has been an active CNF user ever since. He has served on the CNF Executive Committee since 1998 and has chaired that committee since 2007.

Prof. Ralph has led the nanomagnetics thrust in Cornell's Center for Nanoscale Systems since 2001, has served as director of the Laboratory of Atomic and Solid State Physics since 2006, and was appointed Horace White Professor of Physics in 2008. He is a founding member of the Kavli Institute at Cornell for Nanoscale Science.

His research focuses on the fabrication of nanometer-scale devices and the measurement of their electronic and magnetic properties. Recent highlights from his research group include measurements of the electrical properties of individual molecules and studies of magnetic devices controlled by torque from spin-polarized currents rather than by magnetic fields.

L.B. Knight Director of Cornell NanoScale Facility

Dan Ralph with Director of Operations, Don Tennant.
Staff photo

"My aim is to maintain CNF's position as the nation's premier nanotechnology facility by trying to anticipate the needs of its large user community, by keeping the equipment at the frontiers of available technology, and by encouraging new creative uses of the CNF's capabilities," Ralph said. "I have benefited at every stage of my career from the tools in the CNF and its fantastic staff, and it is an exciting opportunity for me to help shape the facility's future."

The CNF is not only a premier user facility; it is also a national leader in providing educational outreach to the general public and educating future leaders in science and technology.

The CNF is supported by the National Science Foundation, the New York State Office of Science, Technology and Academic Research, Cornell and industry. It is a member of the National Nanotechnology Infrastructure Network.

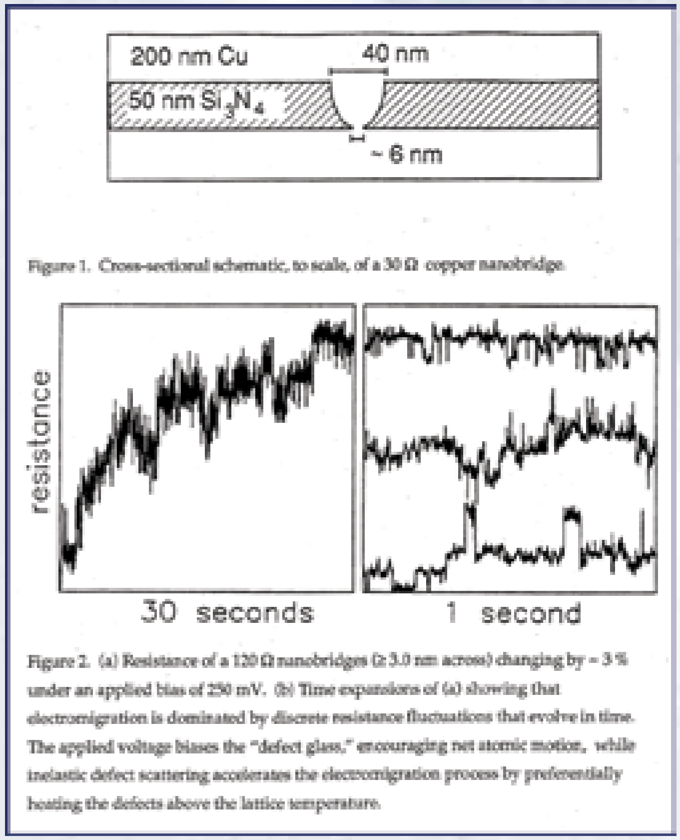


Figure 1. Cross-sectional schematic, to scale, of a 30 Ω copper nanobridge.

Figure 2. (a) Resistance of a 120 Ω nanobridges (≥ 3.0 nm across) changing by ~ 3 % under an applied bias of 250 mV. (b) Time expansions of (a) showing that electromigration is dominated by discrete resistance fluctuations that evolve in time. The applied voltage biases the "defect glass," encouraging net atomic motion, while inelastic defect scattering accelerates the electromigration process by preferentially heating the defects above the lattice temperature.

Figure 1: From Daniel Ralph's first research accomplishments report, CNF Project # 111-80, circa 1988.

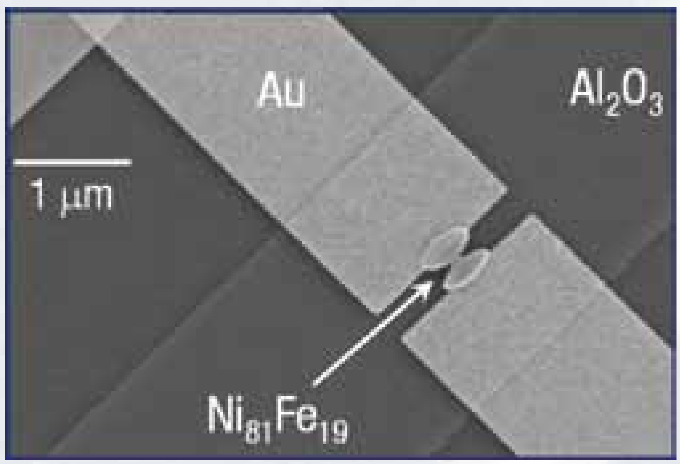


Figure 2: From Dan Ralph's 2009 research accomplishments report with Joshua Parks. SEM of elliptical permalloy ($Ni_{81}Fe_{19}$) electrodes contacted to Au pads, fabricated on an oxidized aluminum gate.

CNF Directors

The CNF has now had six named directors over its 30 year history:

(with several memorable interim directors filling a few gaps)

Edward Wolf, 1978-1988
Harold Craighead, 1989-1995
Noal MacDonald, 1995-1997
Sandip Tiwari, 1999-2005
George Malliaras, 2005-2009
Daniel Ralph, 2010-

New Adhesive Device Could Let Humans Walk On Walls

February 1, 2010
By Anne Ju
Cornell Chronicle

Figure 1: Paul Steen and Michael Vogel's surface tension-based adhesive device with a lego man payload. The researchers demonstrate a larger version of their switchable adhesive device in a video, http://www.news.cornell.edu/stories/Feb10/adhesive.html

Could humans one day walk on walls, like Spider-Man? A palm-sized device invented at Cornell that uses water surface tension as an adhesive bond just might make it possible.

The rapid adhesion mechanism could lead to such applications as shoes or gloves that stick and unstick to walls, or Post-it-like notes that can bear loads, according to Paul Steen, professor of chemical and biomolecular engineering, who invented the device with Michael Vogel, a former postdoctoral associate.

The device is the result of inspiration drawn from a beetle native to Florida, which can adhere to a leaf with a force 100 times its own weight, yet also instantly unstick itself. Research behind the device is published online Feb. 1 in Proceedings of the National Academy of Sciences.

The device consists of a flat plate patterned with holes, each on the order of microns (one-millionth of a meter). A bottom plate holds a liquid reservoir, and in the middle is another porous layer. An electric field applied by a common 9-volt battery pumps water through the device and causes droplets to squeeze through the top layer. The surface tension of the exposed droplets makes the device grip another surface — much the way two wet glass slides stick together.

"In our everyday experience, these forces are relatively weak," Steen said. "But if you make a lot of them and can control them, like the beetle does, you can get strong adhesion forces."

For example, one of the researchers' prototypes was made with about 1,000 300-micron-sized holes, and it can hold about 30 grams — more than 70 paper clips. They found that as they scaled down the holes and packed more of them onto the device, the adhesion got stronger. They estimate, then, that a one-square-inch device with millions of 1-micron-sized holes could hold more than 15 pounds.

To turn the adhesion off, the electric field is simply reversed, and the water is pulled back through the pores, breaking the tiny "bridges" created between the device and the other surface by the individual droplets.

The research builds on previously published work that demonstrated the efficacy of what's called electro-osmotic pumping between surface tension-held interfaces, first by using just two larger water droplets.

One of the biggest challenges in making these devices work, Steen said, was keeping the droplets from coalescing, as water droplets tend to do when they get close together. To solve this, they designed their pump to resist water flow while it's turned off.

Steen envisions future prototypes on a grander scale, once the pump mechanism is perfected, and the adhesive bond can be made even stronger. He also imagines covering the droplets with thin membranes — thin enough to be controlled by the pump but thick enough to eliminate wetting. The encapsulated liquid could exert simultaneous forces, like tiny punches.

"You can think about making a credit card-sized device that you can put in a rock fissure or a door, and break it open with very little voltage," Steen said. "It's a fun thing to think about."

The research was funded primarily by the Defense Advanced Research Projects Agency, and also by the National Science Foundation. Work was partly performed at the Cornell NanoScale Facility.

For more information on "Beetle-based bonding" see the article in Nature News, 1 February 2010, http://www.nature.com/news/2010/100201/full/news.2010.48.html

Sensitive Oscillators Could Lead to Detection of Harmful Molecules and Bacteria

March 10, 2010
By Anne Ju
Cornell Chronicle

By watching how energy moves across a tiny device akin to a springing diving board, Cornell researchers are a step closer to creating extraordinarily tiny sensors that can instantly recognize harmful substances in air or water. The researchers, led by professor of applied and engineering physics Harold Craighead, made a device just 200 nm thick and a few microns long with an oscillating cantilever hanging off one end. They identified exactly how to tune its sensitivity — a breakthrough that could lead to advanced sensing technologies.

The experiments detailed online February 8 in the *Journal of Applied Physics* show how these oscillators, which are called nanoelectromechanical systems (NEMS), could one day be made into everyday devices by lining up millions of them and treating each cantilever with a certain molecule.

"The big purpose is to be able to drive arrays of these things all in direct synchrony," said first author Rob Ilic, a research associate at the Cornell NanoScale Science and Technology Facility (CNF). "They can be functionalized with different chemistries and biomolecules to detect various pathogens — not just one thing."

The cantilever is like a diving board that resonates at distinct frequencies. In past research, the team has demonstrated that by treating the cantilever with different substances, they can tell what other substances are present. For example, *Escherichia coli (E. coli)* antibodies attached to the cantilever can detect the presence of *E. coli* in water.

The researchers have perfected the oscillators' design, Ilic said, by laying their device on top of a layer of silicon dioxide (SiO_2), all of which rest on a silicon substrate. A pad with holes connects pegs of SiO_2, lined up like telephone poles, which eventually end at the cantilever. A laser beam travels down the device and causes the oscillator to wobble. The frequency is then measured by shining another laser on the oscillator and noting patterns in the reflected light. The "telephone poles" allow the energy to move efficiently across the device by preventing it from buckling or sagging. The design makes it easy to read the resonant frequency of the cantilever.

In this process, the researchers discovered that over short distances, the energy from the laser came in the form of heat, which quickly dissipates. But when the laser was parked hundreds of microns away from the cantilever, the energy came in the form of acoustical waves that traveled through the device, dissipated more slowly, and allowed them to make their device longer.

The research was the result of a collaboration with Slava Krylov of Tel Aviv University. The work was supported by the Defense Advanced Research Projects Agency; the Nanobiotechnology Center, which is funded by the National Science Foundation; and New York State. Work was performed at the CNF.

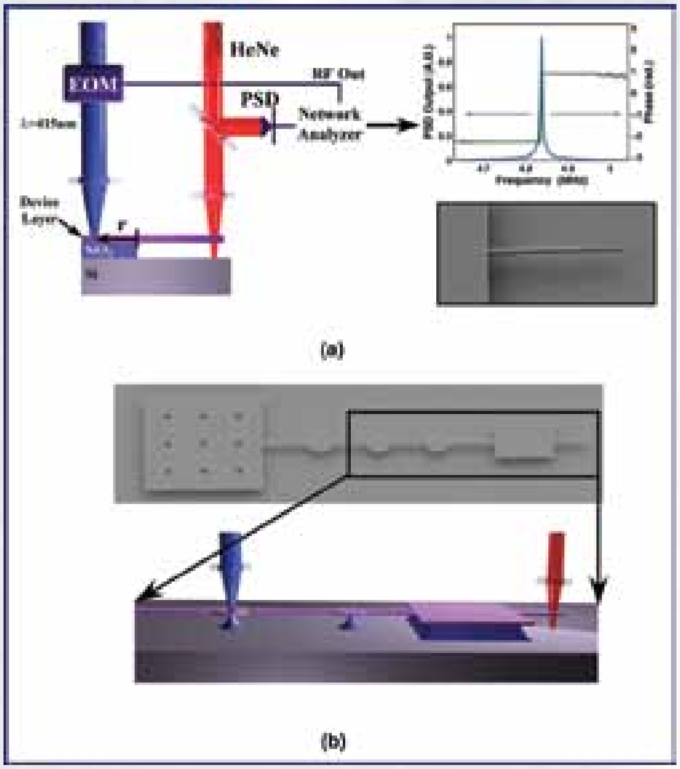


Figure 1: (a) Schematic illustration of laser actuation and interferometric optical setup. Device layers were separated from the Si substrate by a 2 mm thick sacrificial SiO_2 layer. The excitation signal was generated by an electro-optically modulated (EOM) diode laser (λ = 415 nm) focused near the clamped end of the NEMS oscillator. The vibrational amplitude and phase response of the NEMS cantilever were measured using an interferometric optical setup composed of a Fabry-Perot cavity formed by the device and substrate layers and causing refectance variations of the He-Ne laser beam incident into a single-cell photodetector (PSD). Measured amplitude and phase spectra correspond to the nanomechanical cantilever (λ = 8 µm, w = t = 250 nm) displayed within the SEM inset. (b) Oblique SEM of beams linked through circular links. Inset schematic is a tilted three dimensional profile of the structure and experimental setup exemplifying the thermally isolating SiO_2 posts.

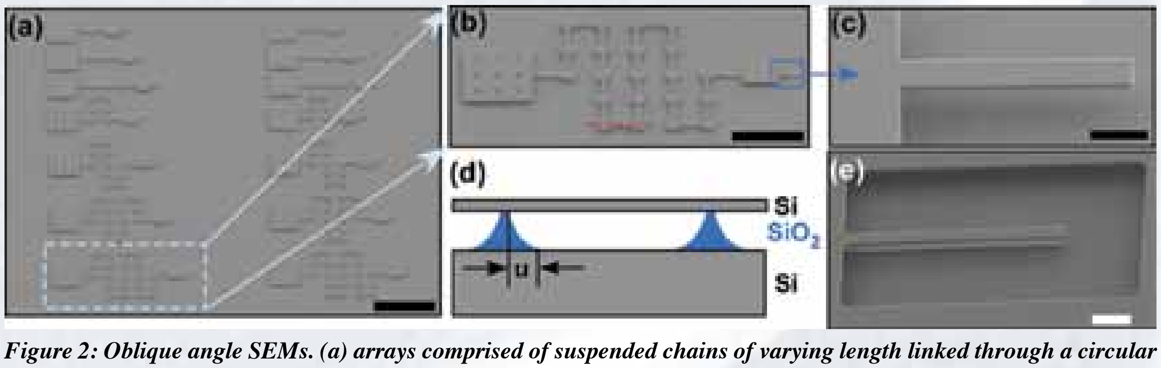


Figure 2: Oblique angle SEMs. (a) arrays comprised of suspended chains of varying length linked through a circular aperture. (b) magnified micrograph of a highlighted region from (a). (c) higher magnification image of the suspended cantilever highlighted in (b). Scale bars correspond to (a) 40 µm, (b) 20 µm and (c) 1 µm. (d) schematic illustration of the cross-section showing a suspended beam between two circular elements depicted by a red dashed line in (b). (e) Suspended cantilever beam with a continuous device layer region. Scale bar corresponds to 2 µm.

Cornell-Developed Battery Technology Company Receives $2.2 Million In Federal Funds

May 4, 2010
By Anne Ju
Cornell Chronicle

A company that uses Cornell-developed technology to create low-power, long-lasting batteries has received a $2.2 million boost from the federal government.

Ithaca-based Widetronix Inc., co-founded in 2003 by Cornell professor of electrical and computer engineering Michael Spencer, has been awarded $1.2 million from The Solar Energy Consortium (TSEC) and $1 million from the U.S. Department of Defense.

U.S. Rep. Maurice Hinchey (D-22nd District), who helped secure the funding, visited Ithaca's South Hill Business Campus May 3 to announced the award, which the company says will create about 30 jobs in the next five years.

"This is a perfect example of how federal efforts can work together with local creativity and ingenuity," said Hinchey during the public gathering of company and Cornell officials.

Widetronix makes betavoltaic batteries, which are relatively low power and extremely long lasting, used in such applications as smoke detectors and pacemakers. Widetronix uses silicon carbide as a semiconductor material, which greatly increases the batteries' efficiency and addresses cost issues. The technology was developed in Spencer's lab at Cornell.

"The actual basic idea of a betavoltaic battery has been around for a while, but the material silicon carbide turns out to be an ideal match for this technology," said Spencer, who is no longer officially part of the company but serves as a consultant.

The $1.2 million grant was awarded through TSEC, a nonprofit organization that Hinchey helped found in 2007 that supports energy independence and sustainability. In particular the consortium supports research for increasing efficiency of photovoltaic systems and boosting the cost effectiveness of solar energy systems.

The additional $1 million from the defense department will support its anti-tamper program, which aims to protect U.S. missile technology from being compromised. Spencer said the Widetronix batteries would be useful in such applications as continuous security monitoring and sensing networks.

The funds will also help Widetronix open a prototyping facility, according to CEO Jonathan Greene '93, MBA '04.

Figure 1: U.S. Rep. Maurice Hinchey (D-22nd District) speaks with CEO Jonathan Greene '93, MBA '04, May 3 during a public announcement of federal funding for Widetronix Inc. Background: Don Tennant, interim director of Cornell NanoScale Science and Technology Facility; and Michael Spencer, professor of electrical and computer engineering. Robyn Wishna/University Photography

On Monday May 3rd, Congressman Maurice Hinchey conducted a press conference at the South Hill Business Park to announce the award of a phase II SBIR and a congressional directed investment to Widetronix Corporation, an Ithaca-based startup company.

Widetronix is developing radio-isotope based batteries for medical and security applications. The MIT Technology review gives a brief overview of the company's technology (http://www.technologyreview.com/energy/23959/?a=f).

The company designs were realized using the facilities of the Cornell NanoScale Facility (CNF). The progress of Widetronix underscores the value of CNF as a resource for small high tech businesses. It is clear that without the staff and facilities at CNF Widetronix could not have gotten as far as it has.

Professor Michael Spencer
Founder of Widetronix

2009 CNF Whetten Memorial Award Winner Profile: Mekala Krishnan

Mekala Krishnan is a fourth year graduate student in the Sibley School of Mechanical and Aerospace Engineering (MAE) at Cornell, and is the 2009 recipient of the CNF Nellie Yeh-Poh Lin Whetten Award. The Whetten Award recognizes an outstanding female graduate student who shows spirit and commitment to professional excellence, as well as professional and personal courtesy.

Mekala received her bachelor's degree in Mechanical Engineering at the Indian Institute of Technology (IIT) Delhi in New Delhi, India in 2002. She joined the Ph.D. program at Cornell in the fall of 2006, and is a student in Prof. David Erickson's research group in MAE. The research group focuses on microfluidics and nanofluidics as applied to optofluidics, biomolecular detection, biologically enabled robotics, nanomedicine, and programmable matter.

Mekala's main research interests involve using novel microfluidic technologies to create programmable materials and systems. Top-down manufacturing techniques used to fabricate structures at the mesoscales do not scale well at the micro- and nanoscales. On the other hand, bottom-up self -assembly methods used to create structures at these scales usually yield regular shapes with limited ability to create arbitrary structures or carry out error correction. Another important limitation of current microscale manufacturing technologies is the inability to program and dynamically reconfigure material structures and properties. Mekala's research focuses on the creation of dynamically programmable materials with reconfigurable structural and material properties, thus helping to overcome some of the limitations discussed above. This approach to fabrication of materials, also referred to as "Programmable Matter" is a collaborative research effort between Prof. Erickson's group and Prof. Hod Lipson's research group at Cornell, as well as Prof. Heinrich Jaeger at the University of Chicago.

Figure 2: Dynamic channel creation and reconfiguration. A narrow straight channel created within a larger microfluidic chamber by selective heating along the sides. The original flow field was obtained on turning the heat off.

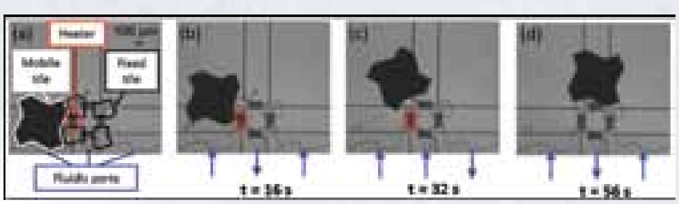


Figure 1: Tile manipulation around the mock tile demonstrating the ability to reconfigure the final structure. The chamber has a mock tile made of PDMS, a mobile tile made of silicon, platinum heaters, and fluidic ports. The blue arrows in the parts represent regions where flow enters or leaves the chamber, while the red circles show the heater being actuated.

Mekala's work has examined this research problem from two different perspectives. The first multiphase approach involves the fluidic assembly of silicon structures with dynamically-switchable affinities between assembling components, thus allowing for on-the-fly programming of the final structure, structure reconfiguration and error correction. In a fluidic assembly process, by locally restricting the flow near one face of the structure, the probability of another component being attracted to that face is limited. Hence that part of the structure represents a negative affinity for an approaching component, while other parts of the structure are still positive affinity regions. While it is possible to use active flow control elements like valves on the assembling components to carry out affinity switching, this requires significant component level fabrication. Instead, through the use of "smart-fluids" that form self-assembled structures on the application of a suitable stimulus, local viscosity changes can be brought in the stimulated region to locally block and valve flow. The fluids used in this work were aqueous triblock copolymers that undergo reversible sol-gel transition on heating to affect a viscosity change to modulate flow and switch affinities. Figure 1 shows experiments demonstrating the ability to carry out structure reconfiguration using switchable affinities. To demonstrate our idea here, we used a mobile tile made of silicon and a fixed "mock" tile made of poly(dimethyl)siloxane or PDMS. The substrate of the chip was patterned with platinum heaters that allowed us to actuate the valves on the four sides of the mock tile. By modulating the valves to change affinities, we were able to move the mobile silicon tile from the left of the mock tile to the top, thus affecting a reconfiguration from a horizontal row structure to a vertical column structure.

The second approach to programmable matter has involved building dynamically reconfigurable microfluidic channels and fluidic elements on chip. This technique has the potential to eliminate the need for design and fabrication of chips a priori and thus create truly flexible, programmable systems. This dynamic structural reconfiguration uses two coupled processes (1) Photothermal conversion, where energy from an optical image is converted into a local thermal field using an absorbing substrate and (2) Sol-gel phase transition, where the thermal field triggers a reversible phase change in a solution of the above "smart-fluid" flowing within the microfluidic device, resulting in the creation of local regions of high yield strength that behave as wall-like structures. Channel networks can thus be created and reconfigured on-the-fly by manipulation of the thermal field using dynamic photomasking. Figure 2 shows an example of an experiment to dynamically create channels within a microfluidic device. The absorbing substrate used here consists of a PDMS film containing carbon black and the dynamic photomasking is carried out using a standard optical projector system.

CNF Workshop Highlight

An intercampus workshop on *Molecular Targeting for Imaging and Intervention* was held on Cornell's Ithaca campus, March 26-27, 2010. This event was initiated by researchers at the Weill-Cornell Medical College (WCMC) who wished to start collaborations with Ithaca campus faculty with complementary capabilities in the design and implementation of agents for cancer detection and therapeutics, and imaging technologies for cancer and cell biology. Ithaca faculty with expertise in engineering, chemistry, cell biology, animal modeling, nanofabrication and materials science attended. There were quick snapshots of research needs, capabilities and models, and breakout sessions and a networking dinner gave opportunities to meet and discuss possibilities.

Thirty-one faculty members attended and presentations were given in the areas of; (1) current challenges for clinical and experimental imaging, (2) development of molecular imaging technologies, (3) imaging agents, (4) tracking cells and cellular responses, and (5) imaging therapies and technologies. The program booklet is available on the web. (*http://www.cnf.cornell.edu/doc/MTII_book_final_small.pdf*)

The event was organized by the Office of Intercampus Initiatives and the CNF, and sponsored by the WCMC Department of Radiology and the NNIN. Future efforts to keep the community connected are underway in the form of constructing a web-based networking resource to match research interests to needs. If you would like to be part of this community, please contact our life sciences liaison, Beth Rhoades (rhoades/at/cnf.cornell.edu).

CNF Staff Volunteer for Local High School Event

This Spring, Michael Skvarla and Alan Bleier participated in Ithaca High School's Student Enrichment. During this time, the school offered over 30 different sessions to students. According to the PTA newsletter, students commented that they really appreciated the opportunity to meet, talk with, and learn from people in the community. They also liked trying things they'd never tried before.

The CNF sessions were entitled "Explorations in Nano-technology" and included short presentations and imaging nanostructures. After the presentations, students got to use two Bodelin ProScope HR handheld USB digital microscopes connected to laptops to inspect microchips, coins, and the nanoguitar sample (Carr/Craighead) that Mike had brought. Evaluations from students who participated in the sessions indicated it was "informative, engaging, and fun."

The CNF continues its commitment to science education for middle and high school students. Please contact Ms. Melanie-Claire Mallison, (mallison/at/cnf.cornell.edu), to bring your school group to visit or to arrange for a CNF staffer to visit your school!

New Staff at the CNF

Noah Clay is the latest technical staff member to join CNF. His responsibility is primarily in the area of process integration where he will team with fellow staff members and the user community to develop and implement advanced processing applications.

Prior to joining Cornell University this spring, Noah was the Nanofabrication Manager at the Harvard University Center for Nanoscale Systems, where he was responsible for day-to-day operations of its 650 member cleanroom, and managing associated technical staff. He has held technical staff positions at Goodrich Corporation in Princeton, NJ, and Infinera Corporation in Silicon Valley, CA, where he fabricated photon-counting devices and photonic integrated circuits, respectively. Coincidentally, Infinera Corporation began proof-of-concept work for their photonic ICs in the CNF's former cleanroom in Phillips Hall.


Noah Clay. Photograph by Don Tennant.

Mr. Clay was born in Central America and raised in the Hudson Valley region of New York State. He attended SUNY, earning an undergraduate degree in Physics and performed Master's work in Electrical Engineering at Tufts University. Outside of work, Noah enjoys spending time with his wife and three sons. His favorite pastimes are sailing and hiking.

National Nanotechnology Infrastructure Network Research Experience for Undergraduates (NNIN REU) Program

Find more NNIN REU Program information, and research reports from past programs, at http://www.nnin.org/nnin_reu

Left; The 2009 NNIN REU Interns at the August convocation held at the University of Michigan. Below; The seven CNF REU Interns with Dr. Lynn Rathbun (left) and Ms. Melanie-Claire Mallison (right). Photographs by Edward Tang.

The NNIN REU Program is so popular that for the 2010 program, we received over one thousand "hits" to our online application, and 755 undergraduate students succesfully completed their application by deadline!

In 2009, the network hired 74 interns (see them all above), and seven of those students came to the CNF to play in our cleanroom for the summer (see the photo above right). As one small response to our popularity, the NNIN has hired 80 interns for 2010 and ten will be arriving in Ithaca in June.

In the meantime, our second-year International Research Experience for Undergraduates (NNIN iREU) Program has proven popular not only with our interns, but also with our international partners! Ten interns from 2008 took part in the 2009 iREU Program, and at right are photos taken by iREUs; the iREUs sight-seeing in Japan, and the iREUs in their lab in Germany.

In order to grow the iREU Program, we have added IMEC in Belgium to our partnership with Jülich in Germany, and NIMS in Japan, and hired 18 of the 2009 interns for 2010; to experience this rare and wonderful opportunity for international research.

We look forward to the youthful enthusiasm of our undergraduate researchers! And we welcome corporate involvement in our programs. If you are interested in sponsoring one or more of our interns, please contact Dr. Lynn Rathbun, rathbun@cnf.cornell.edu, our NNIN REU Program Manager.

CNF Community Share

A paper, by recently-graduated Chemistry & Chemical Biology graduate student Michael Jaquith and Cornell's Associate Professor John Marohn, was featured on the front cover of the 14 September 2009 edition of the Journal of Materials Chemistry.

In this paper, Jaquith et al. reported on the first-ever micro-scopic study of charge trapping in a recently-developed class of organic semiconductors based on functionalized pentacene and anthradithiophene.

The journal cover shows images of sample topo-graphy, over a 7 μm^2 area, overlayed with a colorized map of the trapped charge density. The two right-most samples in the cover image show evidence of grain-boundary trapping. The study harnessed Cornell's nanofabrication, nanocharacterization, and materials facilities, in concert with a highly sensitive electric force microscope developed by Marohn's research team. The work was funded by the NSF and was performed in collaboration with Professor John Anthony of the University of Kentucky.

As a scruffy junior from the University of Maryland, College Park, an REU internship at CNF, working for Professor Steen, was my first introduction to Cornell. The following summer, I found myself on a plane headed for Japan courtesy of NNIN's iREU program, where I fabricated collagen-glycosaminoglycan sponges for tissue engineering. Now, I'm headed for another stint at Cornell as a PhD candidate in mechanical engineering.

I am looking forward to returning to the Cornell campus, and I am deeply grateful to CNF for providing me with a fabulous summer experience three years ago that has now brought me to this next opportunity.

Sarah Grice

(The photograph above is of the 2009 iREUs in Japan. Sarah is second from the left. The photographer is unknown.)

Mechanical Control of Spin States in Spin-1 Molecules and the Underscreened Kondo Effect

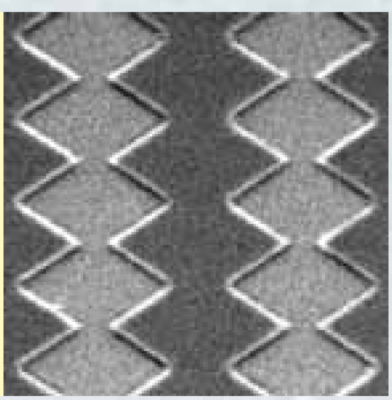
J.J. Parks, A.R. Champagne, T.A. Costi, W.W. Shum, A.N. Pasupathy, E. Neuscamman, S. Flores-Torres, P.S. Cornaglia, A.A. Aligia, C.A. Balseiro, G.K.-L. Chan, H.D. Abruña, and D.C. Ralph

The ability to make electrical contact to single molecules creates opportunities to examine fundamental processes governing electron flow on the smallest possible length scales. We report experiments in which we controllably stretched individual cobalt complexes having spin S = 1, while simultaneously measuring current flow through the molecule. The molecule's spin states and magnetic anisotropy were manipulated in the absence of a magnetic field by modification of the molecular symmetry. This control enabled quantitative studies of the underscreened Kondo effect, in which conduction electrons only partially compensate the molecular spin. Our findings demonstrate a mechanism of spin control in single-molecule devices and establish that they can serve as model systems for making precision tests of correlated-electron theories.

Science 11 June 2010: Vol. 328. no. 5984, pp. 1370-1373
http://www.sciencemag.org/cgi/content/full/328/5984/1370

Britton Plourde, Assistant Professor of Physics, Syracuse University, writes: Dear Melanie-Claire, I wanted to let you know that an image of one of our devices that we fabricated at the CNF was selected by Physical Review B as part of their Kaleidoscope series to appear on their homepage for this month. The selected images are shown here: http://prb.aps.org/kaleidoscope/May2010. Our image is the first one in the second row.

Regards, Britton



A paper, "Parylene Peel-Off Arrays to Probe the Role of Cell-Cell Interactions in Tumor Angiogenesis," was featured on the front cover of the journal Integrative Biology in October 2009. In this work, researchers at Cornell have utilized the nanofabrication processes at CNF to create a chip with a polymeric (parylene C) stencil.

The parylene chip was used for patterning arrays of tumor cells and spatiotemporally controlling the level of cell-cell contact. By monitoring the protein secretions from these normal-ized cells, the study revealed that cell-cell interactions reg-ulate tumor angio-genesis, the process of creating new blood vessels to support cancer development. The findings could pave the way to designing more effi-cacious drugs to block cancer pro-gression.

This research was funded in part by NIH, led by Professor Harold Craighead (Applied and Engineering Physics) and Professor Claudia Fischbach (Biomedical Engineering), together with Christine Tan, Bo Ri Seo, Daniel Brooks and Emily Chandler from the Department of Biomedical Engineering.

Just FYI..... CNF Tech Staff Tool Responsibilities as of June 2010

For more information on a particular tool, contact the appropriate staff member at: lastname@cnf.cornell.edu

STAFF	PRIMARY MANAGER ON TOOL:
Alan Bleier	JEOL 6300
	Olympus MX-50
Garry Bordonaro	ABM Contact Aligner
	ASML 300C DUV Stepper
	Autostep i-line Stepper
	Brewer Automatic Resist Coat
	JBA 1000 DUV Resist Cure Lamp
	YES Image Reversal Oven
	YES Vapor Prime Oven
Edward Camacho	5X g-line Stepper
	Fusion UV Cure
	Hamatech Hot Piranha
	Hamatech Hot SC1/SC2
	Hamatech-Steag Mask Processors
	Hamatech-Steag Wafer Processors
	Karl Suss Gyrset RC-8
	Nanoimprint NX-2500
	Photolithography Wafer Spinners
	Resist Hot Strip Bath
	Suss MA6-BA6 Contact Aligner
	Suss SB8e Substrate Bonder
Jerry Drumheller	Aura 1000 Resist Strip
	Branson Resist Strip
	CVC Sputter Deposition
	FleXus Film Stress Measurement
	Focused Ion Beam - FEI 611
	Glen 1000 Resist Strip
	Hummer Au/Pd Sputtering System
	KS Bonder
	P10 Profilometer - 2
	Polaron Gold Sputtering System
	Rudolph FTM
	Veeco Ion Mill
	Wire Bonder
	YES Asher
Vince Genova	Oxford 100 Etcher
	Oxford ALD FlexAL
	PT720 Etcher
	PT740 Etcher
	Trion Etcher
	Xactix Xenon Difluoride Etcher
Rob Ilic	AFM - DI3100
	AFM - Veeco Icon
	Dicing Saw - K5 7100
	FilMetrics F40
	FilMetrics F50-EXR
	Heidelberg Mask Writer
	P10 Profilometer - 1
	Parylene Deposition
	Woollam Spectroscopic Ellipsometer
Phil Infante	Carbon Nanotube / Graphene Furnace
	CDE ResMap Resistivity 4-pt Probe
	CV Testing System
	GSI PECVD
	IPE PECVD
	IV Probe Station
	MOS Furnaces
Meredith Metzler	Oerlikon Deep Si Etcher
	Oxford 81 Etcher
	Oxford 82 Etcher
	PT72 Etcher
	PT770 Etcher - Left Side (Silicon)
	PT770 Etcher - Right Side (III-V)
	Unaxis 770 Deep Si Etcher
Paul Pelletier	Ion Implanter
	Rapid Thermal Processor - AG 8108
Beth Rhoades	BX-51 Fluorescence Microscope
	Dimatix Printer
	Harrick Plasma Generator
	PDMS Vacuum Oven
	ReynoldsTech Conductive Polymer Vapor Deposition
Michael Skvarla	AutoEL IV Ellipsometer
	PG Mask Writer
	Photolithography Hotplates
	Photolithography Wet Benches
	RTA - AG610
Daron Westly	JEOL 9300
	JEOL Alignment Microscope
	Wyko Optical Profilometer
	Zeiss Supra SEM
	Zeiss Ultra SEM
Aaron Windsor	CHA Evaporator
	PVD 75 Sputter Deposition
	SC4500 Even-Hour Evaporator
	SC4500 Odd-Hour Evaporator
Dan Woodie	Bottle Washer
	Chemical Mechanical Polishing CMP - 6EC
	Electroplating Tanks
	EV620 Contact Aligner
	Hamatech Post CMP Brushcleaner
	Hot Phosphoric Tank
	MVD 100
	Nanostrip Tank
	VCA Optima Contact Angle
	YES Polyimide Bake Oven
Sam Wright	Critical Point Dryer
	Hot Press
	Microdrill
	Spin Rinse Dryer (SRD)

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Save The Date!

2010 CNF Annual Meeting

Thursday, September 16th

http://www.cnf.cornell.edu/cnf_annualmeeting.html

If your corporation is interested in sponsoring the CNF Annual Meeting, please contact Donald Tennant, CNF Director of Operations, at tennant@cnf.cornell.edu



Scenes from the 2009 CNF Annual Meeting.
Photos by Charles Harrington and Donald Tennant.