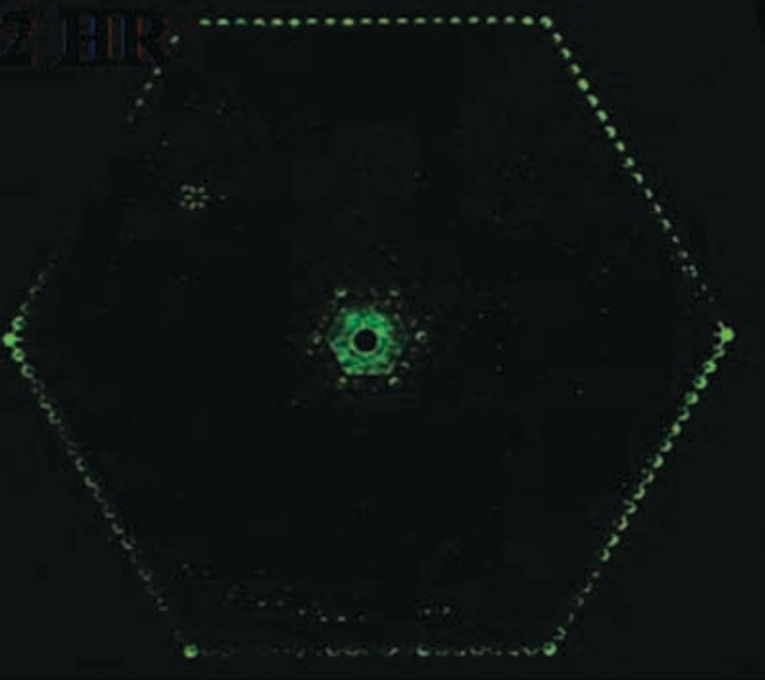
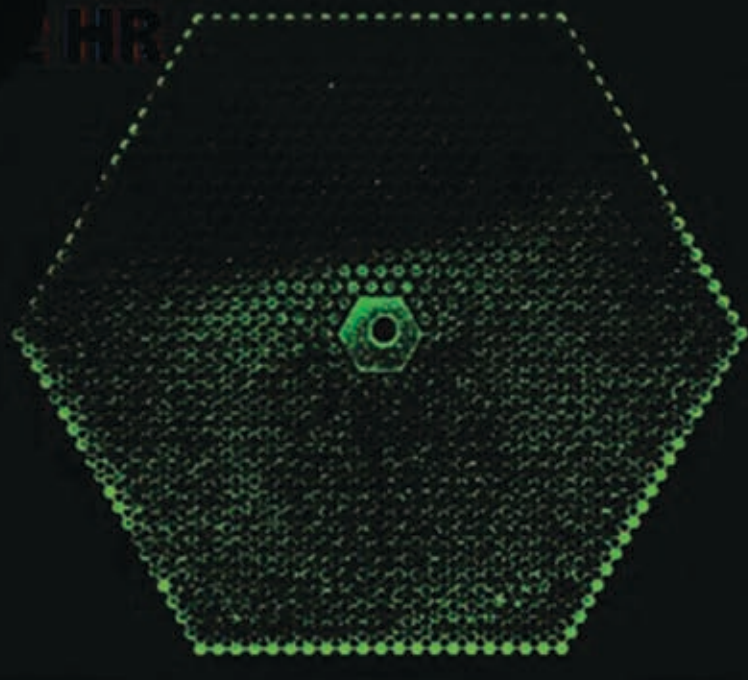


# NanoMeter

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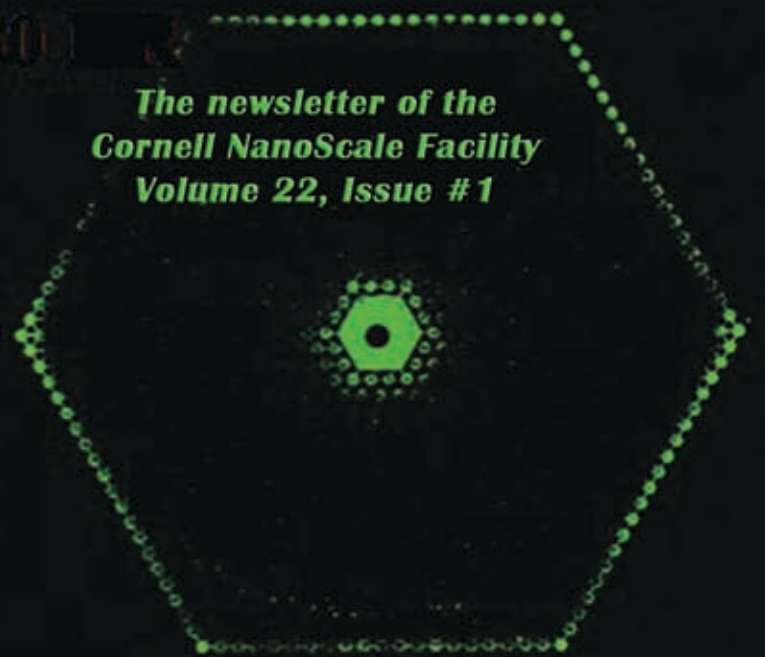


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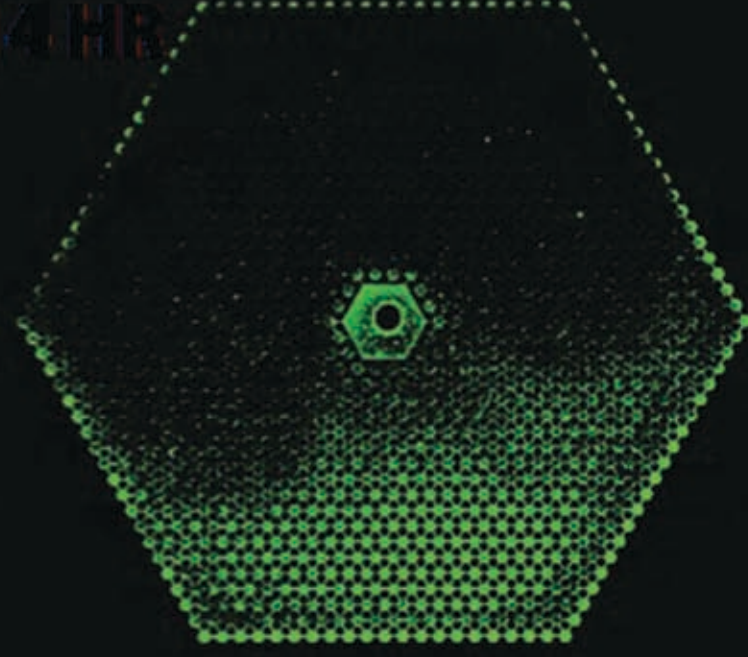


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*The newsletter of the  
Cornell NanoScale Facility  
Volume 22, Issue #1*



004 HR



# Table of Contents

2013 CNF Annual Meeting  
Corporate Sponsors. . . . .2

Welcome to the 2013 Summer Edition  
of the NanoMeter . . . . .3

Micro Transistor Prototypes Made  
at Cornell Map the Mind . . . . .4

Nanoscale Facility Tool Map  
Makes Manufacturing Sense .. . . .5

Energy Harvester Rolls  
to Market Production.. . . .6

Don't Pull the Plug on Basic Research . . . . .7

Edwards' Vacuum Technology and  
Semiconductor Process Workshop . . . . .8

Oxford Instruments Plasma Processing  
Seminar at Cornell .. . . .9

Follow @CNFComputing on Twitter . . . . . 10

New CNF User Wiki . . . . . 10

Remote Process  
Work Options at CNF .. . . . 10

The 2013 CNF REU Interns! . . . . . 10

Leica EM Critical Point Dryer 300 . . . . . 11

Objet30 Pro 3D Printer . . . . . 11

SUSS MicroTec SCIL.. . . . 11

Save the Date!  
January 2014 CNF TCN . . . . . 12

Photography Credits . . . . .2

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The cover image for this NanoMeter is from Prof. Robert Austin's research, "Construction of Synthetic Ecologies" — CNF Project Number: 398-91. As reported in the 2012-2013 CNF Research Accomplishments, pages 2-3.

This background image is from 2013 NNIN/CNF REU Intern Brandon Pereyra. This past summer, Brandon worked with PI Prof. David Erickson and mentor Syed Saad Ahsan (a 2007 NNIN REU Intern, himself!) on "Surface Scatterers on Slab-Wave Guides for Uniform Bacteria Growth." All the National Nanotechnology Infrastructure Network Research Experience for Undergraduates (NNIN REU) Program reports will available online at [http://www.nnin.org/nnin\\_reu.html](http://www.nnin.org/nnin_reu.html).

Photographs in this issue were taken by CNF staff, especially Don Tennant and Sam Wright. Research photographs are credited as noted.

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## Welcome to the 2013 Summer Edition of the NanoMeter

**This issue will highlight several important items of news about the CNF, as well as examples of outstanding science and engineering being done by CNF users.**

As you know the National Nanotechnology Infrastructure Network (NNIN) is in its 10-year and therefore CNF and our university partners are participating in an open recompetition for new network funding. The proposal has been submitted and we are expecting to have the various review aspects of the process completed over the summer - then we wait! We expect to learn of NSF's decision near the end of 2013, with new network funding beginning in early 2014. The accomplishments of the user community continues to be a vital measure of the value that NNIN sites bring to the nation's research enterprise, so please respond promptly to the information requests we make to continue to allow us to serve you at the highest level of performance.

We also have had a busy period of tool acquisitions as we replace many older systems with new equipment to help us to continue to improve leading edge performance, uptime and reliability in the lab. Most noteworthy has been the arrival of the JEOL JBX 9500FSZ. The new system has been developed jointly in a partnership between CNF and JEOL, and funded by a NSF instrumentation grant. The 9500 passed its acceptance tests with ease and is now available for the community to train on and use. We are also pleased to announce that a new Oxford "Cobra" ICP etcher should be arriving this summer to allow HBr etching of silicon and methanol etching of magnetic material. In the pipeline we have new photolithography equipment, 300mm wafer spin and coat equipment, a new ion mill (Dan says the current one predates the ion), an update in the mask making area, a new high purity critical point dryer, and more! Please see the separate articles in this issue of the NanoMeter to learn more about these instrumentation activities.

Please note the dates for upcoming events on the back page and check our web site often for news updates. We hope you enjoy this latest edition and please stay in touch and wish us luck on the recompetition!

*Dan Ralph, Lester B. Knight CNF Director  
Don Tennant, CNF Director of Operations*



**Images  
from the  
JEOL 9500  
Moving Day!**

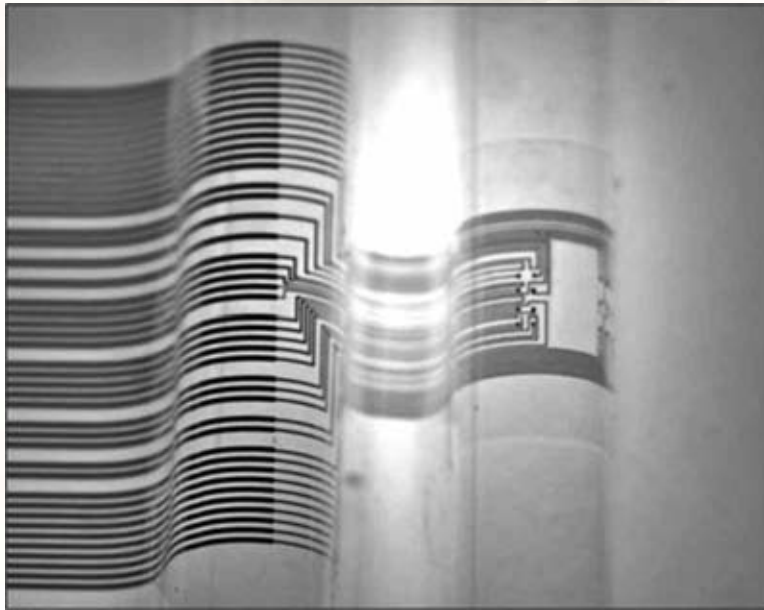


**Our very own Dr. Mandy Esch became a United States citizen this summer! She now has a dual citizenship with Germany.**

## Micro Transistor Prototypes Made at Cornell Map the Mind

April 11, 2013

By Blaine Friedlander, Cornell Chronicle



*This micro transistor can now obtain high-quality amplification and brain-signal recording better than ever before. A French scientific team used the Cornell NanoScale Science and Technology Facility to develop the prototypes. Figure Credit: Department of Bioelectronics, Ecole Nationale Supérieure des Mines de Saint Etienne, France*

To make better mind maps, a group of French scientists — building on prototypes developed at the Cornell NanoScale Science and Technology Facility (CNF) — have produced the world’s first microscopic, organic transistors that can amplify and record signals from within the brain itself.

Helping patients and doctors alike, this is a substantial, 10-fold improvement in signal quality compared with current electrode technology.

In epileptic patients, recordings help to scout brain regions responsible for seizure genesis. For patients with brain tumors, recordings help to chart the brain for tumor removal. In addition, electrical recordings of neuronal activity are being used in brain-machine interfaces to help paralyzed people control prosthetic limbs.

High-quality recordings of brain activity — challenging at best — need to be carefully amplified, but today’s amplifiers are bulky and placed outside the skull, where the signal degrades. These new biocompatible, microdevices are flexible enough to go inside the brain and follow the curvilinear shape of the brain surface.

To develop the prototypes, the scientists used the CNF lithography and characterization suite of tools — which validates never-before-used concepts. The staff’s experience converted initial designs into real devices quickly.

“To understand how the brain works, we record the activity of a large number of neurons. Transistors provide higher-quality recordings than electrodes — and, in turn, record more neuronal activity,” said George Malliaras of the Microelectronics Center of Provence, France, and a lead author on the research. “The CNF prototyping allowed us to skip having to reinvent the wheel and saved us precious time and money.”

The study, “In Vivo Recordings of Brain Activity Using Organic Transistors,” was published in *Nature Communications*, March 2013. The System Neuroscience Institute, Marseille, France, and Microvitae Technologies, Gardanne, France, also contributed to the research. The CNF is funded by the National Science Foundation.

## Nanoscale Facility Tool Map Makes Manufacturing Sense

May 28, 2013

By Anne Ju, Cornell Chronicle

It's a common peril for many small companies that make circuits, sensors or other devices: Making a handful in a few days — no problem — but how are they going to make a million of them in a month?

The problem is called design-for-manufacturing — making devices with an eye toward scaling up for manufacturing processes later. The Cornell NanoScale Science and Technology Facility (CNF) is partnering with a statewide educational and research powerhouse to solve it.

CNF, Cornell's National Science Foundation-supported nanotechnology experimentation and fabrication facility, has formed a partnership with the Smart System Technology and Commercialization Center (STC) in Canandaigua, N.Y., part of SUNY's College of Nanoscale Science and Engineering (CNSE), to streamline the design process and help companies plan for mass manufacturing.

The project is aimed at assisting companies, particularly small businesses and startups, who are planning to make the transition from small-scale research and development to manufacturing of MEMS (microelectromechanical systems), sensors and other microelectronic components.

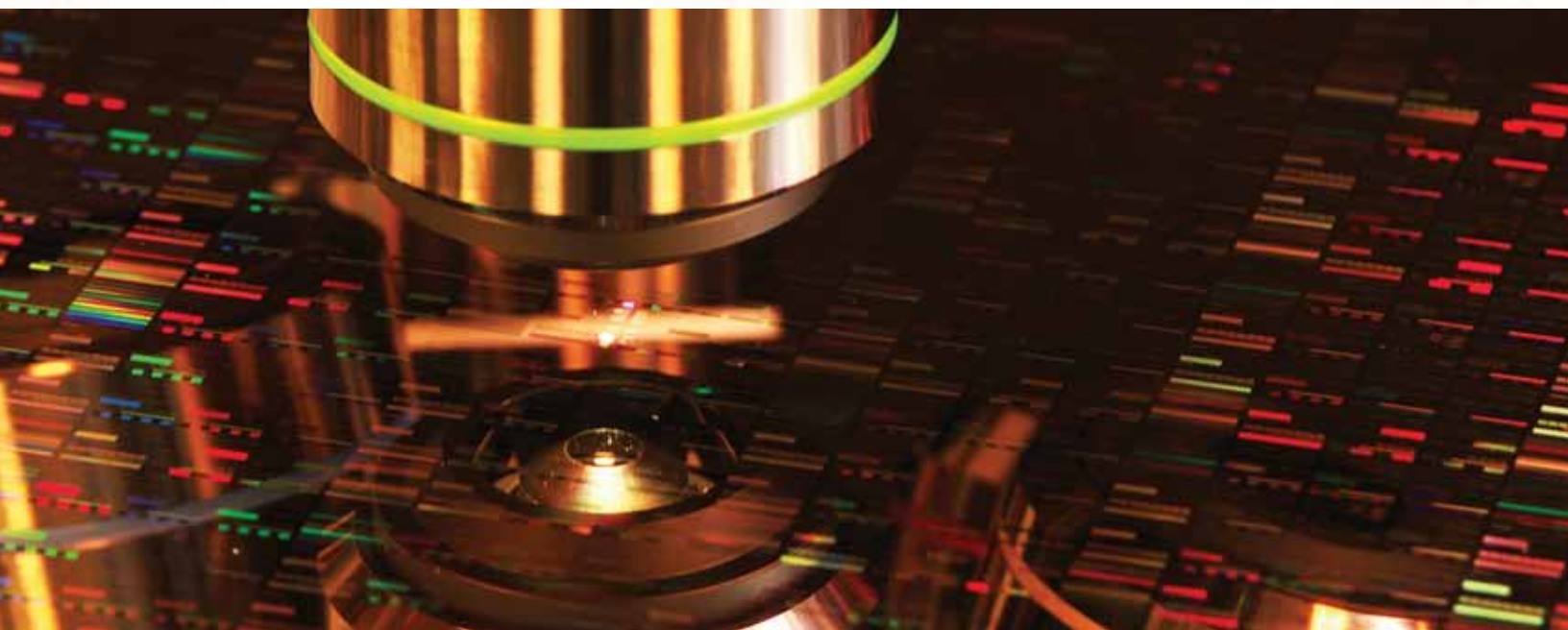
"Often people have a great idea and a great device, but they don't know how to manufacture it," said Don Tennant, CNF director of operations. "We want people to build in manufacturability as soon as possible in the process."

The key is a "tool map" that Christopher Alpha, a staff scientist at CNF, has helped develop. The tool map is a guide for companies who do their device design at CNF, but might want to use CNSE's STC, which is a MEMS foundry, to mass-produce their devices once they're ready for commercialization.

For example, CNF offers eight different lithography tools, only four of which have technical counterparts at CNSE's STC. A company would reference the tool map and align their tool selections in the early design phases at CNF to adhere to the ones also available at STC.

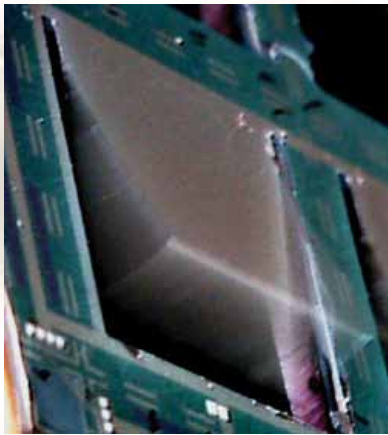
"It is a pain that a lot of small companies end up having," Alpha said. "You start a process at a place like this, and you have a very broad palette of tools to work with here. You go to manufacture your product, and you have to hunt around for a MEMS facility or foundry with the tools that match, but generally they don't, and you have to overhaul everything. This slows down time to market."

The partnership is still in its early stages, Tennant said. The hope is that such a model could extend to other sites in the National Nanotechnology Infrastructure Network, of which CNF is a member, and that research facilities like CNF can be feeders for facilities like CNSE's STC, as a way of bridging high-tech research and high-tech manufacturing.



## Energy Harvester Rolls to Market Production

By Blaine Friedlander, Cornell Chronicle  
May 2, 2013



Like a windmill snags the breeze, ambient vibration causes the tiny micro flap shown here to swing back and forth. This generates electrical current, which is harvested for the rechargeable thin-film battery.

Farewell, expensive single-charge batteries. A new concept becomes proven reality, as MicroGen's nanotechnology-based energy harvester – researched and developed by the company at the Cornell NanoScale Facility (CNF) – begins commercial-scale production this summer.

Batteries – like AA or AAA or lithium batteries – are often cost prohibitive for industrial or commercial entities using wireless sensors in distributed “smart” networks. “Sensors observe equipment status and condition, process automation control points, energy usage and many, many other critical parameters,” says Robert Andosca, president and CEO of MicroGen Systems Inc. of Ithaca, N.Y., and Rochester, N.Y.

“There’s not only the cost of the batteries, but there is labor cost in continually replacing them. With these energy-harvesting devices, it will save prohibitive battery replacement and associated labor costs,” says Andosca.

MicroGen's BOLT micro-power modules (MPM, a complete battery replacement unit), destined for the U.S., European and other markets, gather ambient vibration much like a windmill grabs the breeze and changes it into energy.

In industry parlance, this is a “piezo-MEMS” – or, piezoelectric microelectromechanical systems – device. The low-cost piezo-MEMS energy harvester chips are currently fabricated at the X-Fab MEMS Foundry in Itzehoe, Germany.

MicroGen's BOLT goes into commercial production this summer. Using the CNF, MicroGen used nanotechnology to develop a tiny energy harvester contained in a larger package seen here.

MicroGen's energy harvester had humble beginnings at the National Science Foundation-funded CNF, as MicroGen and CNF staff developed prototypes. “If we are to realize the economic impact of nanotechnology, it is vitally important that the prototyping activities in the lab get translated into products that form commercial ventures,” says Don Tennant, Director of Operations at CNF.

Andosca concurs. “The CNF and its staff were key to MicroGen's development, which has allowed us to get our green, battery-free micropower sources to market,” he said.

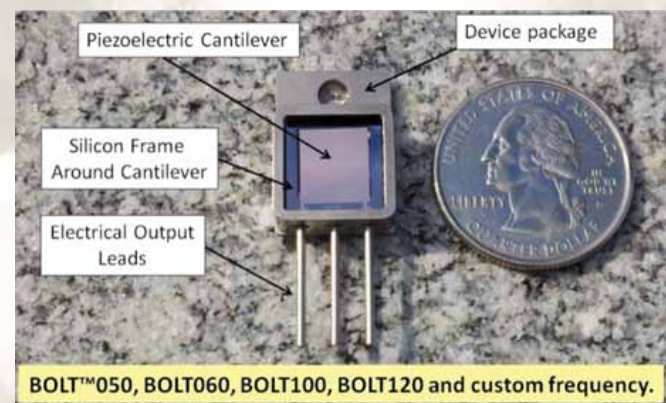
The micropower generator is a low-cost, long-lifetime device that scavenges otherwise wasted vibrational energy. Vibration causes the tiny micro flap in the device to swing back and forth, which generates electrical current that charges an adjacent ultra-capacitor or rechargeable thin-film battery. In an automobile's tire pressure sensor, for example, this device collects the vibrations from the tires meeting the road and offers unending power for the sensor.

The convenience: a car's owner never has to worry about replacing sensor batteries in awkward places. The environmental impact: eliminating 164 million depleted coin-cell batteries each year that would otherwise need to be recycled.

Uses for these energy devices could include industrial, building and commercial wireless sensor markets, machinery monitoring, lighting control and smart utility metering. They could also be used in transportation systems, civil infrastructure monitoring and asset tracking. They could help report outside temperatures at vineyards and help power wireless price tags at stores.

About three years ago, MicroGen obtained a portion of its startup funding from Cornell's Energy Materials Center and the New York State Energy Research and Development Authority (NYSERDA) to support research on this product at the CNF. Eventually, the company will reimburse NYSERDA through royalties, now that commercial scale production will soon begin. The funding enabled MicroGen to build, test and redesign the product to ensure that the energy harvester met industry standards for wireless sensor unit power levels.

Says CNF's Tennant: “MicroGen is a great example of how we can work with companies in order to turn their ideas into designs that are practical to mass produce at commercial fab facilities.”



## Don't Pull the Plug On Basic Research

April 25, 2013

In their Forbes blog today, President David Skorton and Professor Glenn Altschuler tackle federal funding of basic research. They write: "One of the great success stories of the post-World War II era, the NSF [National Science Foundation], we fear, however, is becoming less and less able to enhance our nation's scientific capital."

NSF funding accounts for 22 percent of the \$600 million per year Cornell receives from public and private research sponsors "and is the largest single contributor to research in the physical and mathematical as well as social sciences," they write.

What do taxpayers get from investment in Cornell research? A few examples:

The Cornell Center for Materials Research assembles atoms in ways never seen in nature for applications ranging from computer memory to replacement body parts.

The Center for Advanced Computing provides high-performance computing systems, database, storage, programming, porting, tuning and training services to Cornell researchers, corporations, small businesses and IT industry leaders.

The Cornell High Energy Synchrotron Source houses synchrotron radiation facilities for research in physics, chemistry, biology and environmental and materials sciences.

The Cornell NanoScale Facility provides resources to support a broad range of projects in the physical sciences, engineering and life sciences.

"Cuts in the NSF will surely not enhance our national security," Skorton and Altschuler write. "... For more than 60 years, federally funded scientific research has generated discoveries that lead to new technologies, products and industries. By maintaining a substantial investment in basic research, we invest in ourselves and in our future. The NSF is a national treasure. We need to make it a national priority."



# Edwards' Vacuum Technology and Semiconductor Process Workshop

## A one-day complementary Edwards' technical workshop

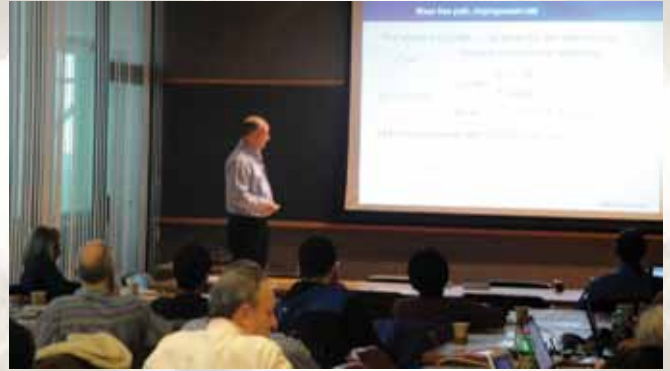
On the 15th November 2012, Edwards Vacuum conducted a vacuum and semiconductor applications workshop in Clark Hall. A morning session was run by Dr. Andy Chew, who received his PhD in Vacuum Metrology from University of York, UK. Dr. Chew travelled from Edwards H.Q. just outside of London to present vacuum theory and concepts covering the physics behind modern vacuum technology, gas flow, materials and also practical application of various pumping and measurement technologies. The afternoon session was run by Dr. Anthony Taylor, who received his PhD in Physics from Rensselaer Polytechnic Institute, and travelled from Boston, MA, to present a detailed review of the challenges faced in Semiconductor and Photovoltaic Panel Manufacturing, and the various techniques and technologies available to achieve reliable operations in both a manufacturing and R&D scale environments.

Edwards Vacuum is a leading global supplier of vacuum pumping and gas abatement for a wide range of applications, including High Energy Physics, Research and Development, the manufacture of semiconductors, flat panel displays, LEDs and solar cells, and a leader in vacuum technology for industrial, pharmaceutical, chemical, scientific, process, glass coating and food packaging industries.

Edwards employs around 3,000 people worldwide in the design, manufacture and support of high technology vacuum and exhaust management equipment. Edwards offers a wide range of other pumping technologies and related products, supported by an international sales and service organization.

Question regarding the Vacuum Workshop can be directed to [vikrant.chidgopkar@edwardsvacuum.com](mailto:vikrant.chidgopkar@edwardsvacuum.com), who is a regular visitor to Connell and supports vacuum pumping applications across the campus.

Regards,  
 Vikrant Chidgopkar | Account Manager | Edwards  
 Cell: 617-515-4877 | Fax: 866-695-3395 |  
<http://www.edwardsvacuum.com>

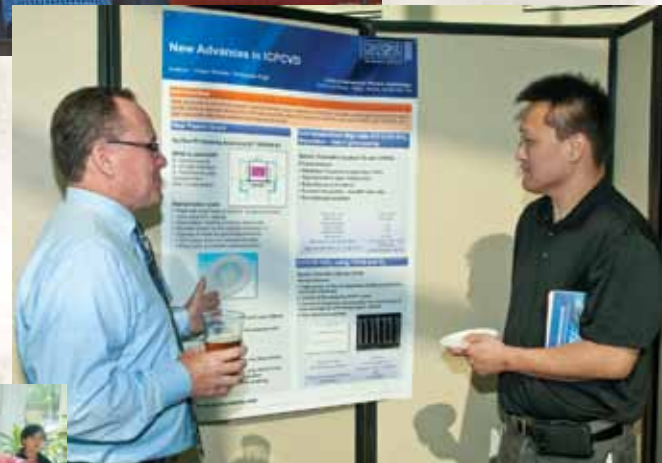




# Oxford Instruments Plasma Processing Seminar at Cornell

In our continuing effort to support our vendors, Oxford Instruments Plasma Technology and the Cornell NanoScale Facility (CNF) co-hosted a technical seminar addressing the latest research and technologies in plasma etch deposition and growth.

This one-and-a-half day event was held in August, at Cornell University, and included presentations, discussions, a poster session focusing on latest innovations, and a networking lunch.



## Remote Process Work Options at CNF

The CNF is primarily a hands-on facility, offering researchers access and training to use a comprehensive tool set with the support of an experienced technical staff. On a very limited basis though, CNF staff assist with small jobs on a best effort basis that involve just a few, routine process steps.

But did you know that in addition, several independent fabrication consultants offer their services to clients? Although not formally affiliated with the CNF, these contractors are trained CNF users, offer expertise in a variety of fabrication technologies, and provide their own liability insurance. While CNF cannot warranty the work of consultants, we are glad to assist in advertising fabrication opportunities to the community of consultants. We leave it to prospective employers to negotiate the terms of service directly with the applicants.

We do believe learning the ropes from our great staff is the best way to get the results you need, however, if traveling to CNF is just not practical, check out our listed consultants on our website at: [http://www.cnf.cornell.edu/cnf\\_remotework.html](http://www.cnf.cornell.edu/cnf_remotework.html)

Follow @CNFComputing on Twitter

“Digital Bits from the CNF IT World.”

What's on the minds of the CNF IT Staff?  
What's trending in the CNF Computing Arena?  
Follow us @CNFComputing!

## New CNF User Wiki

We are pleased to announce the arrival of the CNF's own user wiki! The wiki provides a central location for up-to-date recipes, tool manuals, and tips that will help you reach your fabrication goals.

We strongly urge you to submit recipes of your own using the “contact” link. Put your trials and errors to good use, and pass on those hard-earned tricks that might help someone else!

A mobile version of the wiki is available for cell phones and tablets. Users logged in with a CNF ID can also subscribe to receive emails when specific topics are updated.

Explore the wiki at <http://wiki.cnfusers.cornell.edu/>



The 2013 CNF REU Interns!





**Leica EM Critical Point Dryer 300**

The new Leica EM CPD 300 will expand the critical point drying capabilities at CNF through streamlining the process making it quicker and more efficient by using less CO<sub>2</sub> in a smaller chamber. The chamber will take sample sizes from small chips up to two inch wafers and does not use CO<sub>2</sub> for cooling which will decrease our CO<sub>2</sub> consumption considerably.

Although CNF will continue to offer our existing Tousimis CPD for 3", 4", and 6" wafers it is likely the new Leica tool will relieve much of its work load to accommodate our growing user community.

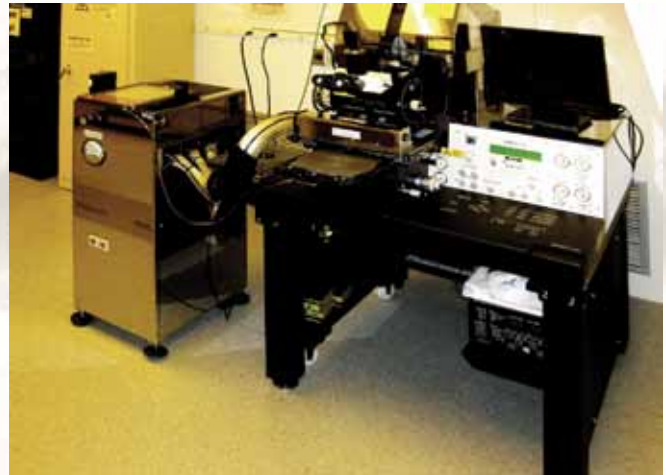
*For more information, contact Sam Wright, [wright@cnf.cornell.edu](mailto:wright@cnf.cornell.edu)*



**Objet30 Pro 3D Printer**

The Objet30 Pro combines the accuracy and versatility of a high-end rapid prototyping machine with the small footprint of a desktop 3D printer. Powered by PolyJet technology, it offers several different 3D printing materials, among them clear and high-temperature, and features the industry's highest level print resolution so you get smooth surfaces, small moving parts and thin walls. With a roomy tray size of 300 × 200 × 150 mm (11.81 × 7.87 × 5.9 in.), Objet30 Pro is ideal for prototyping electronics, devices and more. The Objet30 Pro gives you the power to create realistic models in-house - quickly and easily.

*For more information, contact Daron Westly or Sam Wright.*

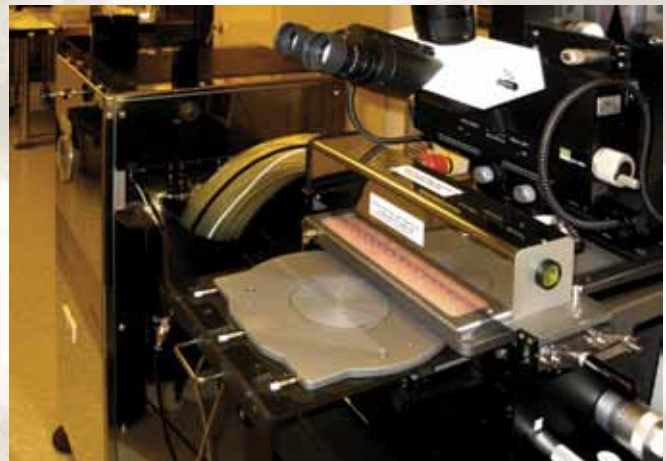


**SUSS MicroTec SCIL**

CNF has purchased a SUSS MicroTec Substrate Conformable Imprint Lithography (SCIL) tool, which had previously been at our site on approval. It will soon be made available for general use. SCIL technology involves the fabrication of an imprint stamp from a master silicon wafer. The stamp, rather than the original master, is used in the imprint process, so the (possibly quite expensive) master wafer is not at risk in the imprint process. Features smaller than 50 nm are achievable; since the final imprint is identical to the features on the master wafer, large arrays of small features that would require large amounts of e-beam time or are otherwise difficult to fabricate can, having been made just once, be replicated many times.

Additionally, the flexibility of the stamp (made in PDMS on a thin fused-silica sheet) can allow for some ability to conform to a lack of substrate flatness due to previous processing steps. Chucks are currently available for 100 mm or 150 mm wafers.

Speak to CNF staff member Dan McCollister for more information.



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**CNF NanoMeter,**  
**Volume 22, Issue 1**

**Your comments are welcome!**

*The next CNF Short Course: Technology & Characterization at the Nanoscale (CNF TCN) will be held January 14 - January 17, 2014. This intensive 3.5 day short course combines lectures and laboratory demonstrations designed to impart a broad understanding of the science and technology required to undertake research in nanoscience. Registration will open online in late 2013. <http://www.cnf.cornell.edu>*



**Save The Date!**

*The Cornell NanoScale Science & Technology Facility (CNF) has been serving the science and engineering community since 1977. The CNF is supported by the National Science Foundation, the New York State Office of Science, Technology & Academic Research (NYSTAR), Cornell University, Industry, and our Users.*

*To be added to our CNF NanoMeter mailing list or to correct a mailing address, please send your request via email to: [information@cnf.cornell.edu](mailto:information@cnf.cornell.edu). You will also find the NanoMeter in PDF on our web site at: <http://www.cnf.cornell.edu>*