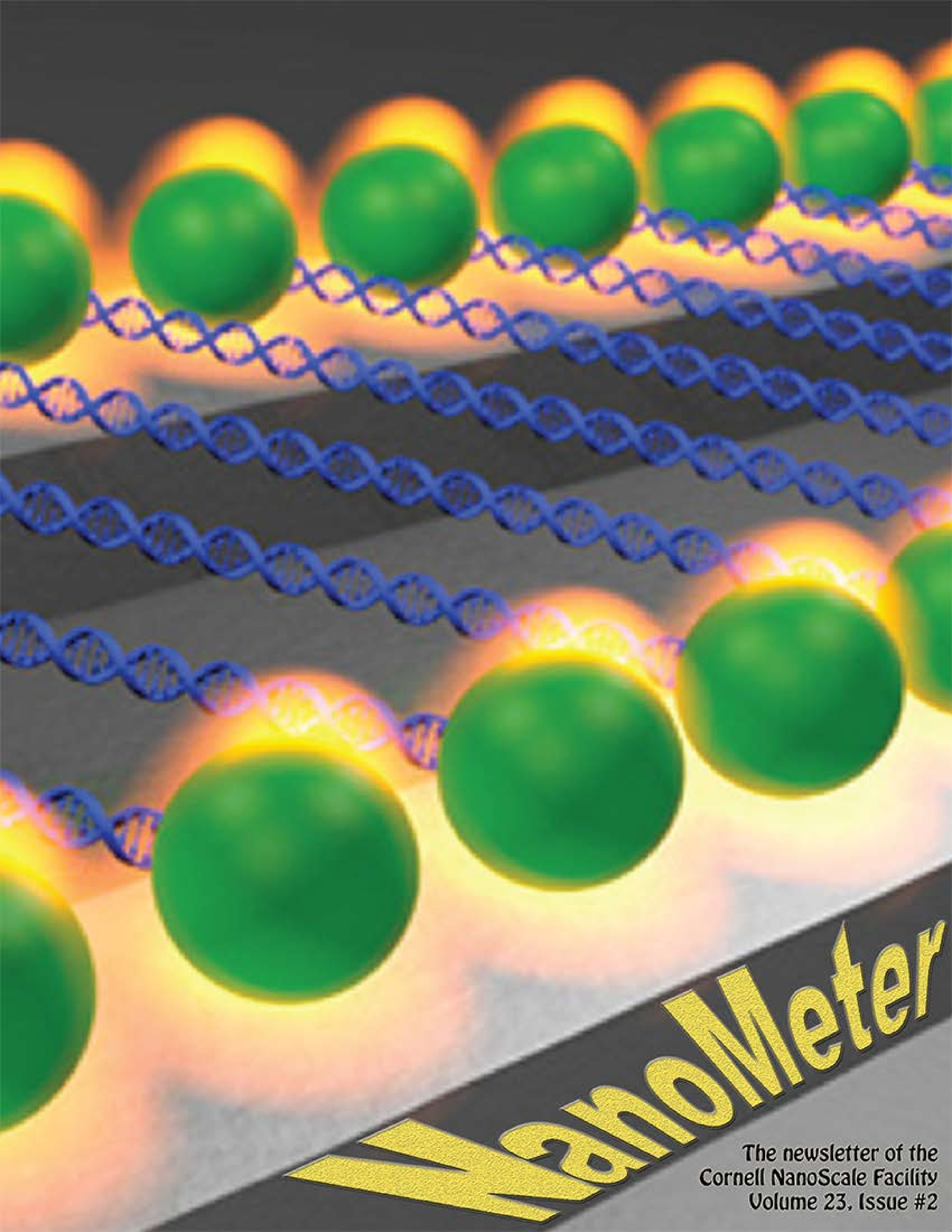

NanoMeter

The newsletter of the
Cornell NanoScale Facility
Volume 23, Issue #2

Table of Contents

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@CNFAnnualMtg #CNFAM2014

Gifts to Cornell NanoScale Facility

Help us to maintain the capabilities and culture of the CNF as an open user facility, dedicated to advancing all fields of nanoscience and engineering, and providing hands-on education in these fields. Whether made by an individual or a corporation, gifts both large and small can make a difference.

Find out more at http://www.cnf.cornell.edu/cnf_gifts.html

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.

The cover image for this NanoMeter is from Professor Michelle Wang's research, featured on page 8. Photographs were taken by CNF staff, especially Don Tennant and Sam Wright. Research photographs are credited as noted.

The NM is printed on 10% post-consumer paper using soy-based inks. Please do your part to reduce, reuse, and recycle.

Send address changes to information@cnf.cornell.edu

Welcome to the 2014 Fall Edition of the CNF NanoMeter

NSF Funding:

The big news over the last several months has involved the actions of the National Science Foundation (NSF) in regard to the competition for the Next Generation National Nanotechnology Infrastructure Network (NG-NNIN), which had been planned as the means by which NSF would fund shared open user facilities for nanotechnology over the next ten years. Most of you have already heard this news via our emails to you.

After more than two years of work, the NSF has announced that they will be not be funding either of the proposals that were submitted as part of this competition. However, they have re-affirmed their support of shared facilities to provide nanotechnology infrastructure, and have provided an extra year of bridge funding for the existing network of facilities, including CNF.

Following a period of open public comments, the NSF convened a panel in August to reconsider the direction for a beyond-NNIN program, and it appears that they are planning to start a new competition all over again from the beginning.

The official NSF announcement is available at http://www.nsf.gov/news/news_summ.jsp?cntn_id=131012.

We will keep you informed by email as we learn anything more. If you would like to be added to our email distribution list, please send a note to Melanie-Claire Mallison at mallison@cnf.cornell.edu.

New Equipment:

The CNF has installed a bumper crop of new instruments and upgrades in the past year. Since the Summer edition of the Nanometer, we have completed installation of a new Ion Mill and the Anatech Resist Barrel Asher (see the articles in this issue). The Oxford Instruments PlasmaLab 100 Cobra ICP etcher also was installed and is already producing nice results with methanol etching of magnetic thin films.

New facilities for LPCVD TEOS are being assembled (check back soon). 300 mm Spin and Bake capabilities are here to support e-beam lithography that requires large wafers. Installation has begun on a new Arradiance ALD that will expand our array of coating materials and will handle micro particles.

Upgrades are underway for our evaporators — the odd hour is completed and the even hour will start later this month. Three PlasmaTherm etchers will soon get computer upgrades (work to begin in September). The two Oxford 80s are getting PLC upgrades and optical emission systems will be installed during the maintenance periods.

And in case you missed it, we are also a 3-D printing house now, and users are finding many new areas of impact for that system.

As always, we welcome your comments about CNF and its operations, as well as your suggestions for improvement.

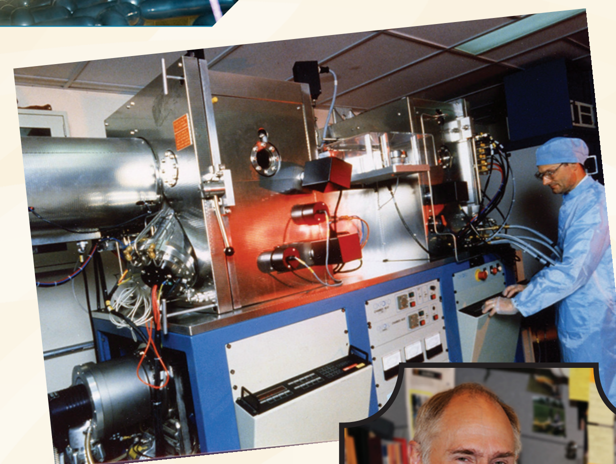
Dan Ralph and Don Tennant

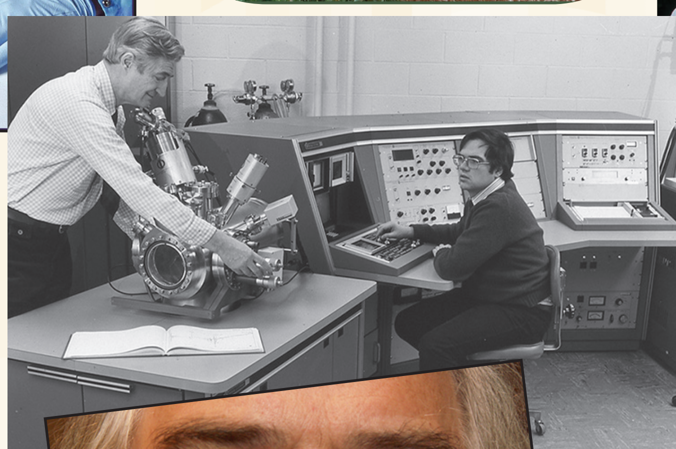




Please help us spread the word — we are open and we continue to welcome researchers from academia, government labs, and industry to the Cornell NanoScale Facility!

A Few CNF Staff ..... Then and Now!





Optical Traps on Chip Manipulate Many Molecules at Once

By Anne Ju, Cornell Chronicle
May 2, 2014

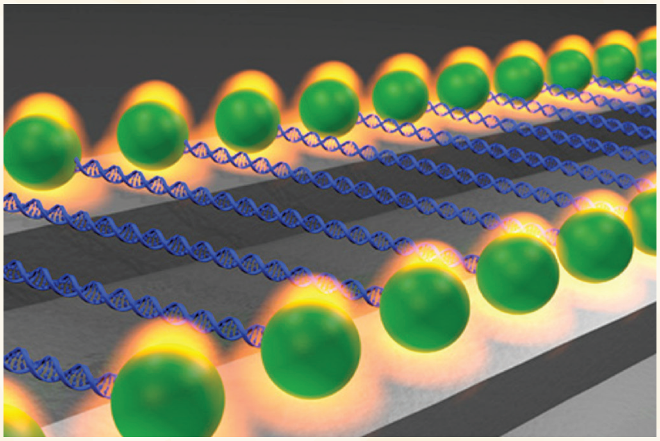


Figure 1: An illustration of a nanophotonic standing wave array trap (nSWAT) for parallel manipulation and measurements of single molecules. Here, an array of DNA molecules with a bead attached at each end is precisely manipulated between two nSWATs. The position of each nSWAT is independently controlled to relocate and transport the array of trapped beads. Robert Forties

Optical trapping, a technique for studying single molecules, is traditionally delicate, requiring special equipment and a soundproof room, with data collected one molecule at a time.

Cornell physicists have shrunk the technology of an optical trap, which uses light to suspend and manipulate molecules like DNA and proteins, onto a single chip. And instead of just one molecule at a time, the new device can potentially trap hundreds of molecules at once, reducing month-long experiments to days.

"We love single-molecule experiments because the data are beautiful and clear, and we learn so much by manipulating and perturbing molecules and watching how things change," said Michelle Wang, professor of physics, who led the study published online in Nature Nanotechnology April 28. But the experimental technique itself could use some improvement, which motivated Wang, who studies DNA and its associated motor proteins, to contemplate solutions.

Wang and colleagues developed a new type of optical trap, drawing on nanophotonics – in this case, using light as nanoscale controllers – as well as on-chip electronics and microfluidics to make a low-power, stable device that can be fitted to conventional microscopes.

Their key innovation is the generation of controllable optical standing waves in nanophotonic waveguides, formed by two counter-propagating light waves, which function as optical trap arrays. This design recycles the same light to produce multiple traps, each of which can hold one molecule, for example, a single molecule of DNA.

"What we have here is a stable and controllable three-dimensional trap array," Wang said. "That's never been done before." They call their device a nanophotonic standing wave array trap, or nSWAT.

To test the device's stability – a key breakthrough – lab members physically tapped on the microscope where they'd mounted their chip. Due to the compact nature of the device, which fits on a penny, they detected little, if any disturbance.

In their paper, they also described transporting molecules over a relatively long distance using the waveguides. This ability lets the new optical trap integrate with existing fluorescence labeling techniques for tagging molecules of interest.

Fabrication of the nSWAT was done exclusively at the Cornell NanoScale Science and Technology Facility (CNF).

Experiments described in the paper, "Nanophotonic trapping for precise manipulation of biomolecular arrays," were completed primarily by co-first authors Mohammad Soltani and Jun Lin, both postdoctoral associates in the Wang lab, with substantial help from several students and postdocs in the lab. Early stages of the project involved helpful discussions with, and loaned equipment from, co-author Michal Lipson, professor of electrical and computer engineering, a nanophotonics expert.

The American Cancer Society, National Institutes of Health, National Science Foundation, and the Howard Hughes Medical Institute, where Wang is an investigator, provided funding.

Move Over, Silicon? New Transistor Material Tested!

By Anne Ju, Cornell Chronicle
June 27, 2014

For the ever-shrinking transistor, there may be a new game in town. Cornell researchers have demonstrated promising electronic performance from a semiconducting compound with properties that could prove a worthy companion to silicon.

New data on electronic properties of an atomically thin crystal of molybdenum disulfide are reported online in Science June 27 by Kin Fai Mak, a postdoctoral fellow at the Kavli Institute at Cornell for Nanoscale Science. His co-authors are Paul McEuen, the Goldwin Smith Professor of Physics; Jiwoong Park, associate professor of chemistry and chemical biology; and physics graduate student Kathryn McGill.

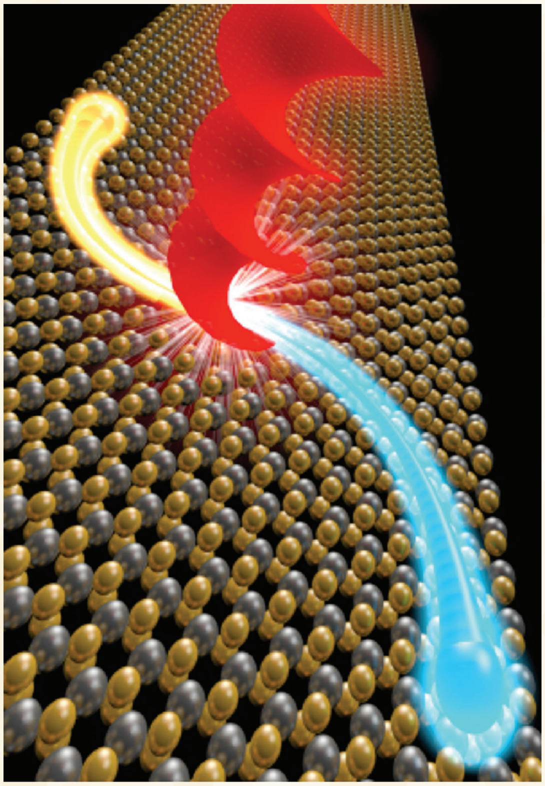


Figure 1: Atoms of molybdenum (gray) and sulfur (yellow) are shown in a two-dimensional crystal formation. A laser hits the surface in a spiral, causing a valley current carried by an electron-hole pair, to move through the crystal. Kathryn McGill

Recent interest in molybdenum disulfide for transistors has been inspired in part by similar studies on graphene – one atom-thick carbon in an atomic formation like chicken wire. Although super strong, really thin and an excellent conductor, graphene doesn't allow for easy switching on and off of current, which is at the heart of what a transistor does.

Molybdenum disulfide, on the other hand, is easy to acquire, can be sliced into very thin crystals and has the needed band gap to make it a semiconductor. It possesses another potentially useful property: Besides both intrinsic charge and spin, it also has an extra degree of freedom called a valley, which can produce a perpendicular, chargeless current that does not dissipate any energy as it flows.

If that valley current could be harnessed – scientists are still working on that – the material could form the basis for a near-perfect, atomically thin transistor, which in principle would allow electronics to dissipate no heat, according to Mak.

The researchers showed the presence of this valley current in a molybdenum disulfide transistor they designed at the Cornell NanoScale Science and Technology Facility (CNF). Their experiments included illuminating the transistor with circularly polarized light, which had the unusual effect of exciting electrons into a sideways curve. These experiments bolstered the concept of using the valley degree of freedom as an information carrier for next-generation electronics or optoelectronics.

The paper is called "The Valley Hall Effect in MoS_2 Transistors," and the research was supported by the Kavli Institute at Cornell for Nanoscale Science, the Air Force Office of Scientific Research and the Cornell Center for Materials Research, which receives support from the National Science Foundation. CNF is also supported by the National Science Foundation.

New Class of Materials Could Power Memory Devices

By Anne Ju, Cornell Chronicle
July 24, 2014

A new phase of matter known as topological insulators, until recently known only for esoteric quantum-mechanical properties, might have a practical use in controlling magnetic memory and logic devices.

A team of Cornell and Pennsylvania State University physicists has demonstrated for the first time that electrical currents flowing along the surface of topological insulators can exert a torque on an adjacent magnetic layer that is ten times more efficient than any other known mechanism. This breakthrough provides a new strategy for making next-generation memory technologies that use the least possible energy and current.

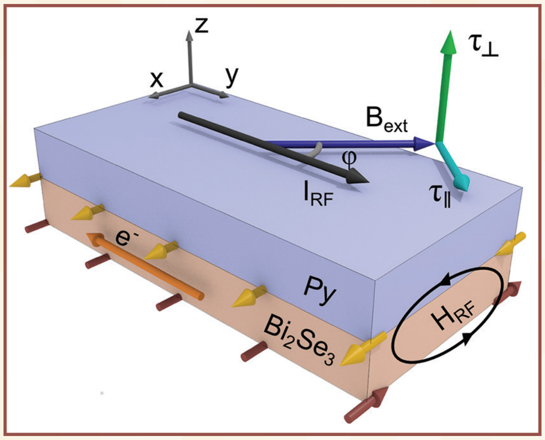


Figure 1: An illustration of the geometry, fields, torques and currents in our experiment.

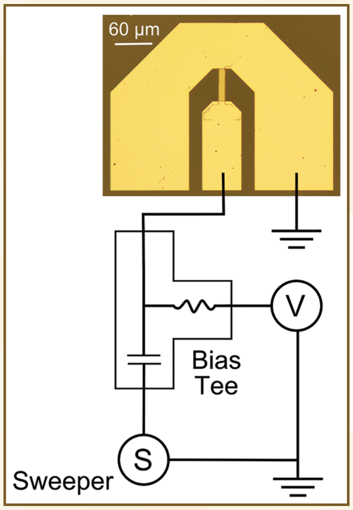


Figure 2: The measurement setup and an image of a typical microstrip device.

The research, led by Dan Ralph, the F.R. Newman Professor of Physics at Cornell, and Nitin Samarth of Penn State, is published online July 24 in the journal Nature. The team used the topological insulator bismuth selenide (a combination of bismuth and selenium) for their experiments.

Like conventional insulators, topological insulators do not allow current to flow through the material, but they are different because they are wrapped in a conducting surface. Electrons flowing on the surface also do something unique: The direction of an electron's spin is always locked perpendicular to its direction of motion. This locking provides a means for the flow of an electrical current along the surface to produce a buildup of spin that can apply torque to an adjacent magnet.

Ralph and colleagues are trying to develop new magnetic nonvolatile memory and logic devices. One of the main challenges in doing so is to find a way to quickly flip the devices' magnetization using the least possible current.

The new results show that electrical current flowing within a thin film of bismuth selenide – at room temperature no less – can be used for this purpose.

The researchers caution that actual memory devices are a long way off, but the paper, Ralph noted, can be viewed as an exciting first step for a new branch of science.

The first author of the paper, "Spin Transfer Torque Generated by a Topological Insulator," is Cornell graduate student Alex Mellnik; co-authors include Eun-Ah Kim, associate professor of physics, and colleagues.

The collaborative Cornell and Penn State work is supported by a grant from DARPA (the Defense Advanced Research Projects Agency). The Cornell team is also supported by the National Science Foundation Materials Research Science and Engineering Centers program through the Cornell Center for Materials Research, by the Army Research Office, and by the Kavli Institute at Cornell for Nanoscale Science. Research was performed in part at the Cornell NanoScale Facility.

(See Alex Mellnik's full report starting on page 182 in the 2013-2014 CNF Research Accomplishments.)

New Device Isolates Most Aggressive Cancer Cells

By Anne Ju, Cornell Chronicle
May 22, 2014

Not all cancer cells are created equal – some stay put in the primary tumor, while others move and invade elsewhere. A major goal for cancer research is predicting which cells will metastasize, and why.

A Cornell cancer research team is taking a new approach to screening for these dangerous cells, using a microfluidic device they invented that isolates only the most aggressive, metastatic cells.

"The approach we've taken is a reverse approach from what is conventionally done," said Cynthia Reinhart-King, associate professor of biomedical engineering and senior author of the recently published Technology Journal paper describing the research. "Instead of looking at what molecules are being expressed by the tumor, we're looking for the phenotype – that is, the behavior – of individual cells first. Then we can determine what molecules are causing that behavior."

Typically, searching for biomarkers of metastasis has focused on screening for certain molecules or genes expressed by large numbers of migrating cancer cells. The problem is that it's easy to miss subtle differences in the tiny subpopulations of cells that are the most aggressive.

Taking, for example, 100 tumors and seeking out molecular biomarkers for metastasis, one particular molecule might be identified as being "upregulated" in those tumors, Reinhart-King said. But it's not the whole tumor expressing that particular molecule – some cells express the biomarker and some do not.

The researchers decided to first sort cells with the most aggressive behavior, and analyze only them for molecular changes. Their innovation is a microfluidic device that contains side channels to wash out the less aggressive cells, while herding the more aggressive ones into a separate channel.

For their proof-of-concept, the researchers screened for cells with migratory responses to Epidermal Growth Factor, for which the receptor is known to be present in most human cancers and is tightly linked to poor prognosis.

"The thing we're most excited about, in addition to the physical device, is the conceptual framework we're using by trying to shift gears and screen for cells that are causing the worst parts of the disease," Reinhart-King said. The device could also be used in other applications of tissue engineering, inflammation and wound healing.

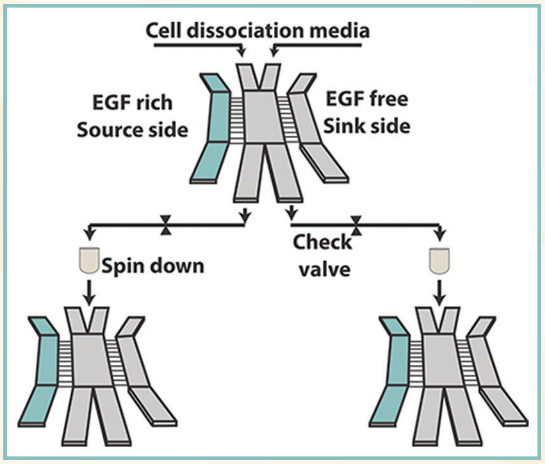


Figure 1: Design of the microfluidic device that sorts for aggressive cancer cells. Reinhart-King Lab

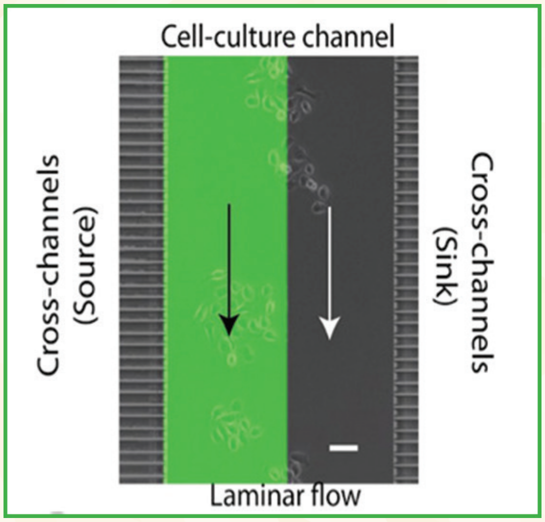


Figure 2: Overlay image of the device showing the three channels that sort the cancer cells. Reinhart-King Lab

King collaborated with co-author Michael King; the husband-and-wife team are project leaders in the Cornell Center on the Microenvironment and Metastasis, a National Cancer Institute Physical Sciences-Oncology Center, which supported the work. Authorship includes former postdoctoral associate Saumendra Bajpai and graduate student Michael Mitchell.

Ingested Nanoparticles May Damage Liver

By Anne Ju, Cornell Chronicle
August 11, 2014

Nanoparticles in food, sunscreen and other everyday products have many benefits. But Cornell biomedical scientists are finding that at certain doses, the particles might cause human organ damage.

A recently published study in Lab on a Chip by the Royal Society of Chemistry and led by senior research associate Mandy Esch shows that nanoparticles injure liver cells when they are in microfluidic devices designed to mimic organs of the human body. The injury was worse when tested in two-organ systems, as opposed to single organs – potentially raising concerns for humans and animals. The study was highlighted in Chemistry World.

Esch works in the lab of Michael Shuler, the Samuel B. Eckert Professor of Chemical Engineering. She participated in a widely read 2012 study about toxicity of nanoparticles in chickens.

"We are looking at the effects of what are considered to be harmless nanoparticles in humans," Esch said. "These particles are not necessarily lethal, but … are there other consequences? We're looking at the non-lethal consequences."

She used 50-nanometer carboxylated polystyrene nanoparticles, found in some animal food sources and considered model inert particles. Shuler's lab specializes in "body-on-a-chip" microfluidics, which are engineered chips with carved compartments that contain cell cultures to represent the chemistry of individual organs.

In Esch's experiment, she made a human intestinal compartment, a liver compartment and a compartment to represent surrounding tissues in the body. She then observed the effects of fluorescently labeled nanoparticles as they traveled through the system.

Esch found that both single nanoparticles as well as small clusters crossed the gastrointestinal barrier and reached liver cells, and the liver cells released an enzyme called aspartate transaminase, known to be released during cell death or damage.

It's unclear exactly what damage is occurring or why, but the results indicate that the nanoparticles must be undergoing changes as they cross the gastrointestinal barrier, and that these alterations may change their toxic potential, Esch said. Long-term consequences for organs in proximity could be a concern, she said.

"The motivation behind this study was twofold: one, to show that multi-organ, in vitro systems give us more information when testing for the interaction of a substance with the human body, and two … to look at nanoparticles because they have a huge potential for medicine, yet adverse effects have not been studied in detail yet," Esch said.

The paper, "Body-on-a-Chip Simulation With Gastrointestinal Tract and Liver Tissues Suggests That Ingested Nanoparticles Have the Potential to Cause Liver Injury," is co-authored by Shuler; former postdoctoral associate Gretchen Mahler, now an assistant professor at SUNY Binghamton; and Tracy Stokol, associate professor in the College of Veterinary Medicine.

The research was supported by the Army Corps of Engineers, the National Science Foundation and the National Institutes of Health. Microfabrication was performed at the NSF-supported Cornell NanoScale Science and Technology Facility.

Mandy Esch coordinates the CNF short course. *See more on page 13.*

Lynden Archer Receives Chemical Engineering Award

August 6, 2014
Cornell Chronicle

Lynden Archer, Cornell's William C. Hooey Director and Professor of Chemical and Biomolecular Engineering, has received the 2014 Nanoscale Science and Engineering Forum (NSEF) Award from the American Institute of Chemical Engineers (AICHE). Established in 2005, the award recognizes individuals who have made outstanding contributions to the advancement of nanoscale science and engineering in the field of chemical engineering. Archer was recognized "for pioneering and sustained research on nanoparticle-polymer hybrid materials and their applications in electrochemical energy storage technologies," according to his award citation. Archer will give a lecture during the NSEF plenary session Nov. 19 at the 2014 AICHE annual meeting in Atlanta.

Evan MacQuarrie from the Fuchs Research Group won the William Nichols Findley Award for his research paper, "Mechanical Spin Control of Nitrogen-Vacancy Centers in Diamond" by E.R. MacQuarrie, T.A. Gosavi, N.R. Jungwirth, S.A. Bhave, and G.D. Fuchs, Physical Review Letters 111, 227602 (2013). The award is made annually by the Cornell University Department of Applied and Engineering Physics for an exceptional research paper within the department.

Greg Fuchs Receives DOE Early Career Award

By Anne Ju, Cornell Chronicle
June 2, 2014

Gregory Fuchs, Cornell assistant professor of applied and engineering physics, has received an Early Career Research Program award from the Department of Energy Office of Science.

Fuchs received $750,000 over five years to support his project, "Time-Resolved Electrical, Optical and Thermal Probes of Topological Spin Textures in Magnetic Nanostructures," which was selected by the DOE's Office of Basic Energy.

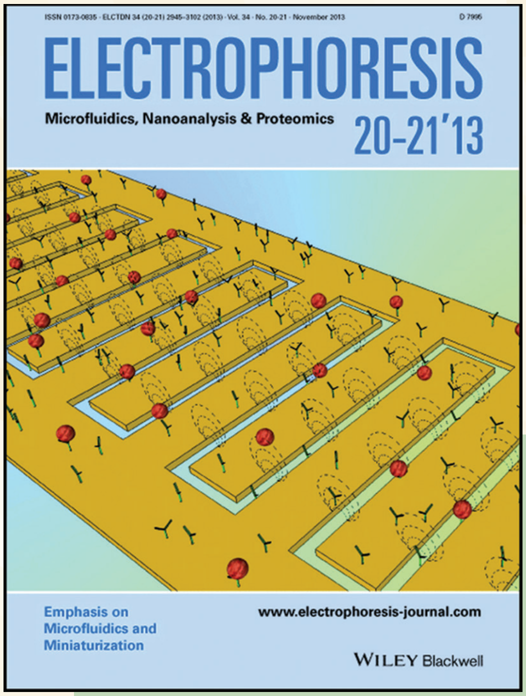
He will investigate the dynamical motion of recently discovered magnetic "particles" known as skyrmions. Skyrmions are nanoscale magnetic configurations that are distinct from ordinary magnetic states, giving them particle-like properties and a measure of protection against defects. They also move under extremely small applied currents, making them potentially useful for ultra-low-power control of information at the nanoscale.

Progress in understanding skyrmions has been limited by a lack of instrumentation to measure their behavior. Fuchs' research project will combine advanced nanofabrication, high-frequency electrical measurements, transmission electron microscopy, optical microscopy and thermal microscopy to overcome these limitations. The goal is to examine how skyrmions move in response to electrical, thermal and magnetic stimuli.

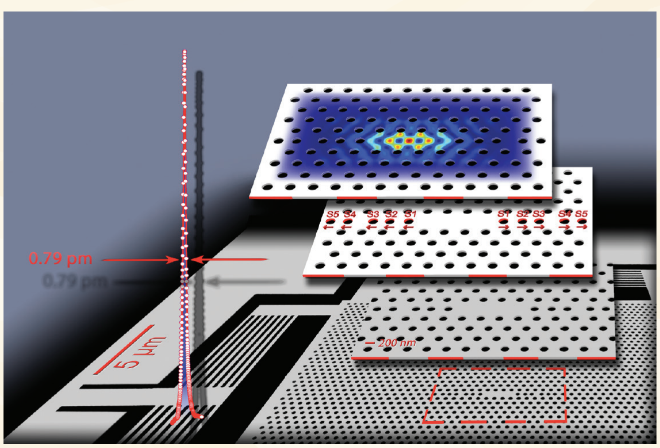
Now in its fifth year, the DOE program supports the development of research programs of outstanding scientists early in their careers, and stimulates research careers in the disciplines supported by the DOE Office of Science.

Fuchs' research at Cornell focuses on understanding and controlling spin dynamics in solid-state systems. Drawing from condensed-matter physics, atomic physics and materials engineering, his group strives to develop new optical, electrical and microwave frequency probes of spin dynamics at the nanoscale.

Fuchs' proposal was one of 36 selected from about 750 submissions.



Chao "Charlie" Huang's research on dielectrophoretic cancer cell capture was featured on the cover of Electrophoresis in November 2013. Charlie recently completed his Ph.D. in Biomedical Engineering working in Brian Kirby's research group and has started as a postdoctoral research staff member at Lawrence Livermore National Laboratory (LLNL) in Livermore, CA — in the Center for Bioengineering, Micro and Nano Technology Section of the Materials Engineering Division. At LLNL, he is continuing to develop microfluidic/ MEMS devices for biomedical applications.



Thanks to the CNF staff expertise, world-class clean-room tools, and great students, the Badolato Research Group was able to demonstrate a nanocavity with record high figures of merit, and was featured on the recent cover of Applied Physics Letters. They also received broad press coverage with more than twenty magazines reporting their results (for example the Optics & Photonics News and Photonics). See http://badolato.pas.rochester.edu/2014/06/20/broad-press-coverage-recent-apl-paper/ for more information.

University of Wisconsin-Stevens Point chemistry professor and CNF principal investigator Michael Zach (left) and Argonne nanoscientist Ani Sumant pose with their award-winning "NanoFab lab…in a box!"

The NanoFab Lab ... in a Box!™

The NanoFab Lab … in a Box!™ was just selected as one of the top 100 emerging technologies that has been added to the market place for 2013. The NanoFab Lab… in a Box!™ is an educational kit that allows easy and rapid duplication of patterned nanowires without the need for a multimillion dollar clean room. It is a completely new and different way to make the type of tiny electronics and other materials that are part of high-tech advanced manufacturing. This was selected from nearly 1000 entries by a panel of experts based upon its potential importance, potential impact to business and innovative method for solving a problem.

From the R&D100 Award website: "Widely recognized as the "Oscars of Invention", the R&D 100 Awards identify and celebrate the top technology products of the year. Past winners have included sophisticated testing equipment, innovative new materials, chemistry breakthroughs, biomedical products, consumer items, and high-energy physics."

http://www.rd100awards.com/about-rd-100-awards

http://youtu.be/W-8rhP2Qf80 is a four minute animation that describes the process behind the kit.

http://youtu.be/SSJa4NlzqKs is the YouTube version that will still make you an expert at the technique in 75 seconds.

http://www.anl.gov/articles/argonne-wins-three-rd-100-awards, Argonne's press release

http://www.uwsp.edu/urc/news/Pages/NanoFabLabaward14.aspx, UWSP's press release

"Anyone see that nanowire? It was here just a microsecond ago."

The 2014 NNIN REU, iREU, and iREG Interns at the network-wide convocation held in August at Georgia Tech.

Photograph by Melanie-Claire Mallison

The 2014 National Nanotechnology Infrastructure Network Research Experience for Undergraduates (NNIN REU) Program drew to a close with a network-wide convocation at the Georgia Institute of Technology. Each year, this special event brings together our interns from all three of our summer programs — Research Experience for Undergraduates (REU), International Research Experience for Undergraduates (iREU), and International Research Experience for Graduates (iREG). Of course the main focus of the convocation is the intern presentations, a valuable learning experience for everyone, but we also have a poster session so that the local faculty and staff have a chance to look over the research of our interns.

For all involved, it was a grand summer of successes and frustrations. Such is research and we hope the curiosity sparked in the students will become a love for the trying.

As Wilson Greatbatch, Cornellian and inventor of the pacemaker, said,

"Just immerse yourself in the problem and work hard. The true reward is not in the results, but in the doing."

For ten years, the NNIN has been "doing" — hosting these programs for 956 interns. And we'll be "doing" our eye-opening and enriching programs one more time in 2015!

Melanie-Claire Mallison
NNIN REU Program Coordinator

The 2014 NNIN REU and iREG Interns at Cornell NanoScale Facility!

Photographs by Don Tennant

This intensive 3.5 day short course offered by the Cornell NanoScale Science & Technology Facility, combines lectures and laboratory demonstrations designed to impart a broad understanding of the science and technology required to undertake research in nanoscience. TCN is an ideal way for faculty, graduate students, post docs and staff members to rapidly come up to speed in many of the technologies that users of the CNF need to employ. Members of the high tech business community will also find it an effective way to learn best practices for success in a nanofab environment. Attendance is open to the general scientific community, but class size is limited.

CNF Cornell NanoScale Science and Technology Facility

Technology & Characterization at the Nanoscale

SAVE THE DATE!

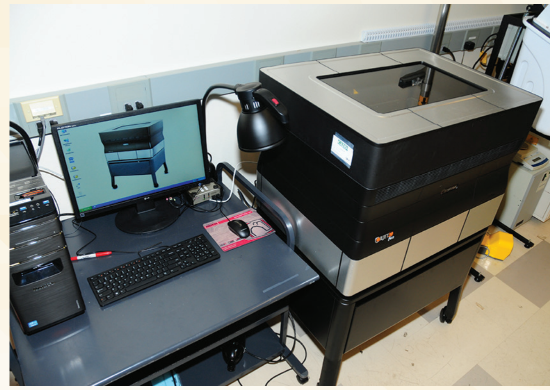
CNF TCN January 2015

Tuesday – Friday
01/13/15 – 01/16/15

Details are now available online at:

http://www.cnf.cornell.edu/cnf_tcn_january_2015.html

Cornell Groups are Printing Useful Devices on the CNF's 3D Printer



July marked the first anniversary of the installment of the CNF's ObJet 30Pro 3D printer, and it is being used by several research groups at Cornell.

The available polymers mimic polypropylene and acrylic and come in several hues (colorless, white opaque and black opaque). Printed devices can withstand low temperatures (less than 80°C) and low vacuum, which lend functionality in cell culture, casting PDMS, and parylene coating. The polymers can withstand short exposures to solvents (isopropanol, acetone, etc.) and pH changes, as well. The printed polymers have proven useful as PDMS molds, cell culture devices, replacement parts for tools, support jigs for fluidic devices and even as accessories for smartphone platforms to measure blood chemistry and physiological parameters of sweat and saliva, such as pH.

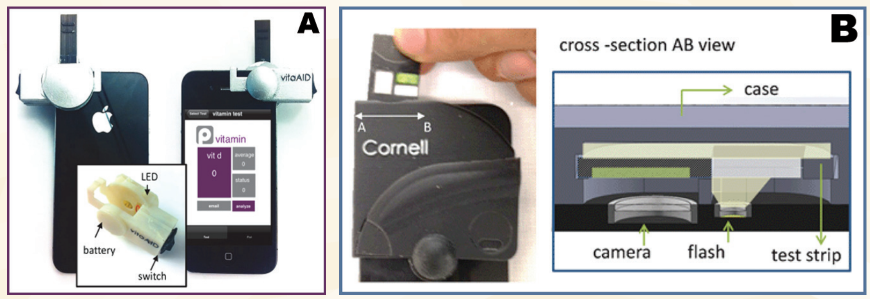


Figure 1: (A) Vitamin AuNP-based Immunoassay Device (vitaAID) accessory on an iPhone with inset showing the 3D-printed housing (RGD525 Hi-Temp material). (B) Test strip being inserted into the accessory on an iPhone for measuring the pH of sweat or saliva with a cross-sectional view of the optical system. CNF Project #2094-11.

CNF Users Seoho Lee, Matt Mancuso and Vlad Oncescu from the Erickson Lab in the Sibley School of Mechanical and Aerospace Engineering and the new start-up company, vitaME Technologies, designed and printed attachments for smartphones. The accessories that look somewhat like smartphone credit card readers, clamp over the phone's camera and have a built-in flash to illuminate a slide-in test strip (Figure 1). Professor Erickson says they are developing systems that can exploit the ubiquity of smartphone for personalized monitoring of important elements of blood chemistry, like vitamins and micronutrients. The system exploits a series of microfluidic components, photonic technologies, and standard smartphone capabilities to analyze the content of a blood sample taken from a finger stick. There is a 3D-printed reusable accessory that contains the optical interrogation infrastructure and a consumable chip that accepts the blood sample, processes it, and conducts colorimetric assay. An on-board app measures color values, compares them with optimal levels, and gives results and recommendations regarding any treatments right on the phone screen. They have made devices to measure cholesterol (Lab on a Chip, 2014. 14:1437-42), the pH of saliva and other body fluids (Lab on a Chip, 2013. 13:3232-38), and they are currently working on the measurement of vitamin D in blood (2013-2014 CNF Research Accomplishments).

CNF users Mandy Esch and Ying Wang from the Schuler Lab (BME) are using the 3D printer to make microfluidic cell culture devices. A cell culture device consists of snap-fit pieces with fluidic channels and culture media reservoirs for long-term culture of liver cells (Figure 2). Once printed, the devices are cleaned, residual polymer is outgassed under a vacuum, and the surface is covered with a few microns of parylene-C as an inert, biocompatible surface. The culture devices can be sterilized in ethanol. Esch says that the short turn-around time for testing prototypes on the 3D printer is especially useful. Previously, the culture devices were machined in polycarbonate and metal in a shop on campus, and a change in design meant weeks of waiting for the next prototype. With the printer, two or even three generations of a device can be printed in the same day.

Contact Beth Rhoades with your ideas or questions about printing a device. We provide CAD software on campus (AutoDesk Inventor 2014). The 3D printer is available to CNF users as a user-operated tool or as a printing service. So if you send the .STL format files, we can send you the printed devices and save a trip.

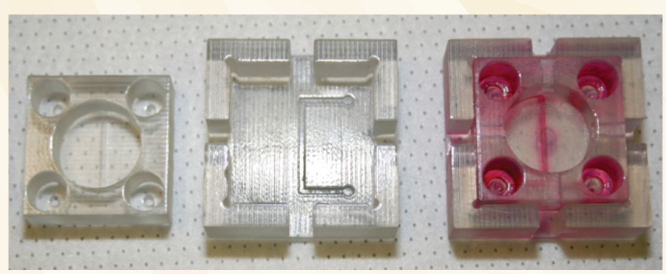
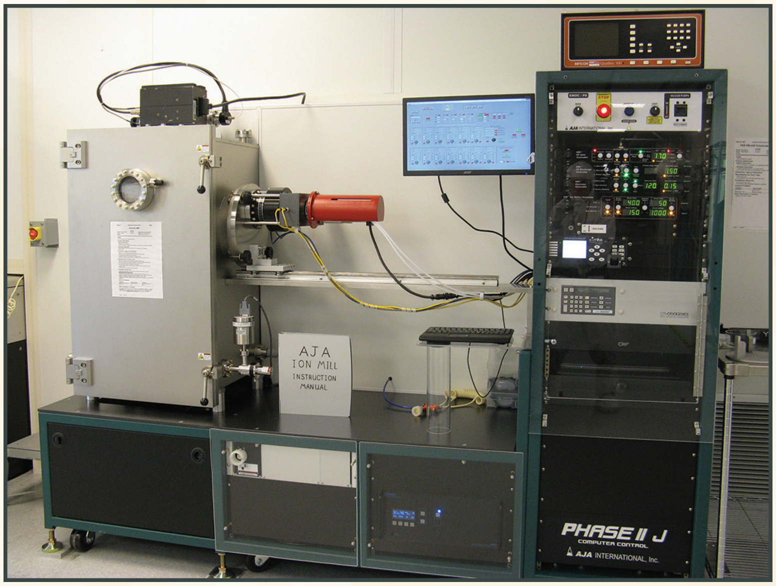


Figure 2: 3D-printed, snap-fit parts (VeroClear material) and an assembled culture device (right) with dye to illustrate fluidic channels and culture media reservoirs. CNF Project #731-98.

AJA Ion Mill



We now have added an AJA Ion Mill to our collection of etchers. It uses a dual grid Kaufaman & Robinson collimated argon ion beam with 22 cm diameter, which gives uniform etching across 6-inch wafers. This ion milling system removes material by physical sputtering, and thus allows for etching of a broad range of materials. The sample stage is water cooled, and can be tilted from 0 degrees to 90 degrees with respect to the argon ion beam.

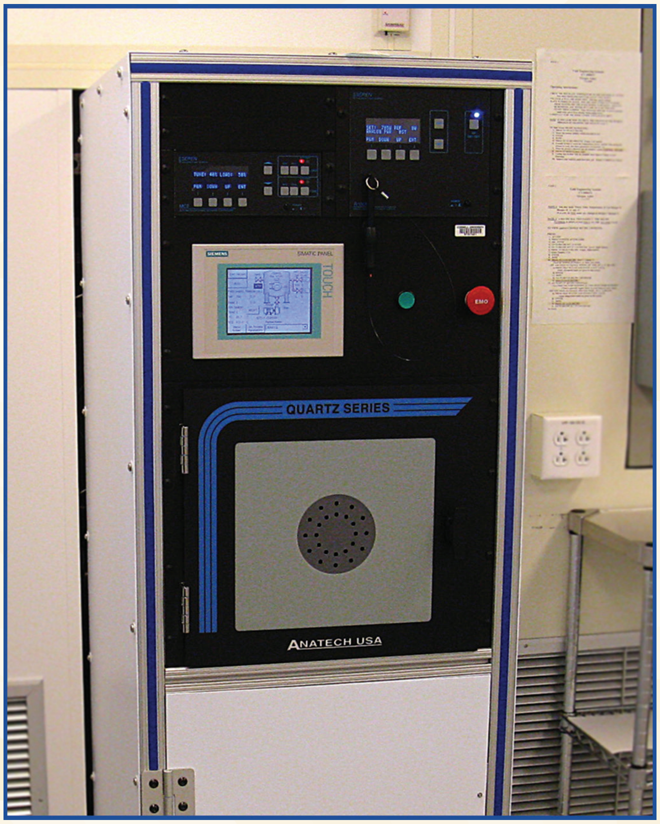
The samples can also be rotated about their perpendicular axis at up to 25 RPM during the etch. This capability is typically used to achieve etch profiles with more vertical walls, as well as higher etch rates.

The system is set up to run at four different beam energy levels, with increasing beam current densities, and they are: 400 eV @ 0.33 mA/cm2, 600 eV @ 0.9mA/cm2, 800 eV, and 1000 eV. The vacuum chamber is pumped by a CTI – 10 cryo pump, which provides very fast pump down times; 1 x 10-6 torr in a few minutes. The system is controlled by intuitive, user friendly, AJA software that allows for complex etch processes with any number of different steps, or layers, which can be set at different angles, different energies, with or without rotation, and also include shutter closed times for substrate cooling.

Typical etch rates for different materials can be determined from published data found at the system.

For more information and to be trained on this tool, please contact Jerry Drumheller at drumheller@cnf.cornell.edu.

Anatech SCE-110



We have added an Anatech USA model SCE-110 RF oxygen plasma asher to our collection of tools designed for the removal of resist and other organics from substrates.

The Anatech is an all quartz system with a 10-inch diameter x 18-inch long bell jar, which is ICP driven at 13.56 MHz. This design has the advantage of easy cleaning and minimum contamination issues. It has both oxygen and nitrogen gases available, and it can run up to three consecutive processes, of which the first process can be set to terminate on a temperature set point, rather than on time.

Oxygen plasma ashing can be done over a wide range of pressures from 0.05 torr up to 2 torr, and power levels up to 1000 watts, making it versatile for resist ashing and organic stripping.

So far, the Anatech has demonstrated the ability to remove stubborn organics that the other ashers would not remove.

For more information and to be trained on this tool, please contact Jerry Drumheller at drumheller@cnf.cornell.edu.

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Your comments are welcome!