University of Minnesota

nanoTECHNOLOGY news

from the University of Minnesota

NNIN
www.nnin.org
Nanoscale Science, Engineering & Technology

SUMMER 2015

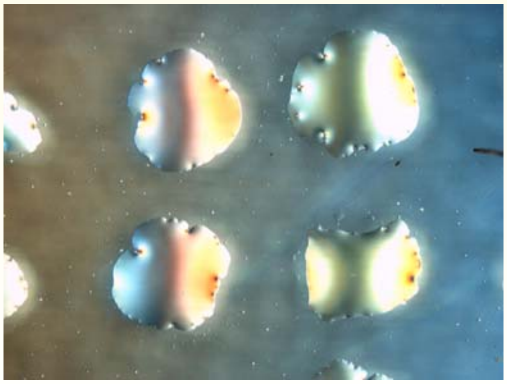
Nanomaterials and Bio-Nano Labs at the Minnesota Nano Center

The Minnesota Nano Center's new home in the Physics and Nanotechnology building has allowed the Center to expand its support of nanoscience research and discovery. In addition to the advanced PAN cleanroom, the Nano Center has opened two research laboratories that offer researchers new capabilities in the areas of nanoparticle analysis and the biological applications of nanotechnology.

The Nanomaterials Lab is a chemistry and analytical lab dedicated to making, modifying, and characterizing micro- and nanoscale materials of all kinds. The lab features particle analysis tools that allow researchers to measure the size distribution, morphology, and ionic properties of particles ranging from a few nanometers to thousands of microns in size. The Nanomaterials Lab also offers a full set of apparatus for synthesizing particles using wet chemistry, along with tools and techniques for particle surface modification, separation and filtration, and handling sensitive powders in an oxygen-free environment. All these tools are supported by Nano Center staff with over two decades of experience with particle analysis. As such, the Nanomaterials Lab is a great resource for researchers who are moving into nanoparticle application areas, but may not have the equipment or expertise they require.

The intersection of the life sciences and nanotechnology is an expanding field that presents great opportunities for medical diagnostics, disease prevention, drug delivery, and environmental biology. The new Bio-Nano Lab is designed to support this interdisciplinary research, enabling lab users to safely work with biomaterials in close proximity to facilities for fabricating micro-devices and for making nanoparticles. The Bio-Nano Lab features tools for live cell culture and processing, namely three CO_2 incubators, materials for cell culturing, a lab refrigerator and freezer for biosample storage, an autoclave, and a controlled atmosphere biological glovebox. The lab also hosts advanced imaging tools, including a fluorescence microscope system with high speed camera and image analysis, and a laser scanning confocal microscope for imaging cells in multiple wavelengths.

Like our cleanroom facilities, both the Nanomaterials and Bio-Nano labs are open for use by U faculty, staff, and students, as well as external users from academia and industry. For more information about these labs, please contact Jim Marti at 612-626-0732 or at jmarti@umn.edu.



Liquid samples (10 mL dots), imaged using the differential interference contrast (DIC) technique on our Zeiss materials microsope.

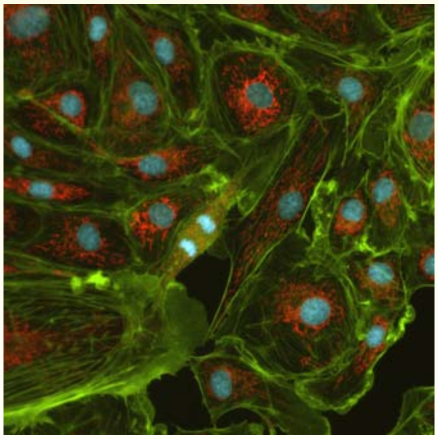


Image of tissue prepared with specific fluorophores, taken with our Nikon Ti fluorescence microscope.

REMINDER: If your work uses the Minnesota Nano Center (formerly NFC) please add the following in the acknowledgements section of any publication: "Parts of this work were carried out in the Minnesota Nano Center which receives partial support from NSF through the NNIN program."

Nanotechnology News from the University of Minnesota is published by the University of Minnesota's Center for Nanostructure Applications and made possible by:

NSF

College of Science & Engineering

CHARFAC DIRECTOR'S MESSAGE

CharFac Director, Greg Haugstad

We are pleased to announce that at least one of two grant proposals (at this writing) to obtain funding for a new surface-analytical spectrometer has been successful. The new X-ray Photoelectron Spectrometer (XPS) with further ultraviolet irradiation capability (UPS) will provide a huge leap in capabilities, from current mid-1980's vintage to state-of-the-art. Modern specifications in sensitivity, small-area analysis, both spatial and energy resolution, and angle-resolved measurements (for controlled near-surface depth perception) are lacking in our current instrument. Moreover UPS, which opens up studies of electronic valence states, is entirely missing from our current set of methods. These collective deficiencies have placed UMN researchers at a significant disadvantage compared to those at peer institutions. Thus we anticipate that this 30-year technological advancement will be a game-changing development.

The new XPS/UPS spectrometer will have approximately double the energy resolution of our current instrument (from ~1 eV to ~0.5 eV), essential to resolving crowded spectral peaks that identify and quantify different chemical states. Moreover, an order-of-magnitude increase in detector sensitivity as well as spatial resolution down to 15 m (compared to our current 500 m) will be superior for analyzing ingredient concentrations and mapping heterogeneous surfaces. UPS provides a number of capabilities that allow researchers to (i) measure valence band edges of inorganic films that are components in multi-junction thin film solar cells; (ii) model current versus voltage behavior in organic thin-film constructs; (iii) measure interfacial dipoles and work functions; and (iv) examine spectral energy loss peaks ("shake-up satellites") that directly report the energies of – * transitions in conjugated molecules. These improvements are critical to the needs of many UMN researchers who are constructing devices, including those with microscopic scales of importance (e.g., in sensors and other microelectromechanical systems), or characterizing the chemistry of complex materials (e.g., nanocomposites) or constructs with critical minority ingredients (e.g., drugs in medical device coatings or in nanomedicine objects).

For more information on the to-be-obtained instrument's capabilities, in the context of your research needs, please feel free to contact the principal instrument specialist, Dr. Bing Luo, or CharFac Director Greg Haugstad.

State-of-the-art Thermo Scientific Surface Analysis System to be placed in CharFac.

The fiscal year that ended on June 30 set records for external users of the CharFac. The industrial clientele for analytical services was exceptionally strong, led by the medical devices sector. As a fraction of overall user-fee revenue, the past fiscal year was the highest for externals (31%) since the year that ended in June 2006. This development sharply reverses a trend of a decreasing external fraction as internal user fee revenue nearly doubled from 2006-2014 (due to the growth of instrumentation and the competitiveness of faculty grant proposals to pay user fees). Strong external revenue helps CharFac hold down recharge rates to internal users, thereby making University investigators more competitive. It also occasionally contributes to the purchase of new equipment of benefit to all. The analytical service activity further adds to the intellectual capital of the CharFac, given that there is usually an element of learning when encountering new sample types and new research questions, especially if utilizing relatively new or upgraded equipment.

CHARFAC AT THE UNIVERSITY OF MINNESOTA

12 Shepherd Labs
100 Union Street SE
Minneapolis, MN 55455

Website: www.charfac.umn.edu
Email: charfac@umn.edu
Telephone: 612-626-7594

Greg Haugstad, Director

MNC DIRECTOR'S MESSAGE

MNC Director,
Steve Campbell

The fiscal year that ended on June 30 also gave MNC good news. Internal income rose by nearly 15% over last year, reaching the highest amount we have ever seen. Industry income, which fell significantly in FY14, rebounded by more than 20% last year. Our contacts suggest that this growth trend will continue. As with CharFac, strong external revenue helps us hold down recharge rates to internal users, making University investigators more competitive. Offsetting this good news however, is the increase in expenses expected from running two clean rooms and the decline in revenue from the drawdown of the National Nanotechnology Infrastructure Network (NNIN). As a result, MNC ended FY15 with a moderate deficit which we covered from our Foundation Fund.

This brings me to MNC's participation in national nanotechnology networks such as the current program, NNIN, which expires in September. MNC is now participating in the NSF National Nanotechnology Coordinated Infrastructure (NNCI) competition. We submitted a proposal in the spring of 2015. After a highly selective competition, Minnesota was one of only a handful of schools to make it through to the Reverse Site Visit stage. The Center presented its case on July 9th. We expect to be notified of the outcome by early September.

Finally, let me bring you up to date on our new equipment status. Our contact aligner in PAN is now available for user training after resolving some issues with the vendor. Purchase orders have been let for both the PlasmaTherm high density plasma chemical vapor deposition system and the Ultratech (formerly Cambridge Nano) plasma enhanced atomic layer deposition system. Delivery of both is expected in November. The PlasmaTherm system will allow our users to deposit very high quality films at temperatures as low as room temperature, and use the plasma parameters to control the stress. This will enable device fabrication on plastic and other soft materials. The Ultratech system, which is load-locked, will enable the ALD of Si_3N_4, TiN, Pt, and other nitrides and metals.

Focused Ion Beam Technology

The Quanta 200 3D is a Dual Beam (FIB/ SEM) system with a tungsten electron column which can be used to section, image and analyze a wide range of conducting and non-conducting samples. FIB systems are similar to scanning electron microscopes (SEM) except that gallium ions are used instead of electrons. The gallium beam can be focused down to a very small spot (10nm size at 30KV acceleration voltage) and can be scanned across the sample. The large mass difference between Ga ions and electrons causes an effect that is not seen in SEMs, namely material removal. Another name for this removal process is ion milling, and whenever the Ga beam is contacting the surface, some surface material is being removed. By focusing the Ga beam to desired areas, controlled removal of material can be accomplished, resulting in the formation of structures with dimensions in the range of nanometers. The process is purely physical, meaning that no chemical effects are involved, so any material can be milled using the Ga beam. In addition to the milling process, introducing an organic-metallic compound containing Pt near the Ga beam impingement site leads to the controlled deposition of Pt metal. The Pt metal will contain some organic residue, and thus is not as conductive as pure Pt. However, the ability to selectively deposit Pt in areas as small as 50nm is a useful feature for nanofabrication. Common uses for FIB technology include TEM sample preparation, device cross-sectioning for failure analysis, and selective deposition of small Pt conducting lines.

MINNESOTA NANO CENTER AT THE UNIVERSITY OF MINNESOTA

140 Physics & Nanotechnology Bldg
115 Union Street SE
Minneapolis, MN 55455

Website: www.mnc.umn.edu
Email: mnc@umn.edu
Telephone: 612-624-8005

Steve Campbell, Director
Greg Cibuzar, Lab Manager

*nano*TECHNOLOGY *news*
from the University of Minnesota

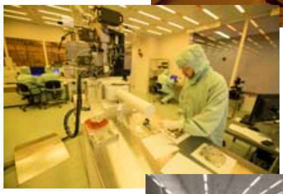
WWW.NANO.UMN.EDU

140 Physics & Nanotechnology Building
115 Union Street SE
Minneapolis, MN 55455

Nanotechnology News from the University of Minnesota
Published by the University of Minnesota's Minnesota Nano Center
and the National Nanotechnology Infrastructure Network.
Comments and suggestions are welcome! Would you like to be added to or removed from our distribution?
Contact: Becky von Dissen at vondi001@umn.edu or 612-625-3069

This publication is available in alternative formats upon request. Direct requests to Becky von Dissen, 612-625-3069/vondi001@umn.edu
The University of Minnesota is an equal opportunity educator and employer.
Printed on recycled and recyclable paper with at least 10 percent postconsumer material.

Minnesota Nano Center: www.mnc.umn.edu



The MNC is a state-of-the-art facility for interdisciplinary research in nanoscience and applied nanotechnology. The Center offers a comprehensive set of tools to help researchers develop new micro- and nanoscale devices, such as integrated circuits, advanced sensors, microelectromechanical systems (MEMS), and microfluidic systems. The MNC is also equipped to support nanotechnology research that spans many science and engineering fields, allowing advances in areas as diverse as cell biology, high performance materials, and biomedical device engineering.

The MNC is composed of two main facilities. Our current clean room and associated labs, formerly known as the Nanofabrication Center, are housed in Keller Hall. The Keller Lab has a 3000 square foot Class 100 clean room, and an additional 4000 square feet of labs and support areas.

In late 2013, the MNC will open a new research facility in the Physics and Nanotechnology (PN) building. The new PN Lab facility will offer a larger and more advanced clean room, with state-of-the-art tools for fabricating structures under 10 nanometers in size. The MNC will also offer two new specialized labs to support interdisciplinary research in bio-nanotechnology and nano-and micrometer-scale materials.

The National Nanotechnology Infrastructure Network: www.nnin.org

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