University of Minnesota

nanoTECHNOLOGY news

from the University of Minnesota

FALL 2015

New tools in the Bio-Nano and Nanomaterials Labs

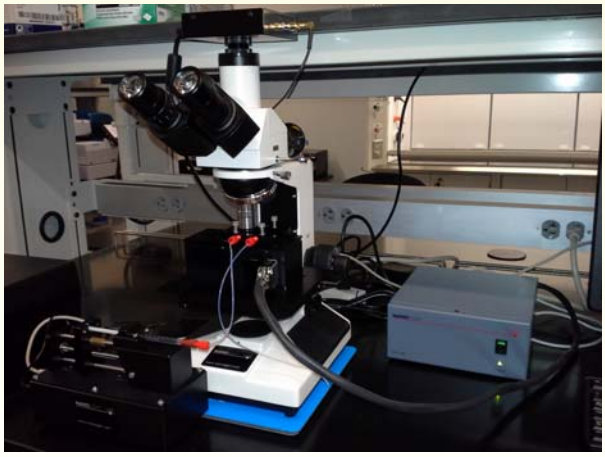
The Minnesota Nano Center has acquired a ThermoScientific Sorval Lynx 6000 superspeed centrifuge for the Bio-Nano lab. This centrifuge is capable of 29,000 rpm and achieves forces of over 100,000 G, enabling separation of nanoparticles and other submicron materials even in viscous liquids. The Lynx 6000 is equipped with two rotors that accept eight 50 ml tubes or six one liter bottles, enabling large volume separation.

The Bio-Nano Lab is also getting a controlled atmosphere biological glovebox. This system will be set up to work with anaerobic bacteria or other organisms that require non-standard atmospheres. It can also be configured to run at variable humidity for biological and non-bio applications, including corrosion testing.

The Nanomaterials Lab now has an additional tool for nanoparticle analysis, the NanoSight Nanoparticle Tracking Analyzer (NTA). The NTA technique captures images of the sample particles undergoing Brownian motion in a liquid, and using frame-by-frame video image analysis, calculates particle sizes and diffusion coefficients. The NTA can yield the size distributions of particles from about 10 to 2000 nm, and is particularly useful for very dilute dispersions.

The new NanoSight complements our other tools for particle analysis, including dynamic light scattering and laser diffraction tools for particle sizing, a zeta potential system, and an optical particle analyzer to obtain information on particle shape. All of the tools in the Nanomaterials and Bio-Nano labs are available for independent use by trained UMN students and staff. To become a lab user or to learn more about our capabilities, contact Jim Marti (jmarti@umn.edu).

The InVivo bio glove box for culturing or handling anaerobic cells.



The Nano Tracking Analyzer, equipped with s-CMOS camera and automatic sample syringe pump.

REMINDER: If your work uses the Minnesota Nano Center, please add the following in the acknowledgements section of any publications: "A portion of this work was carried out in the Minnesota Nano Center."

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characterization FACILITY news

CHARFAC DIRECTOR'S MESSAGE

CharFac Director, Greg Haugstad

Major transformations are underway in surface analysis instrumentation in the CharFac. A more modern Auger electron spectrometer (AES) is now installed and operational, replacing a mid 1970's vintage system, which was mainly used for sputter depth profiling. The newly installed Phi 670 Nanoprobe (donated by 3M) was recently upgraded with contemporary data acquisition software and thus is several generations beyond the system replaced. The 670 is equipped with a field emission electron source (spot size: ca. 50 nm), a cylindrical mirror analyzer (CMA) with a multichannel detector, and the capability to conduct scanning electron microscopy (SEM) as well as scanning Auger microscopy (SAM). As such the 670 is an advance for the CharFac in spatial resolution, electron collection efficiency and ease of operation.

As previewed in our last newsletter, a successful grant proposal has enabled the acquisition of a brand new X-ray and ultraviolet photoelectron spectrometer (XPS/UPS). We expect this system to be fully installed and available to users by early-2016. Among other advanced features, it will quickly collect angle-resolved spectra and have a much smaller X-ray spot than our current XPS system. The latter will be retained for basic survey spectra while the new system focuses on applications that benefit from higher sensitivity, smaller spot, angle-resolved, or superior energy resolution for chemical shift analysis.

The Phi 670 scanning Auger spectrometer in Room 22 Shepherd Labs.

Modern surface-sensitive imaging and spectroscopy of elemental and chemical-state composition, as provided by scanning Auger and XPS, has become increasingly important as device constructs and materials constituents shrink in size, indeed down to nanometer scale. With the arrival of modernized instrumentation, CharFac anticipates considerable expansion of its surface-analysis user base, not only within the College of Science and Engineering but also those from other colleges (e.g., Dentistry, Pharmacy, Food/Ag & Natural Resource Sciences) and from other academic institutions as well as industry. A goal is to attain a breadth of impact comparable to renowned surface analytical labs at peer universities such as the University of Washington. For more information on the capabilities of either the now-installed 670 AES or the to-be-installed XPS/UPS, in the context of specific research problems, please contact the principal instrument specialist, Dr. Bing Luo, or CharFac Director Greg Haugstad.

Other developments in recent months involve nano- to micro-scale mechanical and rheological characterization of hydrogels with colloid-probe atomic force microscopy under aqueous immersion, using our Keysight 5500 SPMs. Notable developments include (i) improved data acquisition and analysis software (e.g., in microscopic mapping of properties via analytical curve fitting within contact mechanical models) and (ii) proficiencies in custom modulation methods, both shear and normal force. The microcantilever-attached colloid probe is three orders of magnitude blunter than a conventional AFM tip, enabling the study of mechanical properties of extremely soft materials (kPa in modulus) by preventing puncturing or tearing. If interested in this kind small-scale mechanical probing of very soft materials, including for example hydrogel coatings for biomedical devices, please contact Greg Haugstad.

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

MINNESOTA *nano* CENTER *news*

MNC DIRECTOR'S MESSAGE

MNC Director, Steve Campbell

The major news is that the National Science Foundation has announced the formation of the National Nanotechnology Coordinated Infrastructure (NNCI) network (http://www.nsf.gov/news/news_summ.jsp?cntn_id=136211). We are pleased to let you know that the Minnesota Nano Center has been selected to be one of the nodes in NNCI receiving an award of 4.5 M$ over five years. This follows an eleven year period of participation in the NSF National Nano Infrastructure Network over which the school was awarded 8 M$. In addition to providing users access to a full range of fabrication equipment in Keller Hall and the new Physics and Nano building, the new NNCI node will support activities in two-dimensional materials, bionano, and, through participation by North Dakota State University, advanced packaging. We review our bio-nano capabilities in this newsletter. In the next few issues we will feature the capabilities in the other two focus areas.

I also wanted to give your our new equipment update. As noted previously, purchase orders have been let for both the Ultratech (formerly Cambridge Nano) plasma enhanced atomic layer deposition system and the PlasmaTherm high density plasma chemical vapor deposition system. We have been notified that construction on the plasma ALD tool has been completed. An on-site inspection is currently underway. Delivery of the system is expected early in October. Installation and acceptance should take about two months. The system will enable the ALD of Si_3N_4, TiN, Pt, and other nitrides and metals. Delivery of the new PECVD is expected in November. The system will allow us to deposit controlled-stress films of SiO_2, Si_3N_4, amorphous silicon, SiC, and diamond-like carbon. Doped films will also be possible. We expect installation and checkout to take about three months as this is a complex tool with extensive facilitation requirements.

Soft Lithography

Soft lithography refers to a group of non-photolithographic methods that can be used to fabricate or replicate structures, using polymers such as PDMS. Examples include micro contact printing, replica molding, micromolding in capillaries and microtransfer molding. Many of these techniques were developed by George Whitesides at Harvard University. Applications include fabrication of microfluidic devices, patterning on non-planar surfaces, fabrication of complex optical surfaces, and stamps for selective application of biological materials. At NFC we have a soft lithography capability centered around SU-8 molding of PDMS. SU-8 is a commonly used molding material for PDMS, and can be formed into structures of a wide range of sizes and shapes. These masters can be made with nanoscale feature sizes using our new Vistec electron beam lithography system, or with larger sizes using conventional photolithographic processing. Please contact us if you are interested in learning how we can help you with soft lithography.

New User Orientation

MNC is offering New User Orientation for new users twice each month. On the first Thursday of every month, the session begins at 1:30pm, and on the third Thursday of the month the session begins at 10am. A MNC staff member provides a tour showing some of the safety related equipment and the gowning process used for the MNC cleanroom. There is also training on using Badger, the lab software. The safety training takes about one hour to complete, and must be done before users will be granted access to MNC facilities. See the 'For New Users' section of our website for complete information: www.mnc.umn.edu/newusers.php.

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

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WWW.NANO.UMN.EDU

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

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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. The Keller Lab has a 3000 square foot Class 100 clean room, and an additional 4000 square feet of labs and support areas.

In January 2014, the MNC opened a new research facility in the Physics and Nanotechnology (PAN) building. The new PAN facility offers a larger and more advanced clean room, with state-of-the-art tools for fabricating structures under 10 nanometers in size. The MNC also offers two new specialized labs to support interdisciplinary research in bio- nanotechnology and nano-and micrometer-scale materials.