University of Minnesota

nanoTECHNOLOGY news

from the University of Minnesota

Summer 2018

MNC Collaborates with Saint Paul College for Internships

Over the past academic year, the Nano Center has hosted four student interns from Saint Paul College to work in the Bio-Nano and Nanomaterials labs. Advised by MNC staff member Jim Marti, the four interns undertook several projects designed to expand our lab capabilities in producing nanoparticles and applying them to biological systems.

Pictured left to right: Jenna Reget, Archie Karpeh, and Glenda Tacheny, all from Saint Paul College (*missing:* Nathaniel Akers).

In one project, interns Glenda Tacheny and Nathaniel Akers employed the cell handling tools of the Bio-Nano lab to transfect the DNA that codes for the production of a fluorescent protein into HeLa cells, a common and well-understood model for cell studies. Upon culturing, these cells expressed the protein, allowing detailed cellular imaging via fluorescence microscopy. In a second project, intern Archie Karpeh synthesized gold nanoparticles, modified the particle surfaces using gold-thiol linkages, then functionalized them by attaching antibodies designed to target the exterior of human cells. These functionalized particles were then applied to cultured HeLa cells to demonstrate the ability to use nanoparticles to selectively target and image cells. In a third project, intern Jenna Reget synthesized magnetite (Fe_3O_4) nanoparticles, currently of great interest for drug delivery and for thermal therapies. She then modified the magnetic nanoparticles via two routes, depositing a thin gold coating followed by applying thiol-based functionalization, and applying a surface layer of oleic acid, giving the particle the ability to adhere to hydrophobic drug molecules.

The interns are documenting their projects by developing detailed protocols for the above lab procedures, thereby expanding the type of projects that the nanobio labs can support. All the interns have completed their courses of study, and are pursuing bachelor's degrees and professional training in biomedical fields.

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 which receives partial support from the NSF through the NNCI program."

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

National Nanotechnology Coordinated Infrastructure

characterization FACILITY news

CharFac Director, Greg Haugstad

After a many-year hiatus, CharFac is thrilled to announce the major infusion of new systems for nano-mechanical/scratch analysis as described below. It is critical to note that this development accompanies the arrival of a new faculty member in Materials Science, Nathan Mara. Dr. Mara comes from the Center for Integrated Nanotechnologies (CINT) at Los Alamos National Laboratory (LANL), where he was a co-director of the Institute for Materials Science and Thrust Leader for the Nanoscale Electronics and Mechanics. His research focuses on the relationship between microstructure and mechanical behavior at the nanoscale, with an emphasis on structural applications in extreme environments such as high temperature, stresses, strain rates, and radiation environments. Nate is past chairman of the Nanomechanical Materials Behavior Committee of the Minerals, Metals & Materials Society (TMS), and has published extensively on topics ranging from synthesis of bulk nanocomposites to performance of advanced materials under extreme conditions. He is particularly renowned for his contributions to modeling plastic deformation and mechanisms in metals and nanocomposites and for undergraduate and graduate student education at LANL.

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

CharFac has acquired two new nanomechanical systems. The first is the stand-alone and broadly functional Bruker (Hysitron) TI 980 TriboIndenter, which replaces the CharFac's previous (much older) Hysitron system. The second system is the PI 88 PicoIndentor, which is used inside of the dual beam FIB/SEM. Some of the specific features and capabilities of these two systems include:

TriboIndentor –
· indentation, compression, and scratch testing at loads ranging from a few µN to 10 N
· quantitative, localized mechanical properties: elastic modulus, hardness, creep, stress relaxation, fracture toughness
· same probe to both raster the sample surface for topography imaging and conduct nanomechanical analysis, providing immediate post-test observation of material deformation behavior
· XPM: speeds of up to 6 nanoindentation measurements/second, enabling property mapping and distributional statistics in short periods of time
· nanoDMA: continuous measurement of elastic-plastic and viscoelastic properties as a function of indentation depth, frequency, and time
· nanoscratch: ultra-sensitive force and displacement measurements in both normal and lateral directions on microstructures and interfaces as well as film-substrate interfacial adhesion characterization

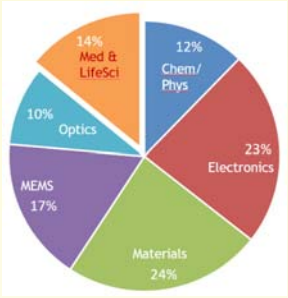
PicoIndentor –
· characterization across a range of temperatures and strain rates coupled with direct observation in the SEM
· nanoindentation, pillar/particle compression, microbeam bending, tensile testing, nanoscratch, fatigue
· up to 800°C measurements
· interchangeable low load transducer (10 mN/5 µm) and extended range transducer (500 mN/150 µm) for studying size-dependent properties from tens of nm's to tens of µm's
· nanoscratch: real-time observation of wear mechanisms
· fatigue studies such as crack nucleation and propagation
· 78 kHz digital feedback routine and a high data acquisition rate up to 39 kHz, enabling characterization of fast transients

Staff member John Nelson is active on the Triboindentor, whereas the Picoindentor is being managed by Dr. Mara's research group. Dr. Mara is also available for discussion and collaboration with interested parties both in academia and industry.

MINNESOTA *nano* CENTER *news*

MNC Director, Stephen Campbell

I hope that you are enjoying our much-delayed summer. The Nano Center continues it steady growth. This year we expect to serve nearly 400 researchers working in an incredibly wide variety of disciplines. Of these, about 140 come from outside the University of Minnesota.



Distribution of MNC users by research field.

Under the support of the National Science Foundation's NNCI program, we held two very successful summer workshops. The first, on 2D materials, was organized by Professors Koester and Low in ECE. It attracted outstanding speakers from around the country. The second, on Nanobio therapeutics, was developed by Professor Reineke (Chemistry) and Dr. Jim Marti from MNC. This will be the first time for this event. If you missed either of them, stay in touch. We expect to offer both again in 2019. And check our website for links to archived talks from both events.

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

Equipment Update

MNC replaced its aging Mechel wire bonder, purchased in 2005 with a new Westbond 7476D wedge bonder. The UM Office of Vice President for Research and the College of Science and Engineering Dean provided the funds for this purchase. The new wire bonder has improved capabilities and is much easier to use, meaning MNC will no longer have to perform all the wire bonding and instead graduate students can be trained to operate the bonder. The wirebonder is located in the Keller cleanroom.

In October 2017 MNC installed a new Model 2010 Labcoter® 2 Parylene deposition system from Specialty Coating Systems (SCS). This deposition system will enable a diverse array of research pursuits, including: encapsulating carbon fiber neural recording arrays, insulating RF circuits to reduce signal migration, and creating ultra-thin mechanically flexible circuits. The tool is located in bay 3 in the Keller cleanroom.

New User Orientation

MNC is offering New User Orientation for new users twice each month. On the first Wednesday of every month, the session begins at 1:00pm, 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.

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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 Nano Center.
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Contact: Becky von Dissen at vondi001@umn.edu or 612-625-3069

Minnesota Nano Center and the National Nanotechnology Coordinated Infrastructure

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.

In September 2015, the National Science Foundation funded the National Nanotechnology Coordinated Infrastructure (NNCI). MNC is part of this initiative, along with our partner facility at North Dakota State University. The NNCI aims to advance research in nanoscale science, engineering and technology by enabling NNCI sites to provide researchers from academia, small and large companies, and government with access to university user facilities with leading-edge fabrication and characterization tools, instrumentation, and expertise within all disciplines of nanoscale science, engineering and technology. The NNCI framework builds on the National Nanotechnology Infrastructure Network (NNIN), which enabled major discoveries, innovations, and contributions to education and commerce for more than 10 years.