University of Minnesota

nanoTECHNOLOGY news

from the University of Minnesota

Fall 2021

MNC Expanding 2D Materials Capabilities

The Nano Center is expanding its capabilities for working with two-dimensional (2D) materials. We have purchased a 2D-material assembly system that features an ultra-high-purity MBraun glove box, and a commercial 2D-material transfer stage from hqGraphene. This combined platform will allow alignment and stacking of a wide range of heterostructures using atomically-thin materials. The glovebox is capable of extremely-low O_2 and H_2O levels that will allow handling of many 2D materials that can degrade in air. It incorporates a dual regenerable solvent absorber which ensures the system maintains its high-purity environment continuously, even during regeneration. The transfer stage has fully motorized position controls and includes the capability for dark-field optics to enable positioning of both 2D flakes and 1D nanowires. This system will be particularly useful for exploring emergent quantum properties of materials (e.g., superconductivity in twisted graphene bi-layers), quantum devices (e.g. Josephson junction qubits), and a wide range of other novel devices. The system, partially funded through a grant from the OVPR at the University of Minnesota, will be one of the first of its kind in an open-access cleanroom facility.

The 2D assembly system will complement the existing 2D materials infrastructure in the Nano Center. These existing capabilities include two tools for growing 2D films. The first is a CVD tool, located in the PAN cleanroom, that can be used to deposit metal dichalcongenides (TMDs). The tool has already been used to grow high-quality MoS_2 and WSe_2 monolayers, but can also grow a wide range of other TMDs. The sulfide and selenide films each have their own growth tubes, and a vacuum transfer chamber allows samples to be moved between the tubes. The MNC also has a CVD growth system, located in the Keller facility, for growing large-area graphene monolayers on copper foils. The MNC has developed recipes for growth of the films, as well as transfer of the graphene onto arbitrary substrates.

This combined infrastructure positions the Minnesota Nano Center as a leading institution in providing 2D materials capabilities to our academic and industrial users.

Image showing the primary components of the ultra-high-purity heterostructure assembly system.

ACKNOWLEDGEMENT REMINDER

If your work uses the Minnesota Nano Center, please add the following in the acknowledgements section of any publications: "Portions of this work were conducted in the Minnesota Nano Center, which is supported by the National Science Foundation through the National Nanotechnology Coordinated Infrastructure, Award Number ECCS-2025124."

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National Nanotechnology Coordinated Infrastructure

characterization FACILITY news

CharFac Director,
Greg Haugstad

As done in fall 2020, now is a fitting time to assess CharFac usage as activity continues to recover from the doldrums of shutdown in March-May of 2020. Summer is our biggest season for academic usage as researchers are free to spend more time in the lab than during the academic year, and as a new crop of first year students dives into training and first usage. We are happy to report that academic users in June-August of 2021 logged 75% more hours on CharFac instruments than in summer 2020. But we are disheartened to report that the 2021 number is only about 70% of the hours logged in summer 2019.

Thus far a compensation of the budget deficit due to the spring 2020 closure, and a lesser deficit during the slow recovery of activity in 2020, was mostly via CharFac's "carry forward", funds banked from industrial sales over roughly 2014-2019… demonstrating another benefit of location in the heart of a major metropolitan area with plenty of materials-based technology companies as clients! (Indeed, during the quieter months due to covid, industrial revenue comprised a notably larger fraction of total revenue as staff members provided analytical services and engaged in industrial collaborations.) Moreover, CharFac is now one year into its NSF-NNCI support (National Nanotechnology Coordinated Infrastructure), which offsets a further portion of the "missing" academic-user revenue. CharFac also has been operating with a significantly smaller technical staff since June of 2019, and has cut other costs by ending some maintenance contracts and holding off on discretionary improvements, as well as reducing administrative costs.

So things have stabilized. But we are conducting a detailed cost-revenue assessment of all of our instrument groups, while closely monitoring activity trends within each group. Other elements of our analysis are (i) the aggregate amounts that individual faculty groups have been spending at current charge rates, and (ii) how our charge rates compare to those in the core facilities of peer universities. We anticipate making further nuanced adjustments to our rate structure this fall, following discussions with advisory committees. (We expect to reverse some rate increases of the past year once activity has recovered to more normal levels. My inbox, at cfac-dir@umn.edu, is always open to those who wish to discuss the CharFac rate structure or other elements of budgeting, usage, policy, and more.)

In lab news, the upgraded AFM-IR has been reinstalled in Hasselmo room 1-214, shared with our two Keysight AFMs (thanks to some creative repositioning along with careful vibration isolation). As such this space is now dubbed the Spectroscopic and Environmental AFM Lab. Meanwhile the former AFM-IR space and its adjacent lab have been combined to accommodate a new ThermoFisher Talos (200-kV) cryo-FEGTEM (mentioned in the previous two newsletters). We expect this instrument to be fully installed and ready for usage in late fall semester. Thus in the course of one year, CharFac will have added two new Talos TEMs, the other in Shepherd (see this past winter's newsletter).

CharFac at the
Univeristy 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,
Steven Koester

This newsletter is my first as Director of the MNC. I assumed the role on July 1st, after Steve Campbell's retirement. I owe a great debt of gratitude to Steve for has past leadership and helping me learn the ropes over the last year as director designate. I have been a professor at Minnesota for over 11 years, and have already seen the great strides the MNC has made, including the addition of an e-beam lithography system and the expansion into the PAN cleanroom. Using my experience as an MNC user, and my 14 years at IBM, I look forward to charting the path forward. We have many important new tools coming online, including state-of-the-art systems for quantum device fabrication and nano-biological analysis. MNC also plays an important role in the NSF-funded National Nanotechnology Coordinated Infrastructure (nnci.net), and we are already expanding our reach internationally through our Global Quantum Leap program (globalquantumleap.org). I look forward to a bright and productive future working with our world-class staff, innovative researchers, partner facilities, and supportive administration.

Minnesota Nano Center at the
Univeristy 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

Summer RET Program

This summer, the Minnesota Nano Center hosted four high school teachers who worked on campus with graduate students and faculty on research projects. The teachers were part of the Research Experience for Teachers (RET) program, funded by the National Science Foundation, which recruits teachers from secondary schools and community colleges to gain experience in cutting-edge science research. The teachers also worked on developing new classroom lessons on nanotechnology and STEM careers. After testing these new lessons on their own science classes this fall, the teachers will present their new programs at the March 2022 meeting of the National Science Teachers Association meeting. The RET program will be repeated the next two summers. If you know of a teacher who may be interested in the RET program, please contact Jim Marti at jmarti@umn.edu.

MNC welcomes new users under its Explore Nano program

The Nano Center is now working with several new lab users from outside the University of Minnesota, thanks to its recently announced Explore Nano program. The program covers some of the initial costs for new users to receive training and to use the Nano Center's labs, cleanrooms, and tools. New users from the Universities of North Dakota and Mississippi will soon be starting projects in our labs, as well as industrial researchers from two local companies.

New user orientation

MNC offers new user orientation twice each month: on the first Wednesday and the third Thursday, both at 9am. Orientation must be completed before new users will be granted access to MNC facilities. For complete details visit https://cse.umn.edu/mnc/becoming-new-lab-user.

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

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.

The CharFac is a three-site set of labs that provide instrumentation, education, services and collaboration in the characterization of engineering, earth and biological materials. Its analytical capabilities include microscopy via electron beams, force probes and visible light; elemental and chemical imaging including depth profiling; elemental, chemical and mass spectrometry; atomic and molecular structure analysis via X-ray, ion or electron scattering; nanomechanical and nanotribological probes; and other tools for surface and thin-film metrology. It is staffed entirely by experts in these characterization methods.

MNC and CharFac are part of the National Science Foundation's National Nanotechnology Coordinated Infrastructure (NNCI). 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.

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