University of Minnesota

nanoTECHNOLOGY news

from the University of Minnesota

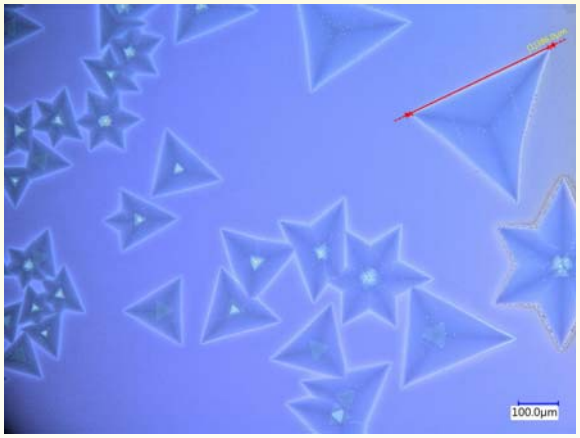
Winter 2018

3rd Annual 2D Materials Workshop at the University of Minnesota June 4-5, 2018

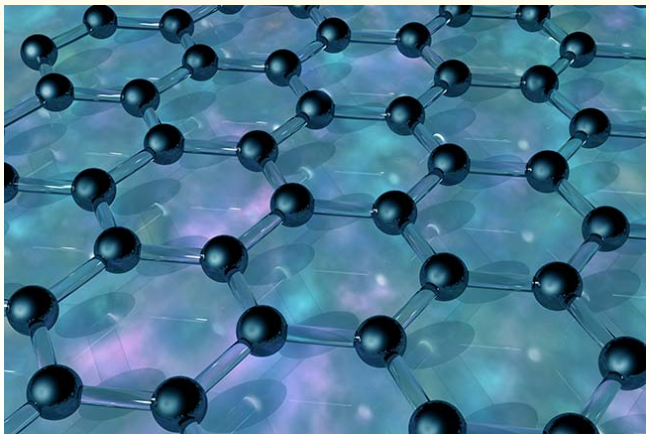
The field of two dimensional (2D) materials is rapidly growing in response to the unique properties of these materials, the ability to tune properties with thickness, and the expanding list of potential applications. The latter include flexible electronics, sensors, high performance computing, information storage, power generation, optoelectronics, nanophotonics, and thermoelectrics. As a result of the diversity of applications, the range of 2D materials systems available is expanding dramatically.

Our annual Summer School is sponsored by the National Science Foundation's National Nanotechnology Coordinated Infrastructure Network (NNCI). The goal is to provide a venue for learning about these materials and applications. The first day, June 4, will feature an outstanding group of speakers who will provide a discussion of the current state of the art in both 2D materials and their applications. Day 1 talks are free and open to all who are interested in attending, but **registration is required.** To register, email Becky von Dissen at vondi001@umn.edu.

The second day, June 5, will provide hands-on exposure to both material growth and processing, and material and device modeling. **Attendees must apply to attend this day and space is very limited.** Information on how to apply for Day 2 events can be found here: http://minic.umn.edu/2d-materials/summer-program-2018.



Above: MoS2 crystals grown in the new MNC reactor.



Left: Two-dimensional materials allow strong light-matter interactions through polaritons.

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."

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National Nanotechnology Coordinated Infrastructure

characterization FACILITY news

CharFac Director, Greg Haugstad

CharFac is experimenting with a new ***collaborative*** mechanism by which UMN faculty can obtain preliminary data to strengthen grant proposals *without needing to fund* the initial work. This initiative addresses multiple problems. In addition to funding shortage, other problems include (i) the need to more fully utilize ***advanced*** capabilities in instrumentation and staff expertise, and (ii) a need for staff scientists to be more engaged with UMN research groups so as to obtain material ***samples*** (to aid methods development). To potentially qualify, a given project must include:

1. a **write-up** (max 1 page) submitted to the CharFac director, containing the scientific purview of the intended grant proposal (in synthetic or earth materials, devices, or life sciences) and containing suggestions in characterization methods;

2. one or more **CharFac staff member(s) as co-investigator(s) for both the preliminary work and the ensuing grant proposal**, and presuming their input on characterization methods in the write-up in #1;

3. appending the write-up with an agreed estimate of **needed instrument and staff time** and its cost per the CharFac rate sheet, in discussion with the staff collaborator(s);

4. upon work completion, a minimum 2-page **powerpoint summary** submitted to the CharFac director, to be placed in a repository of such results for (i) communicating to a faculty advisory group and (ii) possible use in marketing CharFac capabilities;

5. only one active project in CharFac per research group.

The CharFac's scheduling and logging system will accrue charges to an internal-to-CharFac allocation. Session reservations and logged hours will be controlled by the staff collaborator(s). Limits in instrument and staff time, as well as project duration, will be considered case by case. (Please recognize that an urgent request for data to meet an impending deadline, in the absence of discussion with a staff scientist, does not qualify as a project.)

Please feel free to contact me with questions (cfac-dir@umn.edu). Preliminary discussion of methods with the professional staff is strongly encouraged. Although a huge number of methods could be considered ***advanced***, examples include cryogenic electron microscopy; hyperspectral or data cube methods (combining imaging with spectroscopy or material response at each pixel location); environmental methods (e.g., vs. humidity, temperature, liquid immersion); dynamic phenomena (e.g., crystallization, diffusion, phase segregation); correlative methods (on the same material region); probing combination solid/liquid-phase samples; advanced data analysis (e.g., principal component analysis).

In equipment news, we have installed an ultrahigh-vacuum based, low-temperature scanning tunneling microscopy system in a vibrationally isolated room in Shepherd Labs. The Omicron LT-STM is a surface analysis tool which allows characterization of samples under ideal conditions at temperatures between 5 K and ~500 K. The instrument has a capability of ~5 pm topographic resolution, multi-mode single-point surface spectroscopy (STS, i.e., I-V curves, etc.), and atomic-scale mapping of electronic states. The vacuum system includes multiple sample storage, *in situ* sample heater, gas ion sputter gun and tip annealing station. Please contact staff scientist Dr. Geoff Rojas (garojas@umn.edu) for more information on the new STM/STS system, including its complementarity with ultraviolet photoelectron spectroscopy methods on our new Phi Versaprobe.

CHARFAC AT THE UNIVERSITY OF MINNESOTA

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Greg Haugstad, Director

MINNESOTA *nano* CENTER *news*

MNC Director,
Stephen Campbell

We are approaching the halfway point of our support from the National Science Foundation under the National Nano Coordinated Infrastructure (NNCI) program. We will be going through our reverse site visit for renewal of the project this June. Hopefully all will go well and the program will continue through 2024. One of the many things that have been done under NNCI is participation in standardized user feedback polls. Many of you responded to the request for participation and I thank you for that participation.

The NNCI Coordinating Office sent me the results and while there are many responses to consider, I can say that the results were overwhelmingly positive. On a 0.0 to 4.0 scale with 4.0 being excellent, on average users said that their experience with our labs rated 3.7. Perhaps more telling, our users would recommend us to a colleague by a ratio of about fifty to one. The MNC staff is dedicated to the success of your work, now and in the future.

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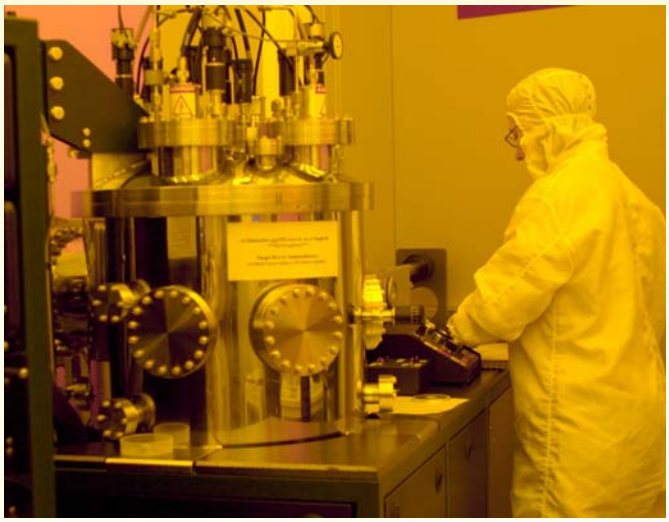
Steve Campbell, Director
Greg Cibuzar, Lab Manager

Processing Capability—Thin Film Deposition Techniques

An important aspect of many micro- and nanofabrication processing sequences is the deposition of thin films. The films may be conductors, insulators, semiconductors or magnetic materials. At the Minnesota Nano Center we have several different process tools for deposition of a wide variety of thin films using the techniques of evaporation and sputtering.



We currently have 3 different electron beam evaporation systems in our facility. Two of these evaporators, the CHA system and the Temescal system, are inside the cleanroom. The CHA is a newer tool with complete automation capability, a six pocket gun, fixturing for both planetary and lift-off deposition, and heated deposition capability. The Temescal is an older, manual operation system with a four pocket gun and lift-off fixturing. Both systems can support four to six inch wafers and smaller. Commonly deposited films include Cr, Ti, Ni, Al, Au, Pt, Pd, Ag, Mo, Cu, and Ge. MNC sputtering capabilities are centered around two AJA International systems. These tools have both RF and DC guns (2 each), load lock loading, single wafer deposition up to 8 inch diameter, and heated deposition. Common materials include Al, Al2O3, Au, Cr, Cu, Ge, ITO, Ni, SiO2, Ta, Ti and W. If thin film deposition is needed for your project, consider having the work done at MNC on these excellent systems.

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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.