University of Minnesota

nanoTECHNOLOGY news

from the University of Minnesota

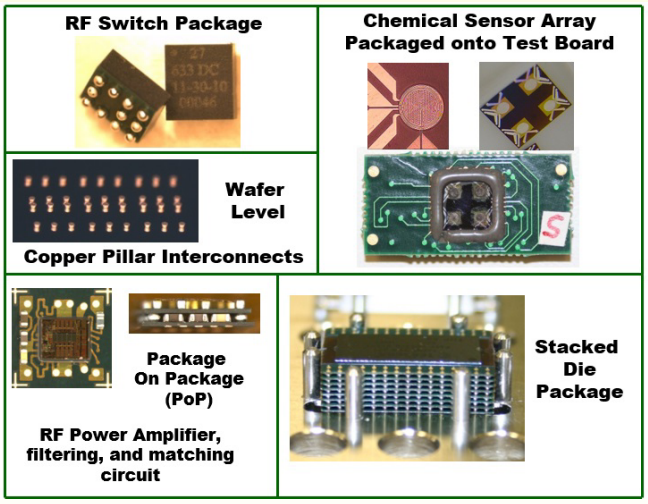
SUMMER 2016

MNC PARTNERS WITH NDSU TO ADD ADVANCED PACKAGING CAPABILITY

North Dakota State University's Device Packaging Laboratory (DPL) is pleased to be a partner with the Minnesota Nano Center as part of the NSF National Nanotechnology Critical Infrastructure Network. NDSU's role in the network node is to provide capabilities in a new focus area in advanced packaging. The goal is to enable researchers in academia and industry to economically package their devices including difficult applications such as RF devices, MEMS, biomedical components, power devices, and 3D multichip systems. This will allow them to move their projects beyond a simple proof of concept to instead build the devices into functional systems for further assessment of performance and reliability. The lab is well suited to small quantity custom prototype projects, but can also package moderate quantities of devices as well if needed. In addition to packaging devices, the lab also works frequently with electronic materials researchers to build test devices for evaluation of packaging material performance.

The DPL was established in 2004 at NDSU's Research & Technology Park. The lab operates in a 75,000 sq. ft. research facility that includes cleanroom and laboratory space to support microfabrication, device packaging, device testing, and reliability/failure analysis. The lab is equipped with a versatile set of equipment including die bonders, wire bonders, printers, a dicing saw, mold press, MYDATA pick and place, ovens, and other assorted tools. Wafer level packaging work is enabled by deposition tools in the fabrication lab. A suite of test and characterization tools are also available to complement the DPL. The lab is staffed by an experienced team (Aaron Reinholz, Fred Haring, Greg Strommen, and Syed Ahmad) that has been with the lab since its inception. To learn more about the advanced packaging capabilities, please contact Aaron Reinholz (aaron.reinholz@ndsu.edu) or view our webpage www.ndsu.edu/research/research_operations/.

Device Packaging Laboratory



Packaging Project Examples

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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characterization FACILITY news

CHARFAC DIRECTOR'S MESSAGE

CharFac Director,
Greg Haugstad

Although major system acquisitions have headlined CharFac news in recent issues as well as on our home page, behind the scenes there have been more "incremental" upgrades and improvements. The following bullets describe recent additions.

· Selected area diffraction aperture for FEI Tecnai Spirit Bio-Twin TEM (Moos Tower). This high-contrast TEM primarily serves research in soft and biological materials (including cryogenic work), thus historically was not fully outfitted for diffraction analysis. But many soft materials such as crystalline polymers, proteins, pharmaceuticals and liquid crystals do in fact diffract electrons to a degree that is analytically very useful. This addition continues the advancement of the Spirit as a broad utility instrument.

· Wide-angle X-ray diffraction. (1) A Vantec 2D detector replaced the old Highstar on the D8 Discover. Both are gassed position sensitive detectors but the Vantec is relatively maintenance free. Analytical advantages of the Vantec include better resolution, higher dynamic range, higher quality 2D diffraction pattern images and larger active area. (2) A sample strain-inducing custom device has been built to use with our XRD instruments and our Keysight scanning probe microscopes. (3) A tight sample holder for XRD has been acquired, which allows exposure to liquid solvents during X-ray irradiation. (4) Liquid nitrogen temperatures can now be reliably achieved on the D8 Advance for analysis of low-T phase transitions.

· We now have the ability to perform TKD (Transmission Kikuchi Diffraction) in the JEOL 6500 SEM. A special set of sample holders allow TEM grids to be placed in the SEM, such that one can perform automated mapping of diffraction in *transmission* mode. Improvements are two-fold: (1) Spatial resolution achieved is ~2-5nm in TKD as compared to ~100 nm in conventional EBSD. (2) Automated mapping, which is not available in the TEM, allows grain orientation maps down to the nanoscale.

· Confocal Raman micro-spectrometer polarization kit. To enable studies of anisotropic samples, this addition provides rotation of the polarization axis of the incident 532 nm laser beam using a half-wave plate. For the scattered light the kit includes a filter module with a rotatable analyzer that provides high transmission and high contrast. This new component adds to other recent upgrades, which among other things expand the spectral range to low wave numbers.

Upcoming CharFac-sponsored events:

(1) Molecular Vista (San Jose) will give a seminar on Monday June 20 followed by demos through that week of their new system for ~10nm resolution chemical microscopy. Similar to recent instrument demos by other vendors, variable-wavenumber laser light impinges on an AFM tip/sample interface, but in this case the near-field enhanced sample polarization is detected via the *dielectric attractive force on the tip*, sensed via lock-in amplification as a higher-order change in the vibrating AFM cantilever. To arrange for a demo on your sample of interest, contact haugs001@umn.edu. Further details will be posted to our home page, www.charfac.umn.edu.

(2) On August 29-30 the CharFac staff will give seminars and provide demos of a wide range of instruments. The motivation is really two-fold: to attract new external users or clients and to induce more advanced and in-depth applications of our techniques by existing users. Although some of the content will be introductory, the main focus will be on more advanced utilization of CharFac capabilities, whether novel modes of operation, special sample treatment or environment, broader exploration of operational parameters, or richer data post processing and analysis; and, thereby, more creative and insightful research applications.

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Greg Haugstad, Director

MINNESOTA nano CENTER news

MNC DIRECTOR'S MESSAGE

MNC Director, Steve Campbell

I just submitted final grades for the spring semester and am more than ready to welcome the summer. MNC has brought the new plasma enhanced ALD system on line. Interest in the tool, which can be used to deposit nitrides and metal films, has been very high. Metal film capability includes TiN and Pt. Filling of features with aspect ratios of 30:1 or more is possible. We had a minor glitch with the checkout of the new high density plasma CVD system, but expect it to be commissioned in June and made available shortly thereafter. This reactor will deposit very high quality films of oxides and nitrides at very low temperature. Furthermore, the high density plasma allows the user to tune the stress level in the film. The system is also capable of depositing diamond like carbon (DLC), a wear coating and an effective treatment for inhibiting biofouling for *in-vivo* applications. The oxides and the DLC can also be doped. This makes the diamond like carbon conductive. The new deposition system for the transition metal dichalcogenides (TMDs) has been ordered from PlanarTech and will be delivered in July.

Processing Capability - ALD tools

Atomic Layer Deposition (ALD) systems allow very well controlled growth of extremely thin films, even over highly nonplanar structures such as nanopores, nanowires, and nanoparticles. Typical films are metal oxides, metal nitrides and metals. The process involves the sequential exposure of the substrate to two gases. The gases are chosen such that at least one of them saturates the surface at one monolayer of coverage and the process conditions are such that neither gas, by itself, will decompose to form a solid. After exposure to the first gas, the system is flushed, but one monolayer of this gas remains on the substrate where it can react with the second gas to form a monolayer of the desired film. The process is repeated until the desired film is grown.

MNC has two ALD systems, a standard thermal tool with ozone as well as a plasma-enhanced tool (PE-ALD). The thermal ALD currently has source materials for the deposition of HfO_2, Al_2O_3, SiO_2, TiO_2, and ZnO. The PE-ALD tool uses a plasma instead of thermal energy to drive the process, and this allows depositions to be done at lower temperatures. This tool currently has these films: HfO_2, HfN_2, Al_2O_3, Al_2N_3, TiO_2, and TiN_2. Please contact us if you have interest in this capability.

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Steve Campbell, Director
Greg Cibuzar, Lab Manager

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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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.