



Wisconsin Centers for Nanoscale Technology Facilities Day Open House

Thursday, January 18th

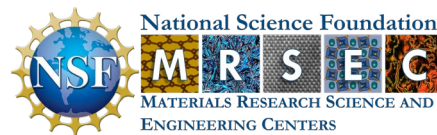
8:00 AM – 4:30 PM

University of Wisconsin–Madison
Engineering Centers Building
Madison, WI





College of Engineering
UNIVERSITY OF WISCONSIN-MADISON



Welcome!

We would like to thank you for your participation in the 9th annual Facilities Day Open House co-hosted by the Materials Research Science and Engineering Center (MRSEC) and the Wisconsin Centers for Nanoscale Technology (WCNT).

This year, our event features tutorials for common microscopy, microanalysis, and nanofabrication techniques available in the UW-Madison shared facilities. These tutorials and introductions are an excellent learning opportunity for everyone, from faculty and graduate students to industrial users.

The WCNT serve hundreds of researchers from UW-Madison, other academic institutions, industry partners, and national labs.

This event is possible because of the support from our sponsors:

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In this booklet, you will find the agenda, maps, and presentation abstracts.

We also welcome any feedback you may have to make future meetings more tailored to your interests and priorities. We are here to help research succeed.

Best regards,

Jerry Hunter

Director, Wisconsin Centers for Nanoscale Technologies

jerry.hunter@wisc.edu

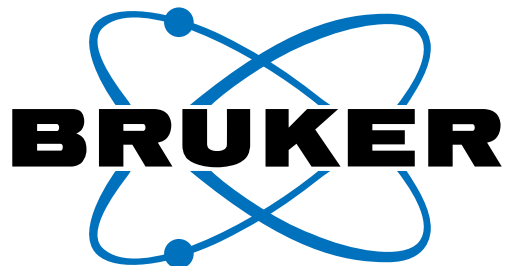
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Agenda

8:00 AM	Registration Opens / Breakfast & Coffee	
8:30 AM	Overview in Tong Auditorium, Room 1003 Jerry Hunter, UW–Madison WCNT	
	Microscopy Techniques Room 1003	Microanalysis Room 1045
9:00 AM	<u>Transmission Electron Microscopy (45 min)</u> Paul Voyles, UW–Madison, MS&E <u>User Application (15 min)</u> Shuoyuan Huang, UW–Madison, MS&E	<u>Optical Spectroscopy (45 min)</u> Nolan Wong, HORIBA Scientific <u>User Application (15 min)</u> Seo Won Cho, UW–Madison, CEE
10:00 AM	Break	
10:15 AM	<u>Scanning Electron Microscopy (45 min)</u> Julie Morasch, UW–Madison WCNT <u>User Application (15 min)</u> Samantha Evans, UW–Madison, Chemistry	<u>Surface Analysis (XPS and SIMS) (45 min)</u> Jerry Hunter, UW–Madison WCNT <u>User Application (15 min)</u> Jiarui Gong, UW–Madison, ECE
11:15 AM	<u>EDS and EBSD (35 min)</u> Michael Hjelmstad, Oxford Instruments <u>User Application (10 min)</u> Cole Evered, UW–Madison, NEEP	<u>Nanoindentation (30 min)</u> Nick Bulloss, UW–Madison WCNT <u>User Application (15 min)</u> Aditya Nagaraj, UW–Madison, ME
12:00 PM	Lunch	
1:15 PM	<u>Focused Ion Beam (45 min)</u> Dan Lawrence, ThermoFisher <u>User Application (15 min)</u> Nicholas Hagopian, UW–Madison, MS&E	<u>Newcomb Imaging Center (20min)</u> Sarah Swanson, UW–Madison, Botany <u>Wisconsin Center for NanoBioSystems (20 min)</u> Michael Poellmann and Narshimha Mamidi, Wisconsin Center for NanoBioSystems <u>Cryo-Electron Microscopy Research Center (20 min)</u> Bryan Sibert, UW–Madison, Biochemistry
2:15 PM	Break	
2:30 PM	<u>Scanned Probe Microscopy (45 min)</u> John Thornton, Bruker <u>User Applications (15 min)</u> Keenan Smith, UW–Madison, Physics	<u>Rheometry and Dynamic Mechanical Analysis (45 min)</u> Greg Kamykowski, TA Instruments <u>User Application</u> John Estela, UW–Madison, ME
3:30 PM	<u>X-ray Analysis Methods (XRD, XRR, etc.) (45 min)</u> Don Savage, UW–Madison WCNT <u>User Application (15 min)</u> Taehwan Jung, UW–Madison, MS&E	<u>Basics of Nanoscale Fabrication (45 min)</u> Frank Flack, UW–Madison WCNT <u>User Application (15 min)</u> Ranveer Singh, UW–Madison, Physics
4:30 PM	Wrap Up in Tong Auditorium, Room 1003 Jerry Hunter, UW–Madison WCNT	
4:40 PM	Adjourn	

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Presentation Abstracts

General Session - Room 1003

Opening Presentation

Jerry Hunter, WCNT Director, UW–Madison

This presentation will introduce the Wisconsin Centers for Nanoscale Technology and then quickly cover the range of techniques available and discuss learning objectives for the day. A broad outline of how the various techniques fit together to provide a comprehensive characterization and fabrication solution will also be discussed.

Microscopy Techniques - Room 1003

9:00 AM

Transmission Electron Microscopy

Paul Voyles, Professor, Materials Science and Engineering and Director, Wisconsin MRSEC, UW–Madison

What if we could know everything there was to know about the structure of a piece of material? Complete knowledge would constitute something like a list of all the 3D positions of all atoms, with the element of each atom specified, and measurement of all the electronic states at high resolution in real and momentum space. Modern electron microscopy cannot provide quite all of that information, but it can get surprisingly close. This talk will review the basics of TEM and STEM, including imaging, diffraction, and spectroscopy, then provide examples of cutting-edge applications measuring atomic structure, defects, and electronic states in a variety of materials and in various sample environments.

SPEAKER BIO:

Paul Voyles is Professor of Materials Science and Engineering and Harvey D. Spangler Professor of Engineering at the University of Wisconsin-Madison. He earned degrees in physics from Oberlin College and the University of Illinois, Urbana-Champaign, then worked as a post-doctoral member of technical staff at Bell Labs in Murray Hill NJ. He joined the UW-Madison in 2002 as an Assistant Professor. His research specialty is the structure of materials, investigated primarily with electron microscopy, supplemented by simulations and data science. He has worked on metallic and other glasses and on materials for microelectronics, spintronics, and superconductors. He was Chair of the Materials Science and Engineering Department from 2018 to 2018 is currently director of the UW-Madison NSF Materials Research Science and Engineering Center. He has published over 200 journal articles, book chapters, and conference proceedings.

USER APPLICATION:

Shuoyuan Huang, UW–Madison, MS&E

10:15 AM

Imaging with the Scanning Electron Microscope

Julie Morasch, UW–Madison WCNT

The SEM is a versatile and heavily used imaging technique for both high resolution imaging and compositional analysis. This tutorial will briefly give an overview the microscope, describe beam sample interactions, discuss how the SEM forms an image, and give some practical advice for your SEM imaging. I will also describe the capabilities of the SEMs in the NIAC.

SPEAKER BIO:

Julie Morasch is an Instrument Manager in the Nanoscale Imaging and Analysis Center (NIAC) for the SEM and FIB instruments. She received her B.S. Electrical Engineering from UW-Madison and her PhD in Materials Science from the University of Minnesota. She did her postdoctoral work at Sandia National Laboratories. She spent 7 years as a research scientist at the UW before moving to her current position in the NIAC, where she has been for over 10 years. During those years she has supported many of the techniques in the center, including AFM, nanoindentation and confocal microscopy.

USER APPLICATION:

Samantha Evans, UW–Madison, Chemistry

11:15 AM

Things You Should Know About EDS and EBSD

Michael Hjelmstad, Applications Specialist, Oxford Instruments

Energy Dispersive Spectrometry (EDS) and Electron Backscatter Diffraction (EBSD) are scanning electron microscope (SEM) based techniques that are commonly used to characterize materials. EDS is used to identify which elements are present within a surface. In EBSD, the electron beam interacts with a tilted crystalline sample producing a diffraction pattern. The diffraction pattern provides information about the crystal structure and orientation. This presentation will offer an overview of both techniques, discussing how the techniques work and what information can be obtained from it. Some applications will be shared to illustrate how EDS/EBSD can solve research problems.

SPEAKER BIO:

Michael Hjelmstad has been with Oxford Instruments for 11 years and has been an Applications Specialist for the NanoAnalysis group in California for the last 9 years. Prior to Oxford, Mike worked at another UW (University of Washington) in Seattle as the Lab Manager of the Microfabrication Facility focusing on MEMS and photonic devices. He holds a Bachelors and Masters degree in Materials Science from the University of Michigan.

USER APPLICATION:

Cole Evered, UW–Madison, NEEP

1:15 PM

Focused Ion Beam (Dual Beam)

Dan Lawrence, ThermoFisher

SPEAKER BIO:

Dan Lawrence is a Senior Account Manager at Thermo Fisher Scientific Instruments, working with SEM, DualBeam, TEM and XPS instrumentation in the Materials Analysis Group. Dan has over 25 years of experience with various e-beam and analytical techniques, working in the semiconductor manufacturing field as well as for a number of instrument suppliers. 10 years of his career was spent doing applications development with a DualBeam.

USER APPLICATION:

Nicholas Hagopian, UW–Madison, MS&E

2:30 PM

Atomic Force Microscopy – Overview and Recent Developments

John Thornton, Bruker Nano Surfaces

The field of Atomic Force Microscopy (AFM) encompasses a variety of techniques that provide the ability to visualize and measure surfaces at high resolution in three dimensions in air and fluid environments. A common application of AFM is the study of surface morphology and dimensional measurements of heights, widths, and roughness, down to sub-nanometer resolution in some cases. However, AFMs are also frequently used to measure mechanical properties, such as modulus and adhesion, as well as electrical properties, such as current or work function of materials. The combination of these abilities produces a wide range of measurements and properties that can be studied with a single AFM. Furthermore, the ability of the AFM to make measurements in a fluid environment at the nanoscale makes it unique, and is often used for biological and electrochemical studies. More recent developments in the AFM field include chemical identification using AFM-IR image and spectroscopy techniques. This presentation will concentrate on providing an overview of the AFM techniques and applications, with an emphasis on the capabilities of the AFM instruments at UW-Madison, but will also mention some new developments in the AFM field.

SPEAKER BIO:

John Thornton is a Senior Applications Scientist at Bruker Nano Surfaces and Metrology with 30+ years of experience in the field of Atomic Force Microscopy (AFM). He learned AFM at North Carolina State University in the 1990s, and then joined Digital Instruments, a pioneering company in early AFM development, and continued with the company through acquisitions by Veeco Instruments, and then Bruker. John has co-authored many scientific publications and developed scanning probe microscopy training courses. Currently, John spends a significant amount of time running AFMs, working with researchers, and educating others on techniques. He currently works from his home in Virginia, and from the Bruker AFM applications lab in Billerica, MA.

USER APPLICATION:

Keenan Smith, UW–Madison, Physics

X-ray Analysis Methods (XRD, XRR, etc.)

Don Savage, UW–Madison WCNT

SPEAKER BIO:

Don Savage earned his PhD in Materials Science at the University of Wisconsin and then stayed on as scientist where he has focused on thin film growth and characterization (using Reflection High-Energy Electron diffraction (RHEED) as well as x-ray diffraction and scattering). He joined NIAC (then the materials science center in 2006) part time, to help the Center with its increased focus on high-resolution X-ray characterization. He also continues with research on thin film deposition. Currently he is developing novel structures used for quantum bits for quantum computing in the silicon/silicon germanium system, with the Eriksson group in Physics. He also collaborates with the MRSEC studying solid phase epitaxy of complex oxides.

USER APPLICATION:

Taehwan Jung, UW–Madison, MS&E

9:00 AM

Optical Spectroscopy:

Nolan Wong, Sales Engineer, North Central Region, HORIBA Scientific

USER APPLICATION:

Seo Won Cho, UW–Madison

10:15 AM

Surface Analysis (XPS and SIMS)

Jerry Hunter, WCNT Director, UW–Madison

SPEAKER BIO:

Jerry Hunter obtained a Ph.D. in Chemistry from the University of North Carolina – Chapel Hill in 1991 and was a Postdoctoral Researcher at North Carolina State University until 1992, and is now the-director of the University of Wisconsin – Madison College of Engineering Shared Research Facilities. Prior to his current position, Dr. Hunter was Associate Director of the Nanoscale Characterization and Fabrication Laboratories at Virginia Tech and Research Professor in the Departments of Materials Science and Engineering and Geosciences. He also spent 15 years in Silicon Valley where he had management and technical positions at Philips Semiconductors, Intel, Accurel Systems and Evans Analytical Group.

USER APPLICATION:

Jiarui Gong, UW–Madison, ECE

11:15 AM

Nanoindentation

Nick Bulloss, UW–Madison WCNT

SPEAKER BIO:

Nick Bulloss is an instrument manager in the Nanoscale Imaging and Analysis Center. He received a B.Sc. in Geology from Imperial College, London, an M.Sc. in Geochemistry from the University of Leeds and a PhD in Geology from the University of Minnesota. Nick managed materials testing labs for Honeywell Aerospace for 8 years before taking the role of Product Manager of the Microanalysis product lines at Thermo Scientific. Nick also worked in the electron microscopy industry for Tescan USA and managed lab facilities at Boise State University before joining NIAC in 2022.

USER APPLICATION:

Aditya Nagaraj, UW–Madison, ME

Newcomb Imaging Center

Sarah Swanson, UW–Madison, Botany

The Newcomb Imaging Center (NIC) is a microscopy core facility in the Department of Botany offering expertise, instruction, and access to instrumentation in modern microscopy to the community of researchers at the University of Wisconsin – Madison and beyond. Capabilities include light microscopy (confocal and super-resolution) along with scanning electron microscopy plus SEM preparation equipment (critical point dryer and sputter coater). Current microscopy imaging projects in the NIC include calcium signaling, embryo development, protein localization in living and fixed cells, signal transduction, and morphology characterization. In addition to biological samples, scientists have used the microscopes in the NIC to observe mineral crystals, nanotubes, silicon surfaces, and synthetic materials. Along with research, the NIC is a teaching space providing introductory demonstrations for a number of classes, a practical hands-on lab for the graduate level course Imaging Techniques and Analyses in Plant Cell Biology and is the site for undergraduate student projects in several other classes. Additionally, the NIC hosts outreach events, demos, and meeting workshops.

SPEAKER BIO:

Sarah Swanson, Newcomb Imaging Center Director since 2007, received her PhD at the University of California, Berkeley. She completed her undergraduate studies in the Botany and Music Departments here at the University of Wisconsin - Madison and worked as a postdoc in the Biology Department at Penn State University. Currently she splits her time between assisting researchers with their microscopy projects in the NIC and working in Simon Gilroy's lab in the Department of Botany studying plant cell signal transduction in response to stress.

Wisconsin Center for NanoBioSystems

Michael Poellmann and Narshimha Mamidi, Wisconsin Center for NanoBioSystems

The mission of the Center is to unify, coordinate, and promote research and scholarship in collaborative efforts in nanomedicine devoted to nanotechnology-based platforms that prevent, diagnose, surveil, and treat various types of diseases, enabling translational drug development. Equipment available for use includes:

- CEM Liberty Blue automated microwave peptide synthesizer
- Asylum Infinity Bio atomic force microscope for nanoscale imaging and force spectroscopy
- Malvern NanoSight NS300 nanoparticle tracking analyzer for particle size and concentration determination
- Malvern Zetasizer ZS zeta potential instrument for particle size and charge characterization
- Biacore X surface plasmon resonance for binding kinetics characterization
- Agilent 1260 Infinity II high performance liquid chromatography for separation and characterization

<https://pharmacy.wisc.edu/centers/wiscnano/>

SPEAKER BIOS:

Narsimha Mamidi, PhD is a Scientist in the School of Pharmacy and primary contact for WisCNano. nmamidi@wisc.edu

Michael Poellmann, PhD is a Scientist in the School of Pharmacy and is the primary contact for AFM-related work. mpoellmann@wisc.edu

Cryo-Electron Microscopy Research Center

Bryan Sibert, UW–Madison, Biochemistry

2:30 PM

Polymer Characterizations on Rotational Rheometers – Standard and Non-Traditional Methods

Gregory W Kamykowski, PhD, TA Instruments

One of the key ways of characterizing polymers and other materials is by rotational rheometry. Steady flow testing and dynamic oscillatory testing are both performed routinely on polymer melts to provide information on the molecular weight and molecular weight distribution of the polymers and other properties that determine a resin's suitability for particular applications. It is also a sensitive way to determine the effects of regrind addition can have on the processability of a resin. Rotational rheometry can also be performed on solid specimens to determine the material's mechanical properties.

Some basic rheology will be presented in this talk. Then standard test methods will be described, as well as non-standard methods that have given additional insight into the processability and mechanical properties of typical polymers.

SPEAKER BIO:

Dr. Gregory Kamykowski is a Principal Scientist for Rheology Applications with TA Instruments and is based in Wood Dale IL. Dr. Kamykowski obtained his BS in chemistry from Loyola University of Chicago, then obtained a PhD under the renowned rheologist, Professor John Ferry, at the University of Wisconsin - Madison. Dr. Kamykowski has held several industrial positions, all of which have been related to rheology, and has been at TA Instruments for almost 20 years now. He is a member of the Society of Rheology, the Society of Plastics Engineers, and ASTM.

USER APPLICATION:

John Estela, UW–Madison, ME

3:30 PM

Basics of Nanoscale Fabrication

Frank Flack, UW–Madison WCNT

USER APPLICATION:

Ranveer Singh, UW–Madison, Physics

Wrap Up

Jerry Hunter, WCNT Director, UW–Madison

This presentation will summarize the learning for the day and discuss rules for determining which technique is the most appropriate for your characterization and fabrication needs.

Parking Directions

Interactive map with real-time availability:

<http://map.wisc.edu>



Parking is available in Lot 17 located at the end of Engineering Drive. There is also some, limited parking in Lot 80, below Union South.

Rates: \$2 per hour. \$15 per day.

Building Map

Engineering Centers Building
1550 Engineering Drive

