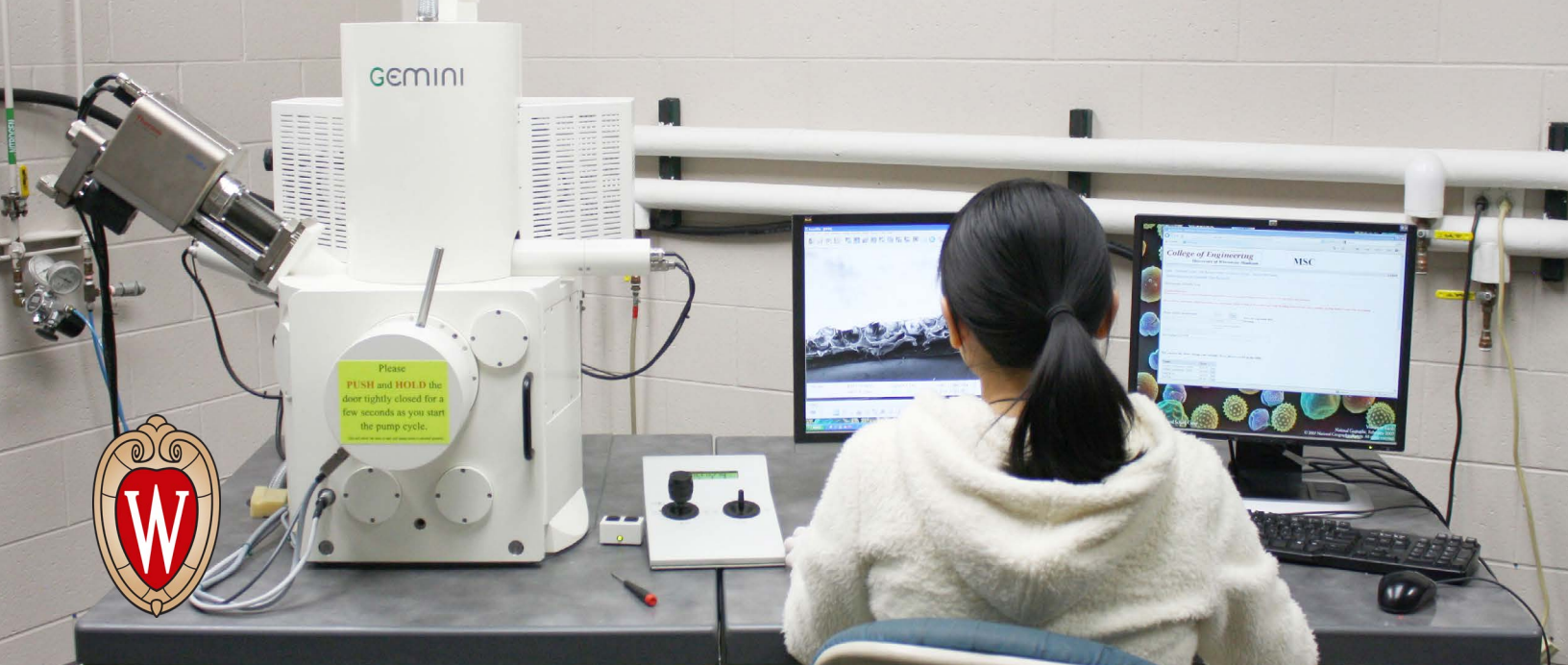




Wisconsin Centers for Nanoscale Technology Facilities Day Open House

Tuesday, November 9th

8:00 AM – 4:30 PM

University of Wisconsin–Madison

Union South

1308 W. Dayton St.

Madison, WI





College of Engineering
UNIVERSITY OF WISCONSIN-MADISON



Welcome!

We would like to thank you for your participation in the 7th 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:

- Bruker
- Cleanroom Labware
- Direct Electron, LP
- Gatan, Inc
- Hitachi High-Tech America, Inc.
- Horiba Scientific
- Jeol USA, Inc.
- Nanosurf
- Physical Electronics
- TA Instruments
- Thermo Fisher Scientific

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

Table of Contents

Table of Contents	iii
Agenda	1
Union South Building Maps	2
Thank you to our Sponsors.....	3
Presentation Abstracts	4
General Session - Varsity II.....	4
Microscopy Techniques - Varsity II	4
Microanalysis - Northwoods	7
General Session - Varsity II.....	8
Parking Directions.....	9

Agenda

8:00 AM	Registration Opens / Breakfast & Coffee	
8:30 AM	Overview in Varsity II Jerry Hunter, UW–Madison WCNT	
	Microscopy Techniques Varsity II	Microanalysis Northwoods
9:00 AM	<u>Scanning Electron Microscopy & EDS (45 min)</u> Rick Passey, Thermo Fisher Scientific <u>User Applications (15 min)</u> Katherine Su and Iman Abdallah	<u>Optical Spectroscopy (45 min)</u> Nolan Wong, HORIBA Scientific <u>User Applications (15 min)</u> Anjali Chaudhary
10:00 AM	Break	
10:15 AM	<u>Transmission Electron Microscopy (45 min)</u> Paul Voyles, UW–Madison MSE <u>Ultrafast Direct Detectors (15 min)</u> Barnaby Levin, Direct Electron	<u>Surface Analysis (XPS and SIMS) (45 min)</u> Jerry Hunter, UW–Madison WCNT <u>User Applications (15 min)</u> Daniel Vincent
11:15 AM	<u>EELS (30 min)</u> Liam Spillane, Gatan <u>User Applications, TEM and EELS (15 min)</u> Debaditya Chatterjee and Curtis Green	<u>Rheometry and Dynamic Mechanical Analysis (30 min)</u> Greg Kamykowski, TA Instruments <u>User Applications (15 min)</u> Lysmarie Figueroa Rios
12:00 PM	Lunch	
1:15 PM	<u>Focused Ion Beam (45 min)</u> Rick Passey, Thermo Fisher Scientific <u>User Applications (15 min)</u> Claire Griesbach and Shuguang Wei	<u>X-ray Analysis Methods (XRD, XRR, etc.) (45 min)</u> Don Savage, UW–Madison WCNT <u>User Applications (15 min)</u> Marlee Newman and Tyler Dabney
2:15 PM	Break	
2:30 PM	<u>Scanned Probe Microscopy and Nanoindentation (45 min)</u> John Thornton, Bruker Nano Surfaces <u>User Applications (15 min)</u> Sean Foradori and Kyle Quillin	<u>Basics of Nanoscale Fabrication (45 min)</u> Dan Christensen, UW–Madison WCNT <u>User Applications (15 min)</u> Sanket Deshpande and Ceci Vollbrecht
3:30 PM	Wrap Up in Varsity II Jerry Hunter, UW–Madison WCNT	
4:00 PM	Adjourn	

Union South Building Maps

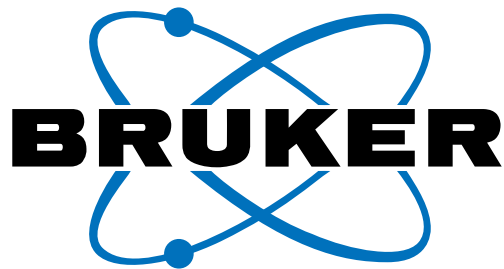
Level 2



Level 3



Thank you to our Sponsors



Presentation Abstracts

General Session - Varsity II

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 - Varsity II

9:00 AM

Imaging and Elemental Analysis Fundamentals with the Scanning Electron Microscope

Rick Passey, Senior SEM/DualBeam Product and Application Specialist, Thermo Fisher Scientific

The scanning electron microscope (SEM) has been a critical material characterization device for universities and industry for almost 60 years. In addition to providing higher resolutions than optical microscopy, the SEM provides a greater depth of focus, multiple detectors for optimizing topographic detail or material contrast, and wide variety of analytical techniques. The focus of this presentation is to introduce the fundamentals of these modern imaging and analytical techniques.

USER APPLICATIONS:

Boundary-Directed Epitaxy of Block Copolymers on Lithographically Defined Templates

Katherine Su, Graduate Student, UW–Madison

Experimental Characterization of Austenitic Stainless-steel Engine Valves Exposed to High-Temperature CO₂ Environment

Iman Abdallah, Post-doc, UW–Madison

10:15 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.

Ultrafast Direct Detectors

Barnaby Levin, Direct Electron

11:15 AM

Electron Energy-Loss Spectroscopy in the Scanning Transmission Electron Microscope

Liam Spillane, PhD, Analytical Application Scientist, Gatan, Inc.

Electron energy-loss spectrum imaging (EELS-SI) is well established as a powerful tool for materials analysis. The wealth of information available beyond simple composition, coupled with high signal collection efficiency in next-generation imaging filters makes this technique particularly advantageous for advanced analysis and mapping. A review of EELS fundamentals will be given, followed by a presentation of typical application examples that highlight central EELS-SI data processing and visualization methods such as: elemental quantification, linear least-squares fitting and multivariate analysis.

USER APPLICATIONS:

Identification of Nanoparticle Facets with Selected Area Electron Diffraction (SAED) in TEM

Curtis Green, Graduate Student, UW–Madison

Orientation Mapping in Anisotropic Molecular Glasses Using 4D-STEM

Debaditya Chatterjee, Graduate Student, UW–Madison

1:15 PM

Introduction to the DualBeam

Rick Passey, Senior SEM/DualBeam Product and Application Specialist, Thermo Fisher Scientific

The combination of the scanning electron microscope (SEM) and focused ion beam (FIB) created a platform providing high-resolution, non-destructive imaging, with the ability to perform site-specific cross-sections. Since its commercial release in the 1990s, the DualBeam has evolved into a platform capable of many diverse functions, including sample preparation (for transmission electron microscopy and atom probe tomography), 3D serial-sectioning tomography, and nano-prototyping. This presentation will introduce the DualBeam technology and these various capabilities.

USER APPLICATIONS:

Overview of FIB-SEM Fabrication and Characterization Techniques: Slice and View, Lift-outs, Transmission Kikuchi Diffraction, and Micropillar Fabrication

Claire Griesbach, Graduate Student, UW–Madison

Focused Ion Beam for Micro-analysis Sample Preparation

Shuguang Wei, Graduate Student, UW–Madison

Overview of Atomic Force Microscopy and Nanoindentation

John Thornton, Bruker Nano Surfaces

This presentation will be an overview of current technologies and new developments in the field of nanometer scale characterization techniques, focusing on the techniques of Atomic Force Microscopy (AFM) and Nanoindentation. The overview will take a brief look at the operating principles and show examples of their common usage in research and development. AFM consists of 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 apply nanoscale force studies to measure mechanical properties, such as modulus and adhesion, as well as electrical properties, such as current or work function of materials. 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. Dedicated Nanoindentation instruments techniques have been a method of choice to characterize the deformation mechanisms of materials at nano/micro-scale, where the mechanical properties often differ from their bulk counterparts. These techniques, which can be performed in a stand-alone unit or inside a SEM and TEM, will also be discussed.

USER APPLICATIONS:

Carbon Nanotube Aligned Arrays

Sean Forador, Graduate Student, UW–Madison

Investigating the Mechanical Properties of PVD Cr Coatings Via Nanoindentation Techniques

Kyle Quillin, Graduate Student, UW–Madison

9:00 AM

Optical Spectroscopy: Applications of UV-Vis, Fluorescence, IR, and Raman Spectroscopy

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

Optical spectroscopy is one of the most useful analytical tools for all researchers because it is non-destructive and typically requires minimal sample preparation. In this talk, we will provide an overview of the basic theory of UV-Vis, fluorescence, IR, and Raman spectroscopy. In addition, we will discuss the types of information that each technique can provide and delve into some key example applications. Through this talk, attendees will have an improved understanding as to how each technique can generate greater insights into their research projects.

USER APPLICATION:

Raman Spectroscopy for Characterizing Strain in Silicon Nanomembrane

Anjali Chaudhary, Graduate Student, UW–Madison

10:15 AM

Surface Analysis

Jerry Hunter, WCNT Director, UW–Madison

This tutorial presentation will cover the surface analytical techniques X-ray Photoelectron Spectroscopy (XPS) and Secondary Ion Mass Spectrometry (SIMS). Together, these techniques can give detection limits down to ppb levels, give in-depth information and provide chemical bonding information. The fundamentals of the techniques, typical data, instrumentation and how these techniques fit into the larger analytical space will be discussed.

USER APPLICATION:

Dielectric Coated GaN Band Bending Characterization (Using XPS and SIMS)

Daniel Vincent, Graduate Student, UW–Madison

11:15 AM

A Brief Tutorial on Rheological Testing to Solve Real World Industrial Problems

Greg Kamykowski, Senior Applications Scientist, TA Instruments

In this seminar, we will discuss the fundamentals of rheology, the geometric configurations of the testing systems, and the test methods that are used to probe the molecular architecture of various materials. With this information, we can help identify reasons for variations in the processability and the ultimate performance of these materials. We will begin with conventional flow testing and then will discuss using dynamic oscillatory testing to get the viscoelasticity of test materials. The test materials that we will discuss include fluids, gel-like samples, polymer melts, and solid samples.

USER APPLICATION:

DMA Applications for Diseased-inspired Tissue Engineered Scaffolds

Lysmarie Figueroa Rios, Graduate Student, UW–Madison

1:15 PM

X-Ray Analysis Methods

Don Savage, WCNT, UW–Madison

The tutorial will cover the basics of x-ray diffraction (XRD) and x-ray scattering. For XRD from polycrystalline materials, I will focus on phase identification, texture, and grain size determination highlighting the use of the Bruker d8 discover x-ray diffractometer. I will also discuss methods to determine thin-film stress, by measuring strain anisotropy. For single crystals, I will discuss high-resolution XRD to determine epitaxial film thickness and strain using the Panalytical Empyrean x-ray diffractometer. For x-ray scattering in reflection (XRR), film density, thickness, and interface roughness can be determined even for amorphous or polycrystalline layers. When used in transmission, the technique is called small-angle x-ray scattering (SAX), where the size and ordering of domains in the 10's of nanometer scale can be analyzed. As the talk proceeds I will focus on the best technique needed to approach a specific materials characterization problem as well as its strengths and limitations.

USER APPLICATIONS:

X-ray Diffraction for Polymer Thin Films

Marlee Newman, Graduate Student, UW–Madison

Characterizing Cold Spray Cr Coatings Using X-ray Diffraction

Tyler Dabney, Graduate Student, UW–Madison

2:30 PM

Example Fabrication of an Electronic Device in the NFC.

Dan Christensen, UW–Madison WCNT

This talk will walk through the fabrication sequence of a simple electronic device. The process steps will be explained, and the semiconductor processing equipment used in the NFC will be shown.

USER APPLICATIONS:

Fabrication of Optical Micro-Resonators for Single-Particle Spectroscopy

Ceci Vollbrecht, Graduate Student, UW–Madison

Fabrication of a Projected Optical Trap Array Mask

Sanket Deshpande, Graduate Student, UW–Madison

General Session - Varsity II

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.