



Wisconsin Centers for Nanoscale Technology Facilities Day Open House

Thursday, January 16th

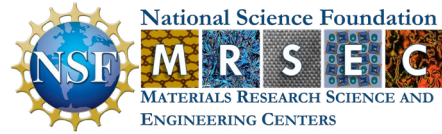
8:00 AM – 4:40 PM

University of Wisconsin–Madison
Mechanical Engineering Building
Madison, WI





College of Engineering
UNIVERSITY OF WISCONSIN-MADISON



Welcome!

We would like to thank you for your participation in the 10th 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 Nano, Inc.
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- Oxford Instruments
- Surface Measurement Systems
- TA Instruments
- TESCAN
- 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

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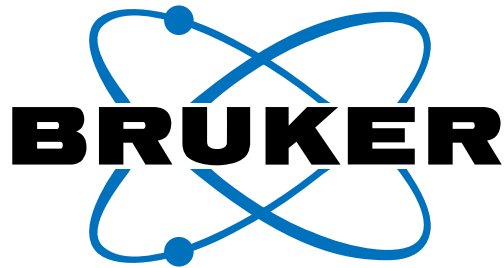
Agenda

8:00 AM	Registration Opens / Breakfast & Coffee	
8:30 AM	Overview in Room 1106 Julie Morasch, UW–Madison WCNT	
	Microscopy Techniques Room 1106	Microanalysis Room 1153
9:00 AM	<u>Transmission Electron Microscopy (45 min)</u> Alex Kvit, UW–Madison WCNT <u>User Application (15 min)</u> Nick Crnkovich, UW–Madison	<u>Unlocking the Power of Spectroscopy: Insights into UV-Vis, Fluorescence, IR, and Raman Techniques (45 min)</u> Sydney Lavan, HORIBA Scientific <u>User Application (15 min)</u> Yashwrdhan Pathaare, UW–Madison
10:00 AM	Break	
10:15 AM	<u>Scanning Electron Microscopy (45 min)</u> Nick Bulloss, UW–Madison WCNT	<u>Advanced Nanomechanical Testing Methods (30 min)</u> Radhika Laxminarayana, Bruker Nano Surfaces Division <u>User Application (15 min)</u> Nathan Curtis, UW–Madison
11:00 AM	<u>EDS and EBSD (45 min)</u> Eric Zhang, Oxford Instruments <u>User Application (15 min)</u> Chuck Koehler, Sub Zero	<u>Surface Analysis (XPS and SIMS) (45 min)</u> John Jacobs, UW–Madison WCNT <u>User Application (15 min)</u> Jeff Becker, UW–Madison
12:00 PM	Lunch	
1:15 PM	<u>Focused Ion Beam (45 min)</u> Dan Lawrence, ThermoFisher <u>User Application (15 min)</u> Lavanya Raman, UW–Madison	<u>Nanoscale Fabrication Center Capabilities and Techniques (45 min)</u> John Janzen, UW–Madison WCNT <u>User Applications (15 min)</u> Elam Blackwell, UW–Madison Samantha Evans, UW–Madison
2:15 PM	Break	
2:30 PM	<u>X-ray Analysis Methods (XRD, XRR, etc.) (45 min)</u> Don Savage, UW–Madison WCNT <u>User Application (15 min)</u> Zach LaDuca, UW–Madison	<u>Managing Process Chemistries and Etch Troubleshooting (30 min)</u> Craig Ward, Oxford Instruments <u>Thin Film Deposition–Physical Vapor Deposition (30 min)</u> Sean Armstrong, Kurt J. Lesker Company
3:30 PM	<u>Scanned Probe Microscopy (45 min)</u> John Thornton, Bruker <u>User Application (15 min)</u> Cole Evered, UW–Madison	<u>A Review of Materials Characterization by TGA and DSC (45 min)</u> Vahid Shabafrooz, TA Instruments – Waters, LLC
4:30 PM	Wrap Up in Room 1106 Julie Morasch, UW–Madison WCNT	
4:40 PM	Adjourn/Optional Tour of WCNT Facilities (Meet in front of 1106)	

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Presentation Abstracts

General Session - Room 1106

Opening Presentation

Julie Morasch, Instrument Manager, UW–Madison WCNT

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.

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.

Microscopy Techniques - Room 1106

9:00 AM

Transmission Electron Microscopy

Alex Kvit, PhD Student, Irradiation Damage, MaDCoR, 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:

Alexander Kvit holds Ph.D. in solid state physics from Lebedev Institute of Physics of Russian Academy of Science. After a postoc in LPI in Russia, Alexander joined the center headed by Jagdish Narayan in Department of Materials Science and Engineering as scientist in North Carolina State University in Raleigh, NC. Later Alexander worked as TEM manager for the same department in NC State University. He joined NIAC as TEM Manager in University of Wisconsin-Madison in 2004. He joined Paul Voyles group as scientist in MS&E Department of UW-Madison from 2008 to 2023, and group of Adrien Couet in the department of Nuclear Engineering and Engineering Physics in 2024. On the same time, he continues to hold his responsibilities for NIAC & WCNT. His research interest includes impurities interaction with native point defects, formation of relevant impurity-related complexes semiconductor compounds and complex oxides, Doping- and irradiation induced phase

transformation, stress relaxation and extended defects formation, atomic structures of interfaces, domain walls and grain boundaries. He has published over 200 journal articles, book chapters, and conference proceedings.

USER APPLICATION:

Nick Crnkovich, Engineering Physics, UW–Madison

10:15 AM

Imaging with the Scanning Electron Microscope

Nick Bulloss, Instrument Manager, 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:

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.

11:00 AM

EDS and EBSD

Eric Zhang, Applications Specialist, Oxford Instruments

Energy dispersive spectrometry (EDS) and Electron backscatter diffraction (EBSD) are the backbone analytical techniques that people utilize in their scanning electron microscope to obtain a deeper understanding of their samples. EDS detects the characteristic X-rays to identify, map, and quantify elemental species in a sample. EBSD on the other hand looks at the electrons diffracted off a crystalline sample to commonly identify the phases, orientation, and grain distribution of a sample. This presentation will go over the basic principles of EDS and EBSD, as well as advance techniques and applications that will assist with research endeavors.

SPEAKER BIO:

Eric received his Bachelor of Science from Rutgers University where he researched CO₂ sequestration of wollastonite material for additive manufacturing. During his time at Rutgers University, he also worked for Johnson and Johnson researching metrology techniques for skincare and Corning Incorporated researching slip phenomena in ceramic extrusion. After graduation Eric went to Clemson University where he investigated high temperature synthesis of radioluminescent nanoparticles for optogenetics. He has now been at Oxford Instruments for 2 years as an application specialist supporting customers on electron microscope applications. Collectively he has over nine years' experience with SEM analytics.

USER APPLICATION:

Chuck Koehler, Staff Engineer, Sub Zero

1:15 PM

Introduction to the DualBeam

Dan Lawrence, Senior Account Manager, ThermoFisher

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 crosssections. 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.

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:

Lavanya Raman, Mechanical Engineering, UW–Madison

2:30 PM

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

Don Savage, Lab Manager, UW–Madison WCNT

X-ray diffraction and X-ray scattering are non-destructive techniques to characterize the structure and morphology of crystalline and amorphous materials. In this talk I will review the fundamentals, and then give examples of crystal phase identification and the determination of grain size, strain, and film texture. For epitaxial films I will show additional ways to characterize strain and film defects. I will also review grazing angle X-ray reflectivity (XRR), where thin-film density, thickness, and roughness are measured quantitatively independent of crystallinity.

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 HighEnergy 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:

Zach LaDuca, MS&E, UW–Madison

Scanned Probe Microscopy

John Thornton, Senior Sales Applications Engineer, Bruker Nano, Inc.

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:

Cole Evered, Engineering Physics, UW-Madison

9:00 AM

Unlocking the Power of Spectroscopy: Insights into UV-Vis, Fluorescence, IR, and Raman Techniques

Sydney Lavan, Sales Engineer, HORIBA Scientific

This talk will go over the basic theory of UV-Vis, Fluorescence, IR and Raman spectroscopy, along with the advantages and limitations of each. Some key applications will be discussed to help the audience understand how each technique can be applied to their individual research projects.

SPEAKER BIO:

My name is Dr. Sydney Lavan. I earned my Ph.D. in Physical Chemistry from Wayne State University in 2021 and continued my research journey as a postdoctoral fellow in the Materials Science Division at the Argonne National Laboratory. With a strong background and expertise in spectroscopy, I now serve as a Spectroscopic Solutions Expert and Sales Engineer at HORIBA. Science has been a lifelong passion of mine, and my fascination with chemistry stems from its integral role in every aspect of our lives.

USER APPLICATION:

Yashwrdhan Pathaare, MS&E, UW–Madison

10:15 AM

Advanced Nanomechanical Testing Methods

Radhika Laxminarayana, Development Engineer, Bruker Nano Surfaces Division

This talk will explore advanced nanoindentation and nano-dynamic testing techniques, highlighting their application to materials such as PDMS, Nylon, adhesives, and biomaterials. The presentation will cover the fundamental principles and instrumentation behind these techniques, as well as innovative approaches for analyzing the mechanical properties of complex, soft, and heterogeneous materials. Attendees will gain a deeper understanding of how nanomechanical testing is essential for revealing critical material behavior at the nanoscale and its impact on material development and performance.

SPEAKER BIO:

As a brief background, I have a Materials Science background and currently work as an Applications Engineer within the Applications Development group, specializing in Hysitron Platform systems.

USER APPLICATION:

Nathan Curtis, Nuclear Engineering and Engineering Physics, UW–Madison

11:00 AM

Surface Analysis (XPS and SIMS)

John Jacobs, Lab Manager, UW–Madison WCNT

USER APPLICATION:

Jeff Becker, UW–Madison

1:15 PM

Nanoscale Fabrication Center Capabilities and Techniques

John Janzen, Process Engineer, UW–Madison WCNT

SPEAKER BIO:

John Janzen received a BS in Chemistry from UW Eau Claire in 1991. He began his industrial career as an integrated circuit process engineer at Cray Research, Inc. in Chippewa Falls, Wi. At Cray, John worked in lithography, thin film deposition and chemical mechanical polish (CMP). John moved to Minneapolis in 1998 to work at Honeywell Aerospace where he integrated CMP into the silicon on insulator (SOI) product line, producing radiation hardened IC's for military and aerospace applications. At Honeywell, he contributed to two fab expansion projects and to many notable programs including national missile defense, DARPA, the space shuttle, mars rover, Trident missile and Orion. His CMP processes helped enable successful manufacturing of the first commercial magnetic random access memory (MRAM) devices. After Honeywell, John worked as an explosives chemist and chemical engineer in the ammunition division of Alliant Tech Systems (ATK) where he was the lead engineer for a chemical plant producing 5,000 lbs of primary explosives per week. John moved back to Madison in 2015 where he worked as a process engineer at a Pfizer, pharmaceutical production plant. In 2019, John joined Sierra Space as a propulsion chemist and engineer where he contributed to numerous spacecraft and thruster projects including the Dream Chaser spaceplane and the VR35k engine. John joined the NFC as a process engineer in 2024. John holds patents in semiconductor processes and aerospace material applications and is a licensed manufacture and user of explosives.

USER APPLICATIONS:

Elam Blackwell, Physics, UW–Madison

Samantha Evans, Chemistry, UW–Madison

2:15 PM

Managing Process Chemistries and Etch Troubleshooting

Craig Ward, Applications and Central Region Account Manager, Oxford Instruments

SPEAKER BIO:

Craig Ward graduated from the University of Wales with a BSc in Physics and has spent the last 27 years working in the Semiconductor Industry. Joining Oxford Instruments in 1998 he now lives in San Jose, California ha has managed the North American Applications Team for Oxford Instruments Plasma Technology Group. During this time, he has provided consultation on plasma etch and deposition processes to leading research and production establishments in the USA, Europe and Asia. Over the last 3 years he has transitioned into an Account Management role covering the Central region of the U.S.

Thin Film Deposition–Physical Vapor Deposition

Sean Armstrong, Technical Sales Manager, Kurt J. Lesker Company

SPEAKER BIO:

Sean is a Technical Sales Manager in the Process Equipment Division (PED) for the Kurt Lesker Company where he has worked since 2011. Sean specializes in deposition equipment for PVD (sputter and evaporation) and ALD. Prior to joining the Kurt Lesker Company, Sean was the Director of Device Fabrication at Plextronics Corp., a start-up in the organic electronic industry, and before this Sean was a staff engineer with the General Electric Company focusing on plastics processing. Sean has a BS in Materials Science Engineering from Lehigh University and an MBA from the University of Massachusetts. Sean lives in Pittsburgh, PA with his family, enjoys mountain biking and running.

3:30 PM

A Review of Materials Characterization by TGA and DSC

Vahid Shabafrooz, Field Applications Scientist, TA Instruments – Waters, LLC

Thermal analysis consists of a series of analytical techniques that characterize materials' properties as a function of time and temperature. Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC) are commonly used techniques for materials characterization. TGA measures the change in mass of a sample, while DSC measures the heat flow into or out of a material as that material is heated at a specific rate or kept isothermal in a controlled atmosphere. These techniques provide qualitative and quantitative information about the material's physical properties, including glass transition, crystallization temperature and kinetics, curing, melting, decomposition, and thermal and oxidative stability.

SPEAKER BIO:

Vahid Shabafrooz is a data-driven & customer-centric scientist with a professional background in materials characterization. Vahid holds a Ph.D. in Mechanical and Aerospace Engineering from Oklahoma State University and has over 10 years of experience with materials testing. He is currently an applications scientist at TA Instruments, providing pre-sales and post-sales support for the thermal analysis product lines, including but not limited to TGA, DSC, SDT, SA, and TMA.

4:30 PM

Wrap Up

Julie Morasch, Instrument Manager, UW–Madison WCNT

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.

Optional Tour of WCNT Facilities Session

4:40 PM

People interested in a tour of the facilities can sign-up at the registration desk. Then, meet in front of room 1106 immediately following the wrap-up session.

Nanoscale Imaging and Analysis Center – Nick Bulloss

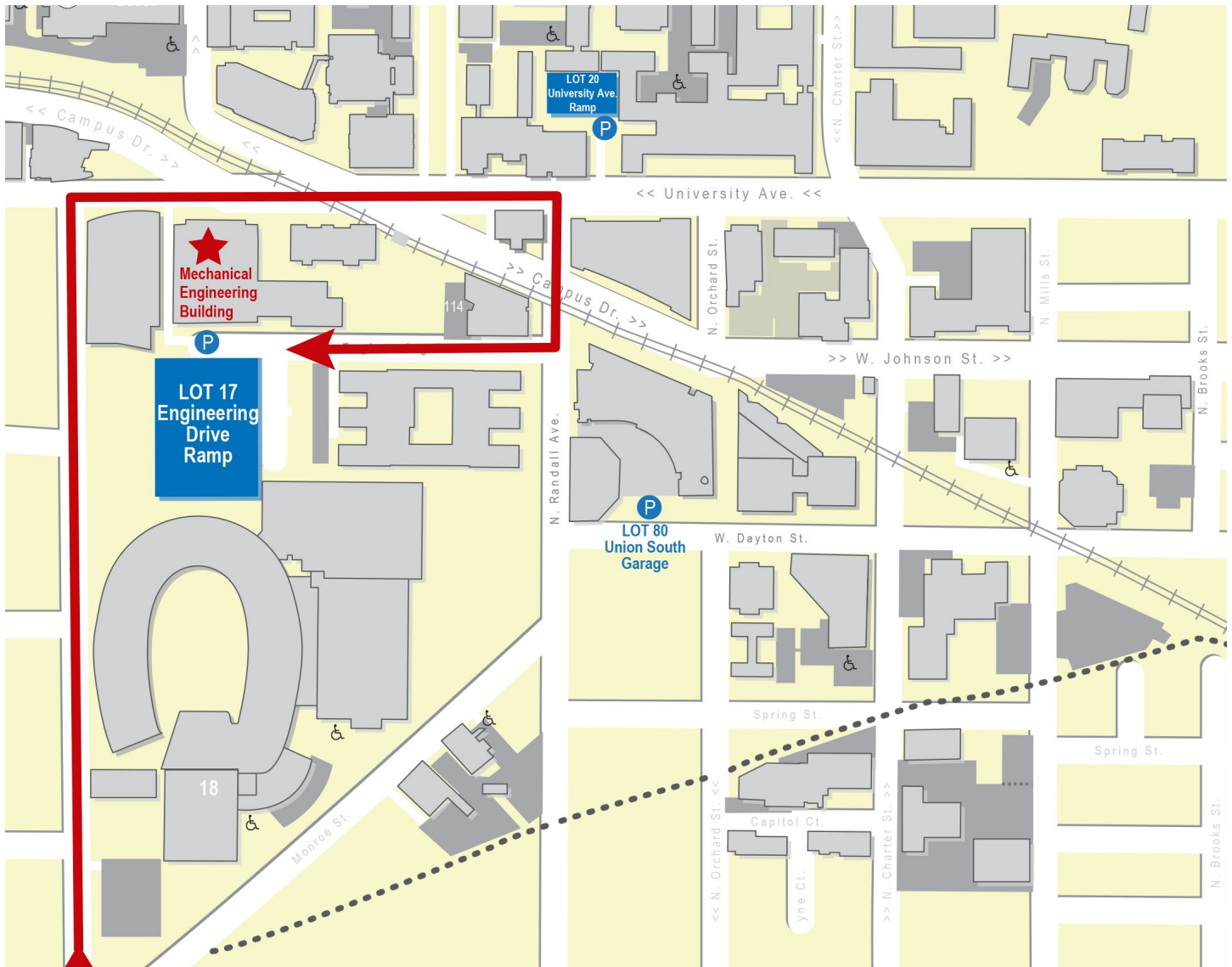
Nanofabrication Center – John Janzen

Soft Materials Characterization Lab – Anna Kiyanova

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.

Due to construction, Engineering Drive can only be accessed via a right-hand turn from North Randall Avenue. For easiest access, approach campus via University Avenue or Campus Drive. Breese Terrace, along the west side of the stadium can provide access from the south.

Building Map

Mechanical Engineering Building

University Ave

