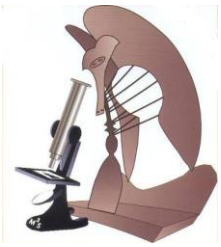

Meeting Announcement from MMMS 2024

Hosted by Baxter Healthcare Corporation

Presented by

Midwest Microscopy and Microanalysis Society (M^3S)

A local affiliate of the Microscopy Society of America and the Microanalysis Society

Friday, November 22nd

Baxter Healthcare Headquarters

1 Baxter Parkway, Deerfield IL, 60015

Directions see page 3

Register by Friday, November 15th

Use the link below, this is required to reserve a lunch for this event

https://cvent.me/ld0Voa?rt=q_7T7stTr0iJ5sxf5g7QIA&RefId=M3SFall2024

Registration Fees

Meeting Free for M^3S members and all students, $20.00 for non-members
(Fee includes M^3S membership for 2025)
Vendors are welcome to exhibit, fee is $125.00.

Program

8:00 – 9:00AM **Registration -** Continental Breakfast

9:00 – 9:10AM **Welcome and Opening Remarks**

9:10 – 10:00AM Industrial Scale Brain Mapping

Professor Narayanan (Bobby) Kasthuri, University of Chicago - **Invited Speaker**

Industrial scale brain mapping, reconstructing the billions of connections made by millions of neurons in a single brain, offers the promise of finding the physical substrates of cognitive processes like intelligence and creativity, providing the 'blueprints' for reverse engineering brain function in silico, and identifying future therapeutic targets for mental illnesses. I will detail our efforts using synchrotron source X-rays, large volume electron microscopy along with advances in new microscopes and genetic labeling in the service of mapping brains at scale.

10:00 – 10:25AM Towards Ghost Imaging using Correlated Electron-Photon Pairs

Harsh Mishra, University of Chicago

Interaction-free measurements have long excited the scientific community as they reduce radiation damage for imaging fragile samples (e.g., biological specimens). However, this has only been shown using correlations in photon pairs, and recent advances in ultrafast electron microscopy open the field for correlations in electron-photon pairs. In this talk, we show temporal correlations between electron-photon pairs in a transmission electron microscope (TEM) by developing a free-space cathodoluminescence setup. A Tecnai F20 TEM with 200 keV electrons was used to irradiate a 100 nm thick mono-crystalline silicon membrane. When an electron interacts with the sample, multiple processes can occur, one of which is the emission of photons known as cathodoluminescence. Due to the spatial constraints at the TEM, a custom sample holder was designed which allows for enhanced photon collection efficiency and due to the free-space photon extraction also spatial and momentum information. A mirror, either plane or parabolic, positioned above the sample directs emitted photons through a window, with the parabolic configuration enhancing collection efficiency by 25\%. Initially, a preliminary setup was used to test the holder, which was later improved to a relay lens system to enable variable magnification, wavelength filtering, and other optics experiments. To correlate photons with their source electrons, each particle is detected and time stamped. Photons are captured by a photomultiplier tube, while electrons are detected by the time-resolved Timepix3 detector. By energy-filtering transmitted electrons, only those electrons involved in photon emission are identified. This free-space setup successfully generated coincident electron-photon pairs and further facilitated ghost imaging by positioning an object in the photon path, creating an image on the electron side without direct interaction.

10:25 – 11:00AM **Break – Visit with Vendors**

11:00 - 11:25AM Automated processing of cells & tissue for TEM in an anatomical pathology laboratory

Rob Goodwin1*, Thomas Strader2 and Clive Wells3 *rgoodwin@mcw.edu

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2 Heartland Biotech, Madison, WI, USA, www.heartlandbiotech.com

3 Medical College of Wisconsin, Dept. of Cell Biology, Neurobiology & Anatomy, Milwaukee, WI

Core electron microscopy laboratories face unique challenges including the need to rapidly prepare many and varied samples of cells and tissues, sometimes derived from complex matrices such as nasal mucus, or miniscule (<0.25mm3) tissue biopsies for TEM imaging with no margin for loss or error, to assist diagnosis in patients awaiting potentially life-saving treatment. "With this comes great responsibility because the findings of our ultrastructural examinations have the potential to alter diagnoses and patient management."1

11:25 - 11:50AM Application of high-pressure freeze and chemical fixation for tEM in examination of endocytic pathways in C. elegans and human iPSC-derived neurons

Dr. Mia Krout, University of Illinois Chicago

Electron microscopy is a powerful tool, and particularly powerful when used in combination with other imaging and molecular biology techniques. My work has made use of both high-pressure freeze and conventional fixation TEM methods to examine endocytic processes in both C. elegans and human iPSC-derived neurons. In this talk I will discuss various studies to which electron microscopy data has provided meaningful support. I will touch on the use of serial TEM reconstruction of single neurons in order to elucidate a role for activity-dependent bulk endocytosis in a developmental synaptic remodeling process in C. elegans. Additionally, I will highlight contributions made to an investigation of the endolysosomal pathway in a constitutively endocytic model cell using immunogold EM in conjunction with fluorescence microscopy and single-cell reconstruction via serial TEM. And finally, I will discuss how ultrastructural analysis via TEM has revealed insights into endo-lysosomal trafficking in a human iPSC-derived neuronal model of neuro- developmental and degenerative diseases.

11:50AM – 1:15PM Lunch – Visit with Vendors

1:15 – 1:30PM MMMS Business Meeting

1:30 – 2:20PM From Nano to Mesoscale: Structure, Composition, and Transport Processes in Human Dental Enamel

Professor Derk Joester, Northwestern University - **Invited Speaker**

Mineralized tissues are paradigmatic hierarchical materials that reap synergy from structural and compositional gradients at multiple length scales in ways that are challenging to reproduce by conventional means. My laboratory studies the formation, functional properties, and degradation of mineralized tissues. We use model systems ranging from single crystalline endoskeletal elements deposited by single cells to the formation of dental tissues that comprise nanocrystalline and amorphous minerals deposited in complex organic matrices. Applications include the development of bio-inspired materials, sequestration of 90Sr from nuclear waste, and improving prophylaxis and minimally invasive intervention in dental care.

Herein, I will focus on dental tissues that are optimized to withstand the forces of mastication and the challenging chemical environment of the oral cavity. Human dental enamel is composed of hydroxylapatite ($Ca_5(PO_4)_3OH$) nanocrystallites, thousands of which are bundled into rods that are organized in a three-dimensional weave; this provides great fracture resistance and a much-enhanced fatigue life but leaves our teeth vulnerable to erosive tooth wear and tooth decay (caries). I will discuss how chemical imaging using UV-laser pulsed atom probe tomography (APT), electron microscopy, and synchrotron X-ray techniques has provided deep new insights into the chemistry of nanoscale organic/inorganic interfaces, presence of amorphous intergranular phases, and complex dopant gradients that are integral to properties of teeth and their resistance to corrosion.[1-5] I will further report on development of correlative elemental imaging using X-ray diffraction at the mesoscale (here: 0.25-20 µm) that allows us to extend the field of view beyond what APT can deliver.[6] Finally, I will provide an update on our investigation of diffusive transport processes in enamel using APT and ToF-SIMS, and discuss my vision for integrating this information to enable predictive modeling of enamel dissolution.

[1] Gordon and Joester, Nature 2011, 469, 194-197. [2] Gordon, Tran, and Joester, ACS nano 2012, 6, 10667-10675. [3] Gordon, Cohen, MacRenaris, Pasteris, Seda, and Joester, Science 2015, 347, 746-750. [4] Gordon, Joester, Front Physiol 2015, 6. [5] DeRocher, Smeets, Goodge, Zachman, Balachandran, Stegbauer, Cohen, Gordon, Rondinelli, Kourkoutis, Joester, D. Nature 2020, 583, 66-71. [6] Free, DeRocher, Cooley, Xu, Stock, and Joester, Proc Natl Acad Sci USA 2022, 119, e2211285119.

This work was in part supported by: NIH-NIDCR R03 DE025303-01 and R01 DE025702-01; NSF DMR-1508399 and DMR-1539918; and DOE DE-AC02-06CH11357.

2:20 – 2:45PM Photoemission electron microscopy for connectomics

Dr. Kevin Boergens, University of Illinois Chicago

Photoemission electron microscopy (PEEM) is emerging as a promising tool for neuronal circuit mapping ("connectomics"), offering an alternative to the established techniques of transmission electron microscopy (TEM) and scanning electron microscopy (SEM). While TEM and SEM have been used to image ultrathin brain slices at synaptic resolution, limitations in throughput and cost have hindered the goal of mapping full mammalian connectomes. PEEM, which illuminates samples on solid substrates with light and images the photoelectron emission, offers a potentially transformative solution. This method works with existing brain sample preparations and can reveal key neural structures such as myelinated axons, somata, dendrites, and organelles. Under optimized conditions, preliminary results suggest that PEEM achieves synaptic resolution at significantly higher speeds, with simulations and experiments demonstrating imaging at Gigahertz pixel rates. By combining the strengths of SEM and TEM with faster data acquisition, PEEM is poised to enable large-scale neural circuit mapping and drive new discoveries in neuroscience.

2:45 – 3:10PM Plasma FIBs: Driving the Next Phase in the evolution of vEM

Matthew Joens Thermo Fisher Scientific, Materials and Structural Analysis Division

Volume EM (vEM) is a flourishing technique that has begun to unlock some of the most challenging biological questions at a remarkable rate. Diamond sectioning and gallium FIB milling have continued to improve over the years with the introduction of newer imaging technologies and machine learning (ML) enhanced segmentation. Beyond these established techniques, advancements in vEM continue to demand higher resolutions, a bigger field of view (FOV), and as much sample charge mitigation as possible. Here, we introduce the latest approach into the vEM workflow: utilizing a plasma source coupled with the spin mill approach to meet these demands.

Oxygen plasma milling is showing a tremendous advantage when it comes to preparing resin-embedded samples. It has the ability to smoothly ablate very large areas, enabling FOVs comparable to most diamond sectioning techniques, all while maintaining the FIB ability of high Z resolution. Samples exposed to a plasma beam also become fully grounded, regardless of sample preparation and amount of resin. This means we can expect to image at high vacuum and with fast dwell times, with confidence that sample charge is under control. We will explore these advantages in depth and demonstrate the science benefiting from spin mill, ranging from plants to tissues.

3:10 – 3:20PM Closing Remarks

Directions to Baxter Corporate Headquarters: 1 Baxter Parkway, Deerfield Illinois, 60015

From South (O'Hare Airport): I-294 (Tri State Tollway) north to the merge with I-94 (west) towards Milwaukee. North on I-94 to Lake Cook Road exit. Turn left (west) to first light, Saunders Road. Turn right on Saunders to Baxter Parkway. Turn right on Baxter Parkway. Keep to the right. Follow the special event parking signs in the garage. See Deerfield Campus Map and proceed to "Cafeteria, Auditorium, Reception" building on ground level.
From South (Edens): North to the merge with I-94 (west) towards Milwaukee on Edens Spur. Exit on Deerfield Road. Turn left (west), then take left on Saunders Road. Turn left on Baxter Parkway. Keep to the right. Follow the special event parking signs in the garage. See Deerfield Campus Map and proceed to "Cafeteria, Auditorium, Reception" building on ground level.
From North (Milwaukee): From I-94 east, going south towards Chicago exit at Lake Cook Road exit. Turn right (west) to first light, Saunders Road. Turn right on Saunders to Baxter Parkway. Turn right on Baxter Parkway. Keep to the right. Follow the special event parking signs in the garage. See Deerfield Campus Map and proceed to "Cafeteria, Auditorium, Reception" building on ground level