SIXTY-FIFTH ANNUAL MAY CONFERENCE

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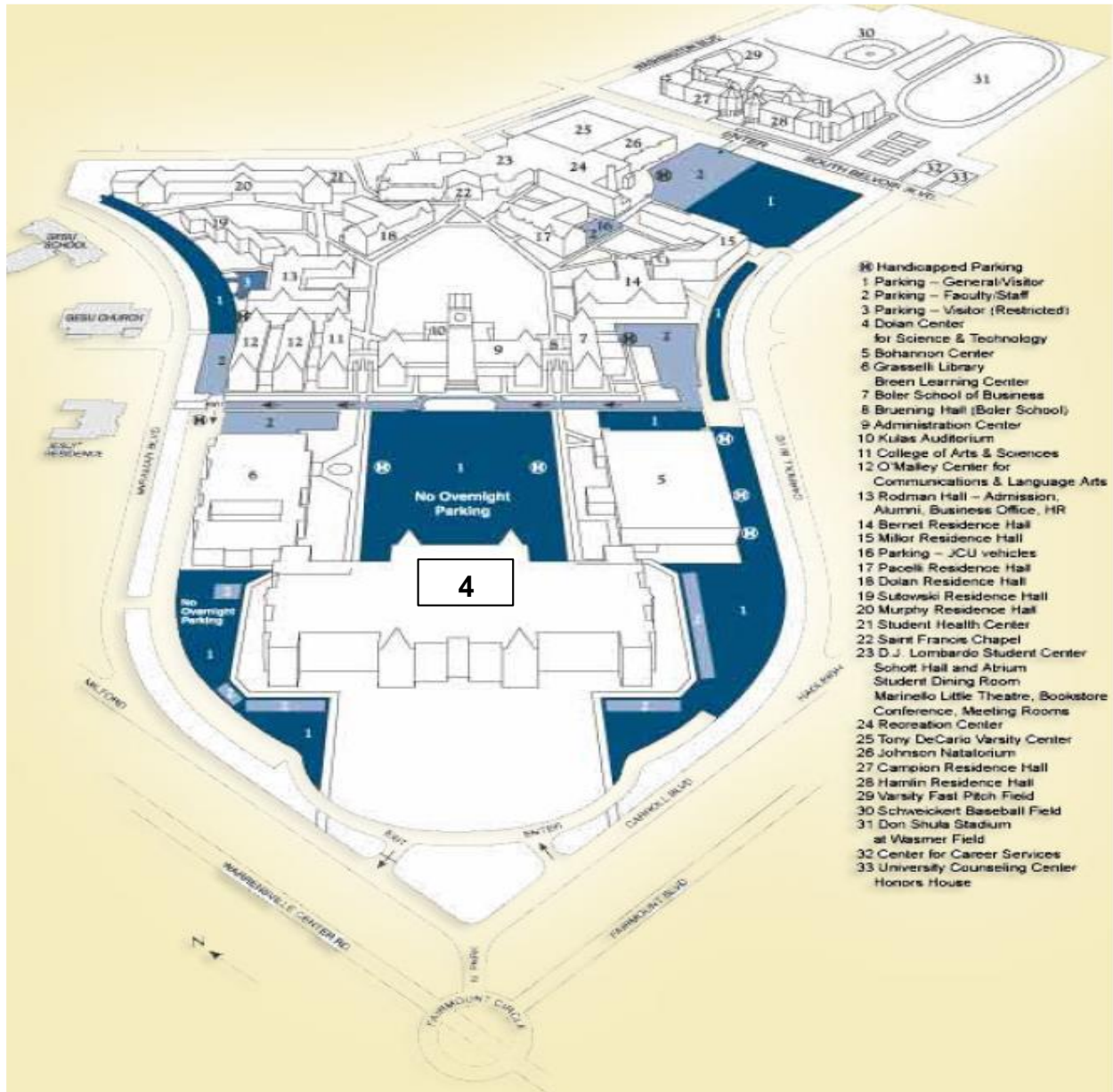

Microscopy Society of NE Ohio

Akron Council of Engineering & Technical Societies

May 24, 2023
Dolan Science Center
John Carroll University
University Heights, Ohio

John Carroll University Campus Map

Legend:

H Handicapped Parking
1 Parking – General/Visitor
2 Parking – Faculty/Staff
3 Parking – Visitor (Restricted)
4 Dolan Center
  for Science & Technology
5 Bohannon Center
6 Grasselli Library
  Breen Learning Center
7 Boler School of Business
8 Bruening Hall (Boler School)
9 Administration Center
10 Kulas Auditorium
11 College of Arts & Sciences
12 O'Malley Center for
  Communications & Language Arts
13 Rodman Hall – Admission,
  Alumni, Business Office, HR
14 Bernet Residence Hall
15 Millor Residence Hall
16 Parking – JCU vehicles
17 Pacelli Residence Hall
18 Dolan Residence Hall
19 Sutowski Residence Hall
20 Murphy Residence Hall
21 Student Health Center
22 Saint Francis Chapel
23 D.J. Lombardo Student Center
  Schott Hall and Atrium
  Student Dining Room
  Marinello Little Theatre, Bookstore
  Conference, Meeting Rooms
24 Recreation Center
25 Tony DeCarlo Varsity Center
26 Johnson Natatorium
27 Campion Residence Hall
28 Hamlin Residence Hall
29 Varsity Fast Pitch Field
30 Schweickert Baseball Field
31 Don Shula Stadium
  at Wasmer Field
32 Center for Career Services
33 University Counseling Center
  Honors House

65th Annual
SAS / MSNO / ACESS
May Conference

May 24, 2023
John Carroll University
Dolan Science Center

PROGRAM

7:30 a.m.   **Registration/Continental Breakfast:**
(Edward M. & Ann Muldoon Atrium)

8:30 a.m.   **Opening Remarks:** (Donahue Auditorium)
Brian Perry, *ParkerLORD*
Janet Gbur, *Case Western Reserve University*
Mike Nichols, *John Carroll University*

Recognition of Meeting Sponsors
Rick Kus

8:45 a.m.   **Keynote Address:** (Donahue Auditorium)
Chair: Janet Gbur, *Case Western Reserve University*

Chris Own – *Voxa*

"Seeing Small Things in the Vastness of Space"

9:35 a.m.   **Break (15 minutes):** (Edward M. & Ann Muldoon Atrium)

Presentation Session I

	Session IA Dolan E138 Chair: Qiang Guan	Session IB Dolan E228 Chair: Mike Dowell	Session IC Dolan E134 Chair: Janet Gbur
9:50 a.m.	IA-1 Robert Clements "Automating Microscopic Data Analysis" *Kent State University*	IB-1 Yue Xu "Polyhydroxy Fullerenes Mediated One-Pot Synthesis of Noble Metal Nanoparticles" *Case Western Reserve University*	IC-1 Grahame Kidd "Volume and Automated Electron Microscopy in Preclinical Therapeutic Testing"" *The Cleveland Clinic*
10:15 a.m.	IA-2 Srikanth Tadisetty " Deep Learning Methods to Quantify Cell Morphology in Multichannel Microscopy" *Kent State University*	IB-2 Ian Houlihan "Photonic Lithotripsy: Effect of Gold and Carbon Based Nanomaterials on Stone Comminution" *The Cleveland Clinic*	IC-2 Eric Rufe "In-situ TEM: A Nanoscale Laboratory" *Protochips*
10:40 a.m.	IA-3 Zackery Knauss "Techniques in Cell-Type Identification and Calcium Imaging Analysis in Live Cells" *Kent State University*	IB-3 Jemila Edmond "The Fate of Banded Iron Formations in Earth's Interior: Iron Oxide Reduction Kinetics at High Pressures" *Case Western Reserve University*	IC-3 Hugues Francois-Saint Cyr "Correlative Microscopy: Boost Time-to-Results with Integrated SEM/EDS" *ThermoFisher Scientific*

11:05 a.m.   **Break (20 minutes):** (Edward M. & Ann Muldoon Atrium)

11:25 a.m.   **Yeager Award:** (Donahue Auditorium)
Co-chairs: Rick Kus
               Melanie Knowlton, *ParkerLORD*

Emma Schell, *The College of Wooster*

"Heterogeneous Ozonolysis of a Novel Fungicide and a Hydrocarbon-Amine System"

12:00 p.m.   **Lunch:** (O'Connell Reading Room)

12:45 – 2:00 p.m.   **Poster Session:** (Second Floor Hallway)

Presentation Session II

	Session IIA Dolan E138 Chair: Miroslav Bogdanovski	Session IIB Dolan E228 Chair: Min Gao	Session IIC Dolan E134 Chair: Rick Kus
2:00 p.m.	IIA-1 Daniel Rakowsky "Effects of Aerosol Jet Printing Parameters on the Fabrication of Flexible Circuits" *Case Western Reserve University*	IIB-1 Xiong Gong "Novel Electronic Materials for Energy Generation" *The University of Akron*	IIC-1 Michael Model " Macromolecular Crowding in Cell Regulation and its Observation by Brightfield Microscopy" *Kent State University*
2:25 p.m.	IIA-2 Janet Gbur "Characterizing the Densification of Aerosol Jet Printed Silver Ink on Polyimide Thin Film" *VA APT Center/Case Western Reserve University*	IIB-2 Ken Wu "Enabling Characterization of Energy Materials using Inert Gas Transfer and Cryo-FIB" *ThermoFisher Scientific*	IIC-2 Louisa Mezache "Vascular Endothelial Barrier Protection Prevents Nanoscale Cardiac Remodeling: A Novel Strategy to Prevent Atrial Fibrillation" *The Ohio State University*
2:50 p.m.	IIA-3 Michael Fricke "Tactile Periodic Table Project" *Akron ACS*	IIB-3 Jay Amicangelo "Observation of the Cyclohexadienyl Radical in an Argon Matrix Using Matrix Isolation Infrared Spectroscopy" *Penn State Erie*	IIC-3 Abhishek Banerjee "Multiblock Polyolefin Compatibilizers-From a Non-Living Metathesis Shuffling Method" *The University of Akron*

3:15 p.m.   **Break (15 minutes):** (Edward M. & Ann Muldoon Atrium)

3:30 p.m.   **Best Student Poster Awards**
Tom Steele, *Godfrey & Wing, Inc.*

MSNO Student Award
Jeffery Pigott, *Case Western Reserve University*

Best Student Paper Awards
Regan Silvestri, *Lorain County Community College*

Presentation Session III

	Session IIIB Donahue Auditorium Chair: Regan Silvestri
3:40 p.m.	III-1 Wayne Jennings "Analysis of Additively Manufactured GRCop-42" NASA-Glenn Research Center
4:05 p.m.	III-2 Joshua Stuckner "Pre-Trained Machine Learning Models for the Segmentation and Quantification of Microscopy Data" NASA-Glenn Research Center
4:30 p.m.	III-3 Jeffrey Eldridge "Y_2SiO_5:Er Luminescence Thermometry to Above 1500°C" NASA-Glenn Research Center
4:55 p.m.	III-4 Phil Abel "Celebrating a Chemist/Spectroscopist, Dr. Kenneth W. Street, Jr." NASA-Glenn Research Center

5:20 - 7:00 p.m.   **Reception/Program**

Chair, Brian Perry, *ParkerLORD*

Bell Award Presentation
Tom Steele, *Godfrey & Wing, Inc.*

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Rick Kus

Closing Comments
Brian Perry, *ParkerLORD*
Jeffrey Pigott, *Case Western Reserve University*

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E. B. Yeager Award
: Melanie Knowlton, *ParkerLORD*
  Rick Kus
  Mike Kenney, *Cuyahoga Community College*
  Doug Rohde, *The Cleveland Clinic*

Student Paper Awards
: Regan Silvestri, *Lorain County Community College*
  Melanie Knowlton, *ParkerLORD*
  Jeffrey Pigott, *Case Western Reserve University*
  Farzin Rahmani, *ParkerLORD*
  Min Gao, *Kent State University*

Student Poster Awards	Tom Steele, *Godfrey & Wing, Inc.*
	Erica Winkler, *ParkerLORD*
	Coleen McFarland*, Envantage, Inc.*
	Mike Dowell, *ACESS*
	Emily Brocious, *ParkerLORD*
John Bell Award	Tom Steele, *Godfrey & Wing, Inc.*
	Brian Perry, *ParkerLORD*
Abstract Booklet	Brian Perry, *ParkerLORD*
	Rick Kus
	Emily Brocious, *ParkerLORD*
	Melanie Knowlton, *ParkerLORD*
	Erica Winkler, *ParkerLORD*

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Ernest B. Yeager Award

Ernest B. Yeager, the Frank Hovorka Professor Emeritus of Chemistry at Case Western Reserve University, was internationally known for his pioneering contributions to the fundamental understanding of electrochemical reactions and to the development of fuel cell and battery technology. During nearly 50 years on the Case Western Reserve faculty, he mentored 80 doctorate students and 45 post-doctorate fellows, authored 270 scientific papers, and edited and co-edited 20 books. He was internationally recognized as an authority in physical acoustics and electrochemistry. His students and colleagues knew him for his uncompromising demand for excellence in research and scholarly writing. Professor Yeager, 77, died March 8, 2002, in Cleveland, Ohio, after a long struggle with Parkinson's Disease.

In 1962, the Cleveland Section of the Society for Applied Spectroscopy established the Ernest B. Yeager Award, which now consists of a certificate and a four-hundred-dollar stipend. This award is made annually by the Cleveland Sections of the Society for Applied Spectroscopy and the American Chemical Society to an outstanding undergraduate student who is attending a college or university in Northeastern Ohio, and who has demonstrated an interest in some phase of spectroscopy. The award also carries a free one-year membership in the Society for Applied Spectroscopy.

Year	Recipient	Year	Recipient
1962	Eric A. Entemann	1993	Baonian Hu
1963	John H. Konnert	1994	Amy L. Lusk
1964	Sheldon J. Green	1995	John W. Cave
1965	Cheryl H. Miller	1996	Michael Fiorentino
1966	Dale Wingeleth	1997	Jonathan Flad
1967	Richard D. Ash, Jr.	1998	Christopher S. Callam
1968	Jon Mynderse	1999	David T. Clark
1969	Virginia E. Coates	2000	Adam Van Wynsberghe
1970	Charles F. Cobb	2001	David C. Oertel
1971	Gerald R. Cappo	2002	Richard L. Barger, Jr.
1972	Donald R. Diehl	2003	Michelle Adams
1973	Fred A. Fortunato	2004	Tiffany Leigh Copeland
1974	Douglas B. Rahrig	2005	Stacey Lynne Dean
1975	William Hart	2006	Colleen M. Burkett
1976	John Havens	2007	Manasi Bhate
1977	Thomas M. Leiden	2008	Nikolas Joseph Neric
1978	Scott A. Raybuck	2009	Deacon J. Nemchick
1979	Jeff Weidenhamer	2010	Rachel V. Bennett
1980	Alexander Kondow	2011	Daphne A. Guinn and Jennifer L. Miller
1981	Raymond E. Cline	2012	Jean Quenneville
1982	Marie Zaper	2013	Yihui Chen
1983	Brian L. Cousins	2014	Jocienne Nelson
1984	Ka-Pi Hoh	2015	Kevin Budge
1985	Chris Scott	2016	Ian Campbell
1986	Ann M. Mulichak	2017	Rachel Molé
1987	Rex Ramsier	2018	Nicole Wagner
1988	Joy Gorecki	2019	Corianna Borton
1989	Sheryl Tucker	2020	Ryan Reffner
1990	No Award Given	2021	Eric Rachita
1991	Stephen C. Stone	2022	Megan Zins
1992	No Award Given	2023	Emma Schell

2023 Ernest B. Yeager Award Recipient

Emma Schell
The College of Wooster

"Heterogeneous Ozonolysis of a Novel Fungicide and a Hydrocarbon-Amine System"

John Bell Memorial Award

John Bell was a long-time member of the Society for Applied Spectroscopy (SAS). The Northeastern Ohio Science and Engineering Fair was one of John's special interests; he took great pleasure in representing our Society's local section as a judge at this event. Unfortunately, John died in November 1994. After his death, the members of the Cleveland Section of SAS voted to honor him by establishing the John Bell Memorial Award, for the Science Fair project which best uses or illustrates a principle of spectroscopy in an innovative manner.

Year	John Bell Award	John Bell Merit Award	Special Mention Award
1995	Mary Elizabeth Bruce		
1996	Jonathan Parkhurst		
1997	Lavanya Kondapalli		
1998	Justine Wang	Vivek Mathur	
1999	Elizabeth Long	Kara Urbanek	
2000	Elizabeth Wood	Srinivas Kondapalli	
		Frank Pucci	
2001	Catherine T. Burke		
2002	Mallory Horejis	Alia Evans	Gabe Jakubisin
		Monica Sberna	Scott Brigeman
2003	Zenon Mural	Cecilia Michel	Matthew McPheeters
		Monica Benedikt	Christina Beall
2004	Kevin Rinz	Emily C. Wirtz	Gabrielle L. Petrie
		Sarah Lynn Martin	Zack Puskar
2005	Christine Debaz	Simone Duval	
		Sara Yacyshyn	
2006	Ellen Napoli	Patrick Rinz	Brittney Williams
		Julia Juster	Derek Poindexter
2007	Anna Faist	Mary Ryan	Rebecca Rabinovich
		Jennifer Haag	Margarat Sivit
2008	Jonathan Sender	Shrey Shah	Daniel Kernan
		Johnathan Ungvarsky	Peter Suwondo
2009	Katherine Reading	Johnathan Ungvarsky	Daniel Krentz
		Morde Khaimov	
2010	Maddie Mooney	Katrina Feldkamp	Samuel Stroebel
			Leat Perez
2011	Kevin Yang	Emily Peterson	Sara Mann
			Jane Kim
2012	Jane Kim	Dongham Kim	Paige Rogozinski
		Maurice Ware	Noah Nicholas
2013	Grace Gamble	Justin Boes	
2014	Alison Jin	Claire Chalkin	Morgan Fink
		Anjali Prabhakaran	Kenna Marblestone
2015	Christine Larson	Nicholas Kernan	Lauren Zipp
			Ian Thompson
2016	Klaudia Sirk	Adriana Gildone	Audrey Higgins
			Kei Kojima
2017	Maya Dori	Natalie Haddad	Patrick McFarland
2018	Kotaro Kojima	Albert Zhu	Tingzhang Li
2019	Daniel Anthony	Henry Poduska	
2021	David Anand	Praveen Kumar	Markus Downie
2022	Jacob Rolda	Mathew Gray	
2023	Emily Meckler		

The 2023 John Bell Memorial Award Recipient

Emily Meckler

"Quantifying the Effectiveness of Various Solvents at Removing Chemical Contaminants from Forensic Laboratory Glass and Plasticware through Mass Spectroscopy Analysis?"

Poster Session

Biological Sciences Section

Noor Deif
Lorain County Community College

A Potential HIV/AIDS Gene Therapy Candidate

Surajit Chatterjee
Case Western Reserve University

Characterization of (Bio)molecular Diffusion in Porous Hydrogels using Fluorescence Correlation Spectroscopy Super-Resolution Optical Fluctuation Imaging (fcsSOFI)

Alyssa Davis
Cleveland State University

Purification of Methanococcus Jannaschii Dihydroorotase and Co-crystallization with a Substrate Analog

Marina Eshbaugh and Samantha Semmler
Penn State Erie

Identification and Characterization of Filamentous Fungi for Degradation of Pre-treated Plastic Films

Physical Sciences Section

John Kim
Case Western Reserve University

XPS and ToF-SIMS Depth Profile Comparison of Si Heterojunction Solar Cells

Anuj Saini
Case Western Reserve University

Optimal System for a Fluorescence Based Multilayered 3D Optical Data Storage System

Ricardo Monge Neria
Case Western Reserve University

Single-Molecule Imaging in Commercial Stationary Phase Particles Using Highly Inclined and Laminated Optical Sheet Microscopy

Jeffrey Pigott
Case Western Reserve University

Materials Analysis Across Disciplines at the CSE-SCSAM

Stephanie Kramer
Case Western Reserve University

Improving the Spatial Resolution of Porous Microenvironments with Fluorescence Correlation Spectroscopy Super-Resolution Optical Fluctuation Imaging (fcsSOFI)

Vignesh Venkataramani
Case Western Reserve University

Expansion Microscopy Through Mechanical Force

Sylvie Crowell
Case Western Reserve University

Characterization of Aging Behavior of Silver Nanoparticle Ink for Aerosol Printing

Taige Li
Case Western Reserve University

Advancing Optical Data Storage Systems Using Fluorescent Materials

Tim Socash
Penn State Erie

Exploring the use of Hypervalent Iodine Complexes to Aid in the Electrochemical Detection of Hydroquinones and Phenolic Compounds

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Keynote Presentation

Seeing Small Things in the Vastness of Space

Christopher Own

Voxa
Seattle, Washington

csown@voxa.co

In the unforgiving research environment of the International Space Station, small things can kill. Unknown foreign object debris (FOD) causes potentially catastrophic emergencies for astronauts on board. The inability to identify such contaminants, often smaller than the eye can see, has halted orbital research and maintenance activities for months to years at a time.

Working with NASA scientists and spaceflight specialists, Voxa developed and deployed the first scanning electron microscope in space -- Voxa's Mochii -- to serve orbital research and mitigate flight risks onboard the ISS. The process of preparing Mochii for deployment in the spaceflight environment was intense, with challenges never anticipated because terrestrial EM technology had never been considered in such an environment. Now on-board and operational as part of the ISS National Laboratory, Mochii is available for international researchers across disciplines to access the microscale in microgravity. Mochii is delivering exciting scientific and engineering results in the extreme environment of low Earth orbit and is paving the way for new capabilities for future missions on the moon and beyond.

Presentation IA-1

Automating Microscopic Data Analysis

Robert Clements

Department of Biological Sciences
Kent State University
Kent, Ohio

rclements@kent.edu

Laser scanning and electron microscopy produce data consisting of thousands of sequential images making up large volumes of data. Functional and structural MRI systems are routinely used to scan subjects and patients over many months using multiple modalities. These types of arrays can have thousands of images and/or discrete time-points per modality generating complex data requiring significant human time (days) to process where sub-sampling is frequently required. Image analysis is a critical part of interpreting microscopic data and the use of automated methods would speed up the process and reduce human error. We have developed two methods to automatically analyze cell types within large 3D multi-channel spatial data; 1. An ImageJ (FIJI) plugin for image based segmentation, 2. A custom trained machine learning implementation. In addition, we have developed an automated server client architecture to offload data computation to dedicated hardware in the cloud. These methods were evaluated on multichannel astrocyte images from mouse brain. Astrocytes are supportive glial cells that undergo morphological and chemical changes during different disease states and as such characterizing these changes in large populations of cells is useful for analyzing tissue damage and developing therapeutics. The implementations were evaluated in cells from the cuprizone model of demyelination, known to show astrocyte activation and morphological changes. Data indicates the methodological approaches are able to categorize different cell subtypes and quantify colocalized stains, features critical to many microscopic studies. Our long term goal is to support all types of automated data analysis pertinent to human health, and as such a major focus of this project is to create an extensible open source platform.

Presentation IA-2

Deep Learning Methods to Quantify Cell Morphology in Multichannel Microscope Data

Srikanth Tadisetty, Ruoming Jin, Jun Li
Qiang Guan and Robert Clements

Department of Biological Sciences
Kent State University
Kent, Ohio

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Segmentation is an important part of analyzing medically relevant microscope images and paramount to data interpretation. Convolutional neural networks have been used to perform image segmentation on blood vessel, optic disc, cells, etc. Image analysis is a critical part of interpreting microscopic data and the use of automated methods would speed up the process, reducing human error. Astrocytes are cells that undergo morphological changes during multiple disease states. Characterizing these changes in large cell populations is useful for understanding disease state and response to potential therapies. In this paper, we propose an encoder to capture spatial information for 2D medical images of astrocytes from the cuprizone model of demyelination. Our custom model contains Faster-RCNN and Unet++ to evaluate nuclei, branches and cell body of multichannel images from the mouse brain. Results show that the method outperforms the original U-net and Mask-RCNN methods for Astrocyte segmentation and branch separation. In addition, our model is capable of analyzing high resolution brain cross section images with many astrocyte without much processing time.

Presentation IA-3

Techniques in cell-type identification and calcium imaging analysis in live cells

Zackery T. Knauss[1], Stephen J. Lewis[2]
Devin T. Mueller[1] and Derek S. Damron[1]

Department of Biological Sciences
[1]Kent State University
[2]Case Western Reserve University

zknauss@kent.edu

A critical second messenger Ca2+ plays a fundamental and diversified role in cellular gene expression, metabolism, plasticity, and neuro-/glia-transmission. Current models of in vivo calcium imaging (e.g., miniscope GRIN) which often employ genetically encoded Ca2+ indicators (GECI) display poor optical resolution which can limit their ability to accurately decode all aspects of Ca2+ signaling dynamics (e.g., amplitude). Further, to obtain sufficient resolution, these studies often require the expression of GECIs within select cell populations. This expressional selectivity complicates, if not entirely prevents, the holistic evaluation of multi-cell-type interactions which can influence Ca2+ signaling in response to intervention. In vitro/in situ calcium imaging often involves the use of Ca2+ dyes (i.e., Cal-520 AM) and pharmacological or electrical stimulation to evaluate the impacts of intervention on Ca2+ signaling dynamics. However, these studies often pharmacologically/mechanistically inhibit intrinsic Ca2+ signaling through the blockade of neurotransmission or changes in the cellular environment. In these models' cell-type is often determined via fixed-cell labeling techniques which can greatly impact the speed and accuracy of activity-to-cell-type colocalization. Our presentation will explore novel high-throughput methods in live-cell dynamic imaging of intrinsic (non-stimulated) Ca2+ activity, and adynamic live-cell labeling for cell-type which have been successfully employed in primary prefrontal cortex, hippocampal, and superior cervical ganglion cell cultures derived from P0 rat pups. Further, we will discuss our novel imaging analysis techniques for sorting individual cells by type and Ca2+ response phenotype which have been successfully used to evaluate the impacts of fentanyl and the thioester drug, D-cysteine ethylester (D-CYSee).

Presentation IB-1

**Polyhydroxy Fullerenes Mediated One-Pot Synthesis
of Noble Metal Nanoparticles**

Yue Xu[1,2], Robert E. A. Williams[3], Min Gao[4] Vijay Krishna[1,2]

[1]Cleveland Clinic
[2]Case Western Reserve University
[3]The Ohio State University
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Electron Energy Loss Spectroscopy (EELS) is a powerful analytical technique that provides valuable insights into the chemical bonding and electronic structure of materials at the nanoscale. Energy dispersive X-ray spectroscopy (EDS), on the other hand, allows for the elemental analysis of materials and is particularly useful for characterizing the composition of nanoparticles. Along with transmission electron microscopy (TEM) imaging, these techniques help illustrate the synthesis mechanism of our novel method for noble metal nanoparticles, as well as the composite structure.

Our research demonstrates that polyhydroxy fullerenes (PHF), also known as fullerol or fullerenol, can effectively reduce and stabilize various noble metal nanoparticles. By means of high-resolution TEM, we confirmed the successful synthesis of gold nanoparticles with diameters ranging from 2 to 100 nm, as well as the synthesis process. We proposed a kinetic agglomerate-dissociation model to explain the formation of gold nanoparticles utilizing PHF. Intermediate carbonyl groups were identified by means of EELS spatial and temporal analysis of the core-shell structure of kinetic agglomerates during the redox reaction of gold nanoparticle synthesis following the electrostatic interaction between PHF and Au3+ ions, and prior to the formation of covalent Au-O bonds. Aberration-corrected TEM images and EDS demonstrated the PHF coating on the surface of the metal nanoparticles.

Presentation IB-2

**Photonic Lithotripsy: Effect of Gold and Carbon Based
Nanomaterials on Stone Comminution**

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Kidney stones affect ~10% of individuals in the USA. The most common surgical stone treatments include laser lithotripsy by ureteroscopy and extracorporeal shock wave lithotripsy. Photonic lithotripsy (PL) is a novel technology for minimally-invasive, non-contact kidney stone treatment. PL utilizes photonic nanomaterials that convert low-intensity. We developed a protocol to enable the examination of the same kidney stone using a number of techniques pre and post PL treatment. This involved the use of SEM, FTIR and micro-CT to gain an deeper understanding of the changes occurring in the kidney stone and elucidating the failure mechanism of these kidney stones with different photonic nanomaterials.
Through the use of these techniques we have been able to show changes in the chemical composition of the kidney stones (using FTIR), microstructural changes in the stone (using SEM) and fragmentation of the stone (using micro-CT) when treated using PL.

Techniques such as FTIR, SEM and micro-CT have been integral in helping to understand how this new technology causes stone breakdown and will be vital in developing this technology into a clinical treatment.

Presentation IB-3

**The Fate of Banded Iron Formations in Earth's Interior:
Iron Oxide Reduction Kinetics at High Pressures**

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Banded iron formations (BIFs) are ancient sedimentary rocks highly enriched in iron oxides. They were deposited on ocean floors and then recycled into the mantle at subduction zones. Little is understood about their chemical evolution during and after their subduction into the mantle. In general, the mantle environment becomes more reducing with increasing depth, such that iron oxides could transform to iron metal upon reaching the deep mantle. A critical question is how rapidly the iron oxide reduction reactions proceed at mantle pressures and temperatures. A fast reaction rate would imply that in the deep mantle, large amounts of metal could have formed from the reduction of BIFs. This work focuses specifically on the final step in the iron oxide reaction sequence: the reduction of wüstite (FeO) to iron metal. We performed a set of wüstite reduction kinetics experiments at pressures of 2-8 GPa and temperatures of 600-1400 °C, and analyzed the run products using the ThermoFisher Apreo 2S SEM. The discussion will focus on preliminary results of these new experiments and their significance for the structure and dynamics of Earth's deep interior through time.

Presentation IC-1

Volume And Automated Electron Microscopy In
Preclinical Therapeutic Testing

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About a decade ago, biological scanning EM went through an "aha" moment, in which the benefits of back-scattered electron imaging of intensely stained EM samples provided access to EM imaging modes that had been either prohibitively labor intensive or simply not possible with TEM instruments. Automated EM imaging of tissue sections (also called array tomography) and serial sectioning (serial block-face SEM, FIB-SEM) became routine, and have greatly impacted basic research. In testing therapeutics using animal and cellular models of human diseases, these EM approaches offer three valuable things: speed, new ways to identify efficacy, and ability to base endpoints on relevant subcellular features of the disease. Heritable diseases of peripheral nerves are a good example. The Charcot-Marie-Tooth diseases are debilitating, and while considered rare, account for a substantial population of people. Therapeutics that suppress aberrant gene expression and repress common protein over-expression pathologies are being employed as treatments. Key questions in measuring the impact of treatments are "is there more myelin, intact axons, or healthier mitochondria?" Rodent models of CMT 1a, 2a, and 2e were generated in multiple labs. In collaboration with the Charcot-Marie-Tooth Association, we developed endpoints based on two and three dimensional EM approaches that best fitted each disease. Use of deep learning-based segmentation expedited quantification, and "virtual FIB-SEM" analysis produced valuable non-linear planes of section through structures of interest. The results indicated that EM approaches can be surprisingly cost effective and provide both reliable endpoints and insights into mechanism of action that are unobtainable by more conventional means.

Presentation IC-2

In-Situ TEM: A Nanoscale Laboratory

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The transmission electron microscope (TEM) has long been the gold standard for high resolution imaging, providing atomic level detail about a sample's structure. One significant limitation of traditional TEM setup is the expectation that the sample must be stable in a high vacuum environment. In-situ transmission electron microscopy (in-situ TEM) techniques were developed to overcome this limitation, enabling samples to be imaged with TEM in non-vacuum environments, and simultaneously introduce real-time stimuli, such as temperature or electrical currents, during a TEM imaging session. Thus, users can observe dynamic processes in real-world conditions at resolution unattainable with other microscopy techniques.

State-of-the-art in-situ tools and software enable users to observe real-time reactions and behavior under a variety of conditions, such as liquid, gas and high temperatures and introduce a range of stimuli to the sample in those environments. These systems incorporate semiconductor MEMs technology into the sample support. MEMs technology enables vacuum-sensitive samples to be encapsulated between ultrathin electron transparent windows for imaging in liquid and gas, provides exceptionally low drift rates at high temperatures, and allows patterning of a variety of features such as electrical contacts. Here, we will review the functionality and use in situ systems developed by Protochips Inc. for dynamic in-situ studies including high-temperature and electrical studies, nucleation and material growth in liquid, electrochemistry, catalysis, and corrosion.

Presentation IC-3

Correlative Microscopy: Boost Time-to-Results with Integrated SEM/EDS

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Many analytical techniques are available to materials scientists, whether they are interested in discovering the latest research breakthrough, testing, like in the R&D phase of a project, or in assessing quality on the production floor. Although qualitative parameters along with their associated metrics may contribute to the overall puzzle to answer a question or validate a process, some characterization methods can create bottlenecks due to a variety of technical and practical steps.

In order to accelerate time-to-results, we aim at showing how adaptive super-pixel clustering-based ChemiSEM empowers both novice and expert SEM users to do elemental imaging at backscatter electron detector (BSD) imaging speeds.

We will see how live elemental imaging of close atomic number elements from various materials reveals compositional variation that might otherwise go completely unnoticed in traditional SEMs.

By performing elemental mapping first, not last, the ChemiSEM workflow reshapes the day-to-day approach used by engineers and scientists.

In addition to the post-processing engine that provides meaning to their collected data, microscopists can raise their game up a notch using phase mapping unveiled by ChemiVIEW.

Yeager Presentation

Heterogeneous Ozonolysis of a Novel Fungicide and a Hydrocarbon-Amine System

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Surfaces have a variety of applications in the atmosphere and undergo unique chemistry with atmospheric oxidants, such as ozone. Two applications in this study that undergo ozonolysis are pesticides and rubber tires. In addition to impacting pollution and health, pesticides emitted into the atmosphere can adsorb to the surface of aerosol particles and react with atmospheric oxidants to form secondary organic aerosols, which can affect climate through light scattering and cloud formation. Another application of ozonolysis occurs while testing the ratio of rubber and antiozonant in the surface of tires to prevent tire cracking. Through reacting a condensed-phase film of the novel fungicide fenpyrazamine with gas-phase ozone in a flow cell and monitoring the reaction in real time via infrared spectroscopy, the rate constant of the reaction and the characteristic timescale of product formation were determined. This process was also applied to rubber chemistry by reacting different ratios of squalene, which serves to mimic the rubber used in tires, and diphenylamine, which is an antiozonant. This work highlights the surface reactivity of gas-phase ozone and has the broader implications of understanding the atmospheric fate of fenpyrazamine as well as understanding how to resist damage and decay from ozonolysis in industrial products.

Effects of Aerosol Jet Printing Parameters on the Fabrication of Flexible Circuits

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Conductive metal traces used in circuits are conventionally manufactured through microfabrication, contact printing techniques (e.g., screen printing, flexography, tampography, gravure, offset lithography) or additive techniques such as inkjet printing. Aerosol Jet Printing (AJP) is a newer direct-write technique in which metal nanoparticles suspended in solvent are aerosolized, carried in a mist, focused with gas flow, and deposited onto a substrate with a 2-5 mm standoff from the surface. This provides some advantages over conventional techniques, including the ability to print over varying topologies and expands the type of substrates that can be utilized in device design. The aim of this project is to characterize the effects of various AJP parameters (i.e., atomizer voltage, aerosol flow, sheath flow, standoff height, platen speed, and platen temperature) on the traits of resulting silver traces, seeking to minimize their resistivity and trace width. The characterization methods include optical microscopy, profilometry, electrical testing, scanning electron microscopy, and static bend testing. Data and images collected will be used to develop parameter maps to identify optimal outcomes, display possible failure modes, and guide future development of AJP electronics.

Presentation IIA-2

**Characterizing the Densification of Aerosol Jet Printed Silver Ink
on Polyimide Thin Film**

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Silver nanoparticle and precursor inks can be used to fabricate flexible circuits using aerosol jet printing (AJP). This study analyzes the densification of a silver precursor ink (also known as a metal-organic decomposition ink) applied to a polyimide thin film and the influence of curing time and temperature on the porosity of the deposited ink. Printed specimens were created with the same atomizer voltage, aerosol flow, sheath flow, standoff height, platen speed, platen temperature, and nozzle tip size then samples were cured at 120°C for 1 hr., 120°C for 3 hr., 250°C for 1 hr., and 250°C for 3 hr. with the overarching goal to minimize resistivity. The ability for the silver precursors (i.e., silver ions in organic solution) to cure and densify into homogenous elemental silver relies on the ability to heat sufficiently to evaporate the organic solvents from the printed deposition but not so quickly as to trap the organics within the deposition leading to porosity. Focused ion beam (FIB) milling was used to obtain cross-sections of the printed structures and scanning electron microscopy was used for imaging. The FIB cross-section was analyzed using Dragonfly software to obtain quantitative information regarding the porosity and hence the densification for a given time and temperature. Data collected from this work can be used to aid in AJP optimization studies.

Presentation IIA-3

Tactile Periodic Table Project

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The tactile periodic table project has started building a prototype braille periodic table. Designed by Mona Minkara, a blind Professor of Bioengineering at Northeastern, the prototype is being hand carved onto maple by artist and PhD chemist Michael Fricke.

Presentation IIB-1

Novel Electronic Materials for Energy Generation

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Solution-processed electronics for efficiently and economically harvesting and storing renewable energy have invoked extraordinary attention in both academic and industrial sectors in the past years. In this talk, I will share with you our studies on the development of novel electronic materials for energy generation and storage. Firstly, I will present high-performance perovskite solar cells through the development of novel hybrid inorganic-organic perovskites, novel device architectures, and ternary perovskite-organic composites for renewable energy generation. In particular, I will focus on novel materials development, characterization and the application in renewable energy generation.

Presentation IIB-2

Enabling Characterization of Energy Materials Using Inert Gas Transfer and Cryo-FIB

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To achieve a sustainable future, the development of clean energy generation, storage and distribution technologies like high energy density batteries and high-efficiency solar cells is crucial. However, scientific and technological advancements in this field require a comprehensive understanding of these materials at the microscopic level. The use of DualBeam (FIB-SEM) for thin lamella preparation and subsequent TEM analysis has been crucial in achieving atomic resolution but maintaining sample integrity during the workflow has been a significant challenge due to their sensitivity to air, moisture, and electron-beam irradiation.

In this study, the Thermo Scientific IGST workflow solution was used to enable a DualBeam to TEM workflow by protecting a bulk Li-metal piece and the prepared lamella in an Ar atmosphere with a CleanConnect transfer module. Due to lithium's low melting point, the entire TEM lamella preparation process was carried out at cryogenic temperatures by using a Thermo Scientific cryo-stage and cryo-EasyLift nano-manipulator.

This study successfully demonstrates the capability of the workflow by achieving atomic resolution from Li-metal, which is one of the most challenging samples in terms of air, moisture, and temperature sensitivity. Moreover, this workflow opens up new possibilities for exploring other materials that are sensitive to either beam or air or both.

Observation of the Cyclohexadienyl Radical in an Argon Matrix Using Matrix Isolation Infrared Spectroscopy

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The cyclohexadienyl radical (C6H7) was observed in low temperature argon matrices with matrix isolation infrared spectroscopy. The C6H7 radical was produced from the reaction of H atoms with benzene (C6H6) in the argon matrices. The H atoms were produced primarily by either vacuum ultraviolet (VUV) photolysis or direct microwave discharge of H2S in argon and co-deposited with C6H6 in the argon matrices. The most intense peak of the C6H7 radical was observed at 621.0 cm-1, with several other weaker peaks also observed. The yield of the C6H7 radical was found be approximately 40 percent larger for the direct microwave discharge experiments as compared to the VUV photolysis experiments. The identification and assignment of the C6H7 radical peaks was accomplished by comparisons to co-deposition spectra without VUV photolysis or direct discharge, the H2S and C6H6 monomer spectra with and without VUV photolysis/direct discharge, filtered (400 – 900 nm) and unfiltered Hg-Xe lamp photolysis, and 35 K annealing. Experiments were also performed in which H atoms were reacted with C6D6 producing the C6D6H radical. Quantum chemistry calculations for the C6H7 radical were performed at the DFT and MP2 levels of theory with the aug-cc-PVTZ basis set to obtain the theoretical infrared spectrum to support the experimental peak assignments.

Presentation IIC-1

**Macromolecular Crowding in Cell Regulation and its Observation
by Brightfield Microscopy**

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When protein concentration approaches the very high levels found in cells (the condition known as macromolecular crowding), even small changes in crowding are expected to have disproportionately large effects on cellular metabolism and signaling. Therefore, macromolecular crowding can regulate processes that are accompanied by osmotic imbalance, changes in ion permeability, or active protein synthesis or degradation. Some authors use indirect measures of crowding, such as diffusion of fluorescent tracers; however, intracellular protein concentration can be conveniently quantified directly on a standard optical microscope by a combination of two techniques: transport of intensity equation (TIE) for protein mass and transmission-through-dye (TTD) for cell thickness and volume. Both imaging modalities are accomplished by acquiring transmission images through bandpass filters in the presence of a strongly absorbing extracellular dye. At the same time, TIE/TTD is fully compatible with fluorescence. The TIE/TTD combination reveals information about cellular processes that is difficult to obtain by other methods.

**Vascular Endothelial Barrier Protection Prevents Nanoscale Cardiac Remodeling:
A Novel Strategy to Prevent Atrial Fibrillation**

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Atrial fibrillation (AF) patients experience inflammation, vascular dysfunction and have elevated levels of vascular leak-inducing cytokines, vascular endothelial growth factor (VEGF). We have identified edema-induced disruption of sodium channel (NaV1.5) –rich intercalated disk (ID) nanodomains as a novel arrhythmia mechanism. Therefore, we hypothesized that: (i) VEGF-induced vascular leak acutely slows conduction in the atria and increases arrhythmia risk by disrupting ID nanodomains, and (ii) protection of the vascular barrier can prevent vascular leak-induced atrial arrhythmias. Electron microscopy revealed ID nanodomain swelling, near gap junctions (GJ) and mechanical junctions (MJ) following VEGF treatment in mouse hearts. STORM and STED revealed NaV1.5 enrichment at GJ and MJ in control hearts. VEGF reduced NaV1.5 enrichment at both sites. VEGF increased distance from GJs to 90% of NaV1.5 signal (3.17µm vs. 0.47 µm in vehicle controls), measured by a distance transformation-based analysis of 3D confocal images of IDs. VEGF slowed atrial conduction and increased atrial arrhythmia incidence relative to vehicle controls in both ex vivo (80 vs 0%) and in vivo (70 vs 20%) studies. Overall, in vivo arrhythmia burden was higher in VEGF–treated mice (7.5±11 vs. 0±6s/hr in vehicle controls). Preserving the vascular barrier by blocking endothelial Panx1 channels (PxIL2P) decreased VEGF-induced in vivo arrhythmia burden (0 ± 6.09 s/hr with 1.6 µM PxIL2P). Concurrently, distance from GJs to 90% of NaV1.5 was restored to control levels (0.57µm) in these hearts. In summary, these results highlight inflammation-induced vascular leak as a novel AF mechanism, suggesting vascular barrier protection as an anti-arrhythmic strategy.

Presentation IIC-3

**Multiblock Polyolefin Compatibilizers—From a Non-Living
Metathesis "Shuffling" Method**

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The transfer of stress between incompatible phases of polyethylene (PE) and isotactic polypropylene, materials which are the two most abundant commodity plastics, is a challenge that contributes to mechanical recycling process losses. Compatibilizers improve the performance of these blends, through non-covalent, supramolecular, and covalent interactions across PE/PP interfaces.

Compatibilizer additives offer a way to address this issue by reinforcing the interfacial strength. Typically, most commercial compatibilizers require high loadings (≥10% by weight) for effective results.

Multiblock compatibilizers are very efficient at low loadings (1-5% by weight) due to their high crystallinity and a large degree of blockiness. However, with the currently known literature method for synthesizing such an architecture, the limitation lies in the living nature of polymerization process, thereby limiting scalability. The development of a multi block system through a non-living route, ways to control the chain length (molecular weight) through catalyst choice, and reaction conditions will be described. Finally, the performance of these materials will be demonstrated through measurements of tensile tests, x-ray scattering, solid state NMR spectroscopy, and microscopy (SEM and TEM).

Presentation III-1

Analysis of Additively Manufacture GRCop-42

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GRCop-42 (Cu-4 at.% Cr-2 at.% Nb) is a copper-based alloy optimized for high temperature, high thermal conductivity applications such as regenerative cooled rocket engine liners. For this application, it is important to minimize contamination such as trace elements and ceramic inclusions. NASA initiated a series of ten builds by eight companies to assess the repeatability of GRCop-42 between vendors and machines. Utilizing inductively coupled plasma – atomic emission spectroscopy (ICP-AES) and energy dispersive spectroscopy (EDS) techniques allowed for identification of contaminants and quantification of their chemistry. In addition, additive manufacturing (AM) creates a unique microstructure that is often highly textured in the build (Z) direction. Electron backscattered diffraction (EBSD) was used to begin quantifying the degree of crystallographic texture in the copper matrix grains. It was also used to identify the crystallographic form of Cr_2Nb, the main strengthening phase, present in the samples. Results showed the presence of ceramic inclusions, highly textured grains, and both the low and high temperature phases of Cr_2Nb being present.

Presentation III-2

**Pre-trained Machine Learning Models for the Segmentation
and Quantification of Microscopy Data**

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Here a machine learning approach for the automatic segmentation of microscopy data is presented. There has been significant progress in the material informatics community in performing semantic segmentation using deep neural networks with encoder-decoder architectures. However, even with data augmentation, generating sufficient labelled pixel-wise training data is a burdensome task. To reduce the burden, previous work has applied transfer learning by using decoder networks pretrained on ImageNet images of everyday human life. While pretrained filters early in the network that activate on edges and textures have led to an improvement, deeper filters that have learned to respond to more abstract features like cat ears or car tires are not as relevant when applied in transfer learning to microscopy data. In this work several encoder architectures including VGG16, Inception, ResNet, and MobileNet have been trained on ~100,000 microscopy images from 60 material classes to generate pretrained models with learned filters that are more relevant to microscopy analysis tasks. Model performance on benchmark microscopy segmentation tasks for models with each segmentation architecture (including U-Net and FCN), encoder backbone architecture, and pretrained data source is compared. Each model's ability to generalize to unseen images taken under different imaging conditions and model performance with different amounts of training data is also compared. Finally, the value of this method is demonstrated by developing software tools to automatically segment and quantify microstructure features.

Presentation III-3

Y_2SiO_5: Er Luminescence Thermometry to Above 1500 °C

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Phosphor thermometry has attracted interest for noncontact temperature measurements in turbine engine environments because of its advantages of being not susceptible to errors associated with emissivity uncertainty or reflections from the hot turbine environment. A transition from metallic to ceramic turbine components that can operate at higher turbine engine temperatures will push component surface temperatures from below 1200 °C into a 1300 to 1500 °C temperature range that is much more challenging for phosphor thermometry measurements. To address this challenge, Y_2SiO_5:Er was selected for its high temperature sensing performance by both luminescence lifetime and luminescence intensity ratio (LIR) methods as well as its thermochemical compatibility with the current generation of rare earth silicate environmental barrier coatings (EBCs) that are required to protect SiC/SiC ceramic composite components. In this investigation, the temperature sensing performance of the luminescence and LIR methods using Y_2SiO_5:Er was compared and the conditions under which each method is favored was identified. For both methods, good temperature sensitivity and signal-to-background ratios were observed to above 1500 °C. An enhanced temperature sensitivity for luminescence lifetime measurements above 1300 °C is explained by a transition from high to low effective phonon energies for multiphonon emission.

Presentation III-4

Celebrating a Chemist / Spectroscopist, Dr. Kenneth W. Street, Jr.

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Over a number of years as both a colleague and as his supervisor, it was my privilege to collaborate with and observe Dr. Kenneth W. Street, Jr. in action. After joining our Tribology and Surface Science Branch in 1997 he was tasked with developing micro-spectroscopic sampling techniques for solving aerospace related materials problems. As an outstanding surface and analytical chemist Dr. Street headed our IR and Raman Micro-Spectroscopy research lab, which became an Agency resource. In 2003 due to speculation that the lubricant in Space Shuttle actuators had degraded since originally installed, Dr. Street led the grease evaluation of the fleet actuators. Having never been opened since installation nearly two decades before in some cases, the ensuing actuator investigation uncovered potentially catastrophic, loss-of-vehicle concerns. Dr. Street was also called upon to examine Geostationary Operational Environmental Satellite (GOES), Hubble Space Telescope, and International Space Station experiment components or instruments, all to good effect. Closer to home, Dr. Street was requested by the Cleveland Museum of Art to examine small surface samples of their prized Egyptian antiquities for preservation purposes and was mentioned in their monograph on the collection. In terms of community outreach, through the SAS Dr. Street advocated funding, developed a program and single handedly presented "Spectroscopy for Kids" to K-12 students beginning in 2002 to over 2500 local area students. He presented multiple outreach workshops to K-12 teachers as well on light and its many interactions with matter in order to give them both a better understanding of the subject and useful experiments for their classrooms. This brief recap of a distinguished professional career can shed only a small light on the many interactions, contributions, and accomplishments of Dr. Street during his time in Cleveland.

Poster Number One

A Potential HIV/AIDS Gene Therapy Candidate

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The primate lentivirus Human Immunodeficiency Virus Type-1 (HIV-1) is the cause of Acquired Immunodeficiency Syndrome (AIDS). HIV-1 infects a cell by interacting with one of two co-receptors, CCR5 or CXCR4, as well as the primary receptor CD4. A naturally occurring mutation in ccr5, known as ccr5delta32, encodes a 32 base pair frameshift mutation that produces a truncated CCR5 protein that is localized in the cytoplasm instead of the membrane. The truncated protein appears to downmodulate the surface expression of the full length CCR5 and CXCR4. Individuals who are ccr5delta32 homozygous are resistant to HIV-1 infection. People who are ccr5delta32/ccr5 wildtype heterozygotes can be infected, but progress to AIDS at a slower rate than homozygous wildtype. Individuals with Leukemia and HIV-1 who received bone marrow transplant (BMT) from ccr5delta32 homozygous donors have undetectable levels of HIV.

Ccr5delta32 will be evaluated as a gene therapy to reduce viral burden. A lentiviral vector system was used to construct viral particles containing ccr5 wildtype, ccr5delta32, and ccr5delta33. The packaging cell line HEK293-ft was co-transfected with pLenti-ccr5wildtype, or pLenti-ccr5delta32, or pLenti-ccr5delta33 and helper plasmids psPAX2, pMD2.G. The plasmid psPAX2 encodes HIV metabolic genes and pMD2.G has a Vesicular Stomatitis Virus envelope gene. The pseudotyped viral particles produced were frozen and used to infect H9 and primary lymphocytes. The ability to down-modulate co-receptors by ccr5delta32, using lentiviral vectors has not been determined. If ccr5delta32 can downmodulate wildtype CCR5 and CXCR4 in vivo, an effective AIDS therapy that does not rely on lifelong chemotherapy, can be evaluated.

Poster Number Two

Characterization of (Bio)molecular Diffusion in Porous Hydrogels Using Fluorescence Correlation Spectroscopy Super-Resolution Optical Fluctuation Imaging (fcsSOFI)

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The nanoscale physicochemical structure of porous microenvironments affects the diffusion dynamics of molecules within them. Chemical interactions between the diffusing molecules and porous media can further significantly change diffusion. Fluorescence correlation spectroscopy super-resolution optical fluctuation imaging (fcsSOFI) has been successfully applied to measure biomolecular diffusion in simulated hydrogels of varying matrix densities. In this work, we applied fcsSOFI to systematically characterize the diffusion dynamics of different molecules in complex matrices such as patterned nano surfaces and porous agarose hydrogel. Our data shows that fcsSOFI can quantitively measure diffusion rates in these heterogeneous media as well as resolve their pore structures with high resolution. Using neutral dextran molecules of different size, we show that diffusion coefficient in agarose hydrogel decreases with increasing the size. Currently, we are working on preparing engineered hydrogels with pores of controlled size and viscosity and study diffusion under the confinement due to these different phases inside the hydrogel. Also, to investigate how the interaction between the matrix and diffusing molecules within them changes diffusion dynamics, we are currently testing different kind of probes within hydrogels such as proteins BSA, lysozyme.

Poster Number Three

**Purification of Methanococcus Jannaschii Dihydroorotase and
Co-crystallization with a Substrate Analog**

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Dihydroorotase catalyzes the reversible cyclization of N-carbamoyl-L-aspartate (CA) to L-dihydroorotate (DHO) in the third step of de novo pyrimidine biosynthesis. The reaction is pH dependent, at low pH the biosynthetic reaction is favored, CA ◊ DHO, and at high pH the degradative reaction (DHO ◊ CA) is favored. In this poster we describe (1) the purification of the enzyme from the archaeon Methanococcus jannaschii and (2) its co-crystallization with citrate, an analog of its natural substrate CA. The overall goal of the project is to determine how the substrates bind and the conformational changes in the protein upon binding of each substrate. The purification was carried out as described previously (1) and consisted of ammonium sulfate precipitation, a heat step at 85° C, and cation and hydrophobic interaction chromatographies. The crystallization was carried out with the hanging drop method by extrapolating the conditions of the native protein (2). Citrate, which is a substrate analog of CA, was added to the drop. Our progress on the project will be discussed in the presentation.

Poster Number Four

**Identification and Characterization of Filamentous Fungi for Degradation
of Pre-treated Plastic Films**

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Plastic waste pollution is an increasingly dire environmental problem, as certain types of plastic can take anywhere from 20 to 1,000 years to fully decompose. One potential method of eliminating plastics from the environment is to use fungi to biologically degrade plastic polymers. When plastics are fed to fungi as the sole carbon course, the fungi will consume the carbon that is present in the plastic. This research focuses on high-density polyethylene (HDPE) which contains hydrocarbon backbones that can be degraded using fungal strains. To increase the rate of biodegradation, the following pretreatments were applied to the HDPE samples: nitric acid, microwave and ultraviolet radiation to introduce more readily degradable functional groups into the polymer. The experimentation to degrade the HDPE is located at Penn State Erie, The Behrend College. In collaboration with Penn State University Park, different fungal strains are being analyzed to biodegrade the films that have been pretreated for favorable functional groups for fungal consumption. The goal of the project is to find the optimal pretreatment and fungi combination that degrades HDPE most efficiently.

Poster Number Five

XPS and ToF-SIMS depth profile comparison of Si Heterojunction Solar Cells

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X-ray Photoelectron Spectroscopy (XPS) is one of the most widely used analysis techniques for probing surface composition as well as the composition variation with depth (e.g. depth profile). Even though XPS offers quantitative analysis, limitations do exist when using the technique for depth profiling measurement of Si Heterojunction (SHJ) Solar Cells: probe depth (7-10 nm), detection limit (0.1 atomic %), peak overlaps, inability to measure Hydrogen. Such limitations can be overcome by utilizing another surface analysis technique: Time of Flight – Secondary Ion Mass Spectrometry (ToF-SIMS). ToF-SIMS offers a shallower probe depth.

Poster Number Six

Advancing the Optical Data Storage Systems Using Fluorescent Materials

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Over past decade the total amount of data produced per year increased from 0.9 zettabytes (ZB) to 20 ZB. It has been predicted that this will rise to a staggering 175 ZB by 2025 because of massive amount of data being generated by internet of things, mobile technology, artificial intelligence, and social media. Currently, there is a huge demand for replacing data storage materials involving magnetic materials to be replaced by optical data storage, which provide lower energy consumption, higher capacity, along with longer lifetimes. It is not possible to store large amounts of data generated onto traditional optical and electronic data storage media (tapes and USB flash drives). Polymeric optical data storage (ODS) medium has been combined with the microscopy technologies to provide advantages in cost, performance, and durability. However, there has been a fundamental limitation imposed by far-field diffraction physics that creates a restriction on the current state-of-the-art in ODS systems. There are also limitations imposed by the amount of laser power required to write in such a media. Here, I present a couple of projects that will change the face of the ODS systems by solving these problems using techniques from single molecule microscopy and nanoparticles.

Poster Number Seven

Single-Molecule Imaging in Commercial Stationary Phase Particles Using Highly Inclined and Laminated Optical Sheet Microscopy

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We resolve the three-dimensional, nanoscale locations of single-molecule analytes within commercial stationary phase materials using highly inclined and laminated optical sheet (HILO) microscopy. Single-molecule fluorescence microscopy of chromatography can reveal the molecular heterogeneities that lead to peak broadening, but past work has focused on surfaces designed to mimic stationary phases, which have different physical and chemical properties than the three-dimensional materials used in real columns and membranes. To extend single-molecule measurements to commercial stationary phases, we immobilize individual stationary phase particles and modify our microscope for imaging at further depths with HILO, a method which was originally developed to resolve single molecules in cells of comparable size to column packing materials ($\sim$5–10 μm). We describe and characterize how to change the angle of incidence to achieve HILO so that other researchers can easily incorporate this method onto their existing epi- or total internal reflection fluorescence microscopes. We show improvements up to a 32% in signal-to-background ratio and 118% in the number of single molecules detected within stationary phase particles when using HILO compared to epifluorescence. By controlling the objective position relative to the sample, we produce three-dimensional maps of molecule locations throughout entire stationary phase particles at nanoscale lateral and axial resolutions. The number of localized molecules remains constant axially throughout isolated stationary phase particles and between different particles, indicating that heterogeneity in a separation would not be caused by such affinity differences at microscales but instead kinetic differences at nanoscales on identifiable and distinct adsorption sites.

Poster Number Eight

Materials Analysis Across Disciplines at the CSE-SCSAM

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The Case School of Engineering's Swagelok Center for Surface Analysis of Materials (CSE-SCSAM) is Case Western Reserve University's Core user facility for characterization of materials across disciplines. CSE-SCSAM is a multi-user facility offering a suite of instrumentation for materials characterization through microscopy, spectroscopy, and mechanical testing. From April 2022 – March 2023, 166 individual researchers from the academic, non-profit, and commercial sectors utilized SCSAM's instrumental capabilities and staff expertise. SCSAM is currently staffed by an Executive Director and 2.8 full-time engineers with PhD degrees or comparable experience. In this poster presentation, we will present multi-disciplinary examples of how SCSAM and its capabilities facilitate high-impact research of materials that impact humanity, science, and technology to create a just and thriving world. We will highlight techniques such as X-ray Photoelectron Spectroscopy and Time-of-Flight Secondary-Ion Mass Spectrometry for determining surface chemistry, as well as Optical, Atomic Force, and Scanning Electron Microscopy methods for imaging materials, and Nanoindentation for determining mechanical properties.

Poster Number Nine

Improving the Spatial Resolution of Porous Microenvironments with Fluorescence Correlation Spectroscopy Super-Resolution Optical Fluctuation Imaging (fcsSOFI)

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The local nanoscale physiochemical structures that biomolecules encounter have an impact on their diffusion dynamics in porous environments such as the extracellular matrix (ECM). However, a lack of research into the effects of the steric and chemical environment of the ECM or analog environments on biomolecule diffusion dynamics is partially attributable to the lack of adequate characterization methods. While there are numerous microscopic methods for precisely characterizing in either space or time, simultaneous characterization is still a challenge. In a previous study, we established an autocorrelation method, fluorescence correlation spectroscopy super-resolution optical fluctuation imaging (fcsSOFI), for evaluating the diffusion dynamics of molecules as well as the various topologies of their diffusion environments, such as porous agarose hydrogels and nanopatterned surfaces. However, we discovered that our spatial resolution was 200 nm, which was too great for more biorelevant structures. Here, we demonstrate how integrating cross-correlation in the SOFI analysis can increase the spatial resolution of the fcsSOFI. Through the creation of "virtual" pixels, we may use this technique to multiply the amount of pixels present in the image by a factor of four in order to reduce pixelation. By reducing the pixelation, we will be able to accurately resolve the smaller spatial features found within ECM environments.

Poster Number Ten

Expansion Microscopy Through Mechanical Force

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In biophysics interesting phenomenon take place during the interaction between biological molecules on the order of nanometers. Optical super-resolution imaging techniques surpass the diffraction limit of light enabling higher resolutions to study these phenomenon. However, super-resolution techniques usually require expensive equipment. Expansion microscopy (ExM) is a sample preparation method that facilitates super-resolution imaging by leveraging osmotic forces to physically separate features smaller than the diffraction limit of light. ExM is cheaper than and compatible with other super-resolution methods to reach the nanoscale. Currently, ExM commonly produces 4.5X linear expansion and 20X has been achieved using successive expansion steps, but this can result in fragmentation of the biological sample. Allowing the gel to absorb water to expand is also a slow process. To overcome the fragmentation and time issues, here, we use a highly stretchable cross-linked polymer gel and a mechanical stretcher device to achieve similar 20X linear expansion in minutes. Since we do not rely on osmotic forces for the expansion, this method is more compatible with other techniques which are incompatible with excess water. We demonstrate our expansion microscopy method by imaging MOSE cells at 50nm resolution. We establish mechanical force expansion microscopy as a viable sample preparation method with the same advantages as ExM while being much faster. This will also allow researchers to study time sensitive phenomenon.

Poster Number Eleven

Characterization of Aging Behavior of Silver Nanoparticle Ink for Aerosol Printing

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The response of nanoparticle ink to aging is not well understood. Silver nanoparticle ink can be used for aerosol printing, an additive manufacturing process where aerosolized droplets of conductive ink are deposited onto a substrate in a designated pattern. Aerosol printing allows for rapid prototyping and development of microelectronics for applications including transistors, flexible circuits, and strain gauges. After encountering development issues relating to printer nozzle tip clogging and poor sintering of deposited silver ink, it became necessary to gain a better understanding of the silver nanoparticle ink itself. Literature suggests that nanoparticles may grow in size or agglomerate over time, which could contribute to difficulties during printing and sintering. An aging study was carried out on UT Dots Ag40X silver nanoparticle ink. The ink was analyzed unsintered on a biweekly basis for a total of 10 weeks, then approximately monthly for a total of 30 weeks using a transmission electron microscopy detector on a scanning electron microscope to determine the effect of time on its particle size distribution and morphology. The data was used to determine the accuracy of the manufacturer shelf life on the ink and better understand how ink age may affect aerosol print quality.

Poster Number Twelve

Advancing Optical Data Storage Systems Using Fluorescent Materials

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There has been a fundamental limitation imposed by far-field diffraction physics that creates a restriction on the current ODS systems. Therefore, further improvements need to be developed through the use of far-field evanescent radiation and/or promoting the technology from 2D surface operations to 3D volumetric implementations. Fluorescence microscopy has faced very similar challenges. In the mid-1990s, Stefan Hell used far-field optics to overcome the diffraction limit in fluorescence microscopy by using the concept of stimulated emission depletion (STED) microscopy. The success of which has inspired us to use this approach to enhance the resolution of ODS.

Poster Number Thirteen

Exploring the Use of Hypervalent Iodine Complexes to Aid in the Electrochemical Detection of Hydroquinones and Phenolic Compounds

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Exposure to environmental hydroquinones and phenols that are used in certain industrial processes can cause detrimental effects to humans and animals if not disposed properly. It can be difficult to continuously detect these compounds, which makes it hard to safely dispose of them. Electrochemical detection of phenol is attractive due to its high sensitivity and potentially high selectivity. Unfortunately, the electrochemical oxidation of phenols is known to foul electrodes, thereby prohibiting continuous monitoring.

To avoid electrode fouling, this project focused on a preliminary proof of concept method to detect hydroquinones and phenols by using a hypervalent iodine complex to initially chemically oxidize the analyte of interest, which then can be detected by electrochemically reducing the resulting product. Hydroquinone was initially used as a model compound that readily oxidizes to its benzoquinone substituent through the iodine complex and can be detected when its reduced electrochemically. Additionally, the iodine complex used is an environmentally safe molecule that breaks down overtime into its iodonium salts.

This presentation will investigate the mechanism involved in oxidizing hydroquinone and phenol, as well as other similar compounds such as catechol and resorcinol. This will involve FTIR, NMR, and electrochemical methods. Optimized reaction conditions will be presented to give the best results for the oxidation of the analyte and produce consistently accurate data upon electrochemical reduction. The reductions were preformed using a glassy carbon electrode in a pH 2.8 buffer with 1M KCl. This allows easy proton transfer during the reduction of the species in question.