67th Annual May Conference

May 21, 2025
John Carrol University: Dolan Science Center
University Heights, OH

Sponsors/Partners:

SOCIETY FOR APPLIED SPECTROSCOPY

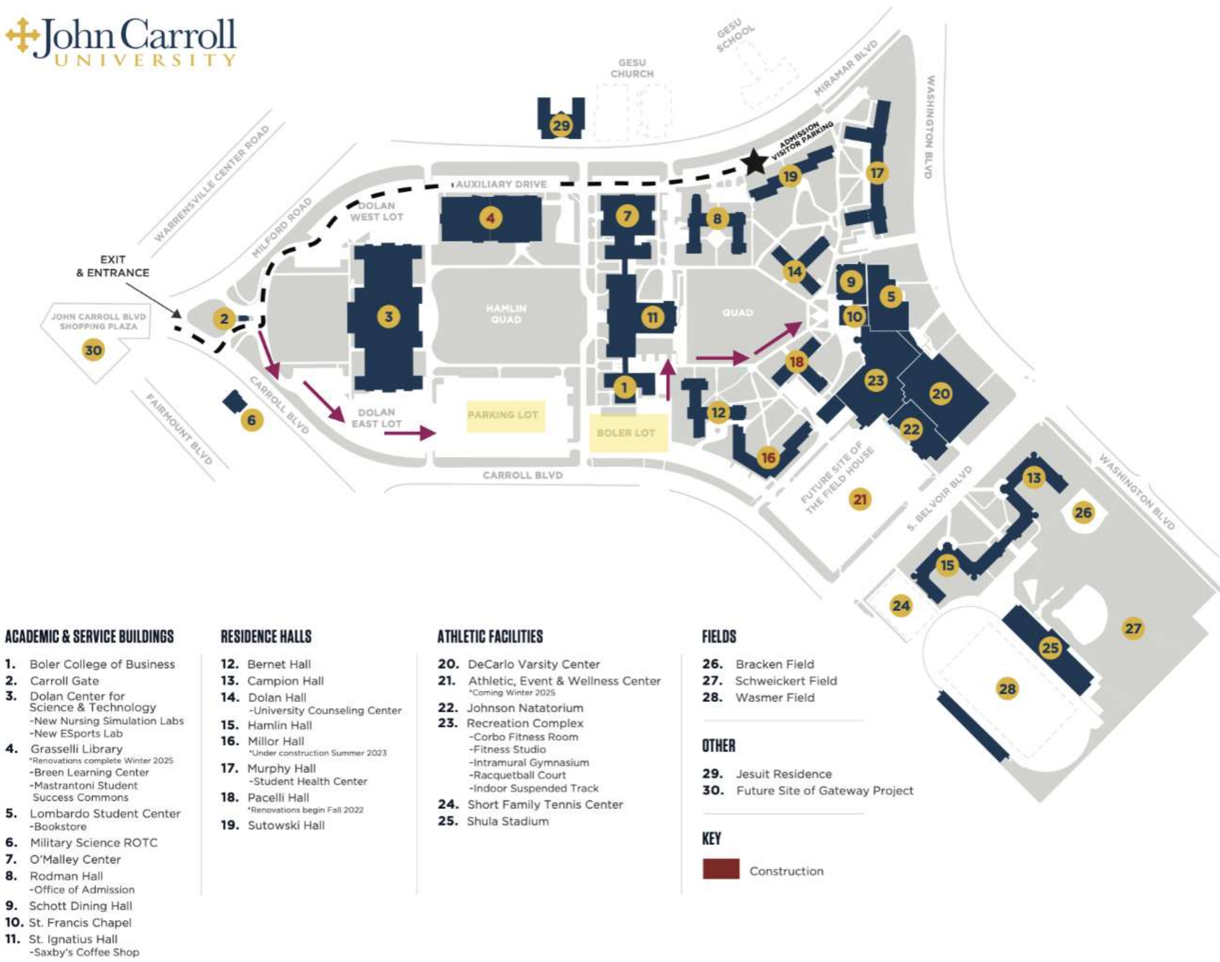
ACESS Akron Council of Engineering and Scientific Societies
Incorporated 1946

Microscopy Society of Northeastern Ohio
Established 1966
An Affiliate Society of MSA & MAS

ACS Local Section
Akron

John Carroll University

John Carroll University Campus Map



PROGRAM

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

8:30 a.m. **Opening Remarks:** (Donahue Auditorium)
Brian Perry, *ParkerLORD*
Laura Wilson, *NASA-Glenn*
Mike Nichols, *John Carroll University*

Recognition of Meeting Sponsors:
Rick Kus

8:45 a.m. **Keynote Address:** (Donahue Auditorium)
Chair: Kim Fraser, *Lubrizol*
Cheri Hampton, *Air Force Research Laboratory*
"From Inner Space to Outer Space: A Journey in Electron Microscopy Applications"

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

Presentation Session I

	Session IA **Dolan E138** Chair: Mike Fricke	**Session IB** **Dolan E228** Chair: Abigail Jarosz	**Session IC** **Dolan E134** Chair: Kim Fraser
9:50 a.m.	IA-1 Arvind Singh Heer "Ohmic Microscopy of Electrochemically Induced CO Oxidation" *Case Western Reserve University*	IB-1 Jae Yang "Advancing Integrative Cryo-EM to Study in-situ Crystalline Structure of the Human Eosinophil Major Basic Protein-1" *University of Wisconsin*	IC-1 Eugene Pashkovski "Application of Ultrafast Video Imaging for Characterizing Elastocapillary Thinning and Rotary Fluid Atomization" *The Lubrizol Corporation*
10:15 a.m.	IA-2 Aaron Nino Gonzaga "Thermodynamic Water Activity Explains the Unusual Electrochemical Stability of Aqueous Deep Eutectic Solvents" *Case Western Reserve University*	IB-2 Zoey Lockwood "Optimizing the Optical and Therapeutic Performance of Indocyanine Green for Cancer and Imaging Treatment" *Case Western Reserve University*	IC-2 Jocelyn Mateo & Andrew Nagy "Quantifying Antioxidants in Non-Alcoholic Beers" *Lorain County Community College*
10:40 a.m.	IA-3 Jay Amicangelo ""Investigation of the Effect of H Atom Precursor on the Yield of C6H7 Radical in Argon Matrix Using Matrix Isolation Infrared Spectroscopy" *Penn State Erie*	IB-3 Samuel Tosin "Empirical Insights into Fungal Sensory and Communication Abilities" *Case Western Reserve University*	IC-3 Robert Stroud "Multimodal Characterization at the Nanoscale with the TESCAN TENSOR Analytical 4D-STEM" *Tescan US*

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

11:25 a.m. **Yeager Award:** (Donahue Auditorium)
Co-Chairs: Lisa Ponton, *Baldwin Wallace University*
Melanie Knowlton, *ParkerLORD*

Kayla Poling, *Case Western Reserve University*
"Water-Driven Enhancement of Electrochemical Mass Transport and Kinetics in Deep Eutectic Solvent Electrolytes with Grotthuss-Enhanced Proton Conductivity"

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

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

1:45 p.m. **Break** (15 minutes): (Edward M. & Ann Muldoon Atrium)

Presentation Session II

	Session IIA **Dolan E138** Chair: Jeff Pigott	**Session IIB** **Dolan E228** Chair: Aryel Clarke	**Session IIC** **Dolan E134** Chair: Emily Graves
2:00 p.m.	IIA-1 Zachery Oestreicher "Using Immunolabeling to Understand Proteins Involved with Biomineralization of Magnetite in Magnetotactic Bacteria" *Miami University*	IIB-1 Megan Macnaughtan "Unravelling the Dual Nature of a C. trachomatis Protein with NMR and Chromatography" *John Carroll University*	IIC-1 Janet Gbur "Mechanical Evaluation and Characterization of Neuromodulation Electronics Connections" *Case Western Reserve University*
2:25 p.m.	IIA-2 Hemal Weerasinghe "Synthesis and Development of Water-stable All Inorganic Perovskite Quantum Dots for Multi-Photon Fluorescence Bio-Imaging" Case Western Reserve University	IIB-2 Alan Chen "X-Ray Photoelectron Spectroscopy Investigation of the Interaction between Oxidized Fullerene and Proteinogenic Amino Acids" *Lerner Research Institute*	IIC-2 Alexandria Miskey "Aerosol Jet Printing Challenges for an Instrumented Pressure Sensing Prosthetic Liner" Case Western Reserve University
2:50 p.m.	IIA-3 Md Sirajul Islam "Sulfur-doped MXene Quantum Dots for PB^{2+} Detection Using Fluorescence Quenching" *Case Western Reserve University*	IIB-3 Justin Zimmerman "Experimental Design for In-Vitro Simulation and Evaluation of Cardiovascular Pacing Lead Failure" *Case Western Reserve University*	IIC-3 Olivia Bogna "Locating PSR B0904+77 Using Regional Spectral Data from Astronomical Surveys" *Lorain County Community College*

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

Presentation Session III

	Session IIIA **Dolan E138** Chair: Mike Dowell	**Session IIIB** **Dolan E228** Chair: Emily Benson	**Session IIIC** **Dolan E130** Chair: Laura Wilson
3:30 p.m.	IIIA-1 Brett Ley Defect-Driven Fatigue Behavior in LPBF Ti-6Al-4V: Insights from Fractographic Analysis” *Case Western Reserve University*	IIIB-1 Marwan Shalih “CARs Imaging to Understand Remyelination in Multiple Sclerosis” *Kent State University*	IIIC-1 Michael Ulatowski “ A Simple, Effective Solution for Characterization and Quantification of Microplastics by PR-GC-MS” *Shimadzu Scientific Instruments*
3:55 p.m.	IIIA-2 Hairo Yu “Azimuthally Resolved Scattering Morphology resolved Total Internal Reflectance Microscopy (SMR-TIRM) of Anisotropic Colloidal Particles” *Case Western Reserve University*	IIIB-2 Myxie Tana Rogado “The Evolution and Development of Lipid Nanoparticles as Therapeutic Carriers” *Case Western Reserve University*	IIIC-2 Brian Strohmeier “Surface and In-Depth Characterization of Polymeric Materials using X-ray Photoelectron Spectroscopy (XPS) Combined with Argon Cluster Ion Sputtering”” *Pittcon Conference and Exposition*
4:20 p.m.	IIIA-3 Kate Vanderburgh “Analytical Strategies using SEM and Correlative Software for Comprehensive Characterization” *Thermo Fisher Scientific*	IIIB-3 Lavanya Jain “Microscopy-Guided Analysis of Ligand-Dependent Gold Nanoparticles Binding on Human Kidney Stones” *Lerner Research Institute*	IIIC-3 Kayleigh Harvey “Turning Minerals into Smartphones: FE:EPMA Advanced Critical Materials Research” *JEOL, USA, Inc.*

4:45 p.m. **Program/ Reception** (Edward M. & Ann Muldoon Atrium)
Chair: Brian Perry, *ParkerLORD*

TRI-C Youth Technology Program
Will Canaday, *YTA Staff member*
Recognition of Meeting Sponsors
Rick Kus, *Treasurer, MSNO*
MSNO Special Awards, Regional Science Day
Laura Wilson, President, MSNO
MSNO NEOSEF Awards
Kim Fraser, President-elect, MSNO
Bell Award Presentation
Brian Perry, *ParkerLORD*
Best Student Poster Awards
Emily Graves, *ParkerLORD*
MSNO Student Award
Laura Wilson, *NASA-Glenn*
Best Student Paper Awards

Regan Silvestri, *Lorain County Community College*
Closing Comments
Brian Perry, *ParkerLORD*

2025 May Conference Planning Committee

General Committee	Jeffrey Pigott, *Case Western Reserve University* Brian Perry, *ParkerLORD* Janet Gbur, *Case Western Reserve University* Min Gao, *Kent State University* Rick Kus, *SAS/MSNO* Kim Fraser, *Lubrizol* Regan Silvestri, *Lorain County Community College* Laura Wilson, *NASA-Glenn* Mike Nichols, *John Carroll University* Tom Steele, *SAS* Emily Graves, *ParkerLORD* Melanie Knowlton, *ParkerLORD* Coleen McFarland, *Envantage, Inc.* Miroslav Bogdanovski, *Cleveland State University* Michael Fricke, *Akron ACS* Emily Benson, *The Cleveland Clinic* Mike Dowell, *ACESS* Grahame Kidd, *The Cleveland Clinic* Grace Rohaley, *Kent State University* Brett Ley, *Case Western Reserve University*
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Finance	Bob Williams, *SAS* Rick Kus, *SAS, MSNO*

E. B. Yeager Award	Melanie Knowlton, *ParkerLORD* Lisa Ponton, *Baldwin Wallace University* Mike Kenney, *Cuyahoga Community College* Doug Rohde, *The Cleveland Clinic*
Student Paper Awards	Regan Silvestri, *Lorain County Community College* Melanie Knowlton, *ParkerLORD* Laura Wilson, NASA-Glenn Michael Fricke, *Akron ACS* Jeffrey Pigott, *Case Western Reserve University* Anushree Deshpande, *ParkerLORD* Min Gao, *Kent State University*
Student Poster Awards	Emily Graves, *ParkerLORD* Erica Winkler, *ParkerLORD* Coleen McFarland*, Envantage, Inc.* Kim Fraser, *Lubrizol* Mike Dowell, *ACESS* Tom Steele Emily Benson, *The Cleveland Clinic* Tim Socash, *ParkerLORD* Miroslav Bogdanovski, *Cleveland State University*
John Bell Award	Tom Steele, *SAS* Brian Perry, *ParkerLORD* Rick Kus, *SAS/MSNO*
Abstract Booklet	Brian Perry, *ParkerLORD* Rick Kus, *SAS/MSNO* Emily Graves, *ParkerLORD* Melanie Knowlton, *ParkerLORD* Erica Winkler, *ParkerLORD* Miroslav Bogdanovski, *Cleveland State University*

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Vice-President	Thomas Steele
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Administrator	David Shultz, SPE
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Councilor	Daryl Stein
Councilor	Mike Fricke, *Olon Ricerca Bioscience*
Committee Chair	Charles Kausch, *Lorain County Community College*

American Chemical Society, Cleveland Section

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Secretary	David Mathur, *Case Western Reserve University*
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Councilor	Michael Kenney, *Cuyahoga Community College*
	Michael Levy, *Anachrom Analytical Specialties*

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.

2025 Ernest B. Yeager Award Recipient

Kayla Poling

Case Western Reserve University

" Water-Driven Enhancement of Electrochemical Mass Transport and Kinetics in Deep Eutectic Solvent Electrolytes with Grotthuss-Enhanced Proton Conductivity "

Ernest B. Yeager Award Past Recipients:

Year	Recipient	Year	Recipient
1962	Eric A. Entemann	1994	Amy L. Lusk
1963	John H. Konnert	1995	John W. Cave
1964	Sheldon J. Green	1996	Michael Fiorentino
1965	Cheryl H. Miller	1997	Jonathan Flad
1966	Dale Wingeleth	1998	Christopher S. Callam
1967	Richard D. Ash, Jr.	1999	David T. Clark
1968	Jon Mynderse	2000	Adam Van Wynsberghe
1969	Virginia E. Coates	2001	David C. Oertel
1970	Charles F. Cobb	2002	Richard L. Barger, Jr.
1971	Gerald R. Cappo	2003	Michelle Adams
1972	Donald R. Diehl	2004	Tiffany Leigh Copeland
1973	Fred A. Fortunato	2005	Stacey Lynne Dean
1974	Douglas B. Rahrig	2006	Colleen M. Burkett
1975	William Hart	2007	Manasi Bhate
1976	John Havens	2008	Nikolas Joseph Neric
1977	Thomas M. Leiden	2009	Deacon J. Nemchick
1978	Scott A. Raybuck	2010	Rachel V. Bennett
1979	Jeff Weidenhamer	2011	Daphne A. Guinn & Jennifer L. Miller
1980	Alexander Kondow	2012	Jean Quenneville
1981	Raymond E. Cline	2013	Yihui Chen
1982	Marie Zaper	2014	Jocienne Nelson
1983	Brian L. Cousins	2015	Kevin Budge
1984	Ka-Pi Hoh	2016	Ian Campbell
1985	Chris Scott	2017	Rachel Molé
1986	Ann M. Mulichak	2018	Nicole Wagner
1987	Rex Ramsier	2019	Corianna Borton
1988	Joy Gorecki	2020	Ryan Reffner
1989	Sheryl Tucker	2021	Eric Rachita
1990	No Award Given	2022	Megan Zins
1991	Stephen C. Stone	2023	Emma Schell
1992	No Award Given	2024	Diego Zubieta Sempertegui
1993	Baonian Hu	2025	Kayla Poling

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.

The 2025 John Bell Memorial Award Recipient

Lila Morley

"Effects of Gut Microbially Produced Phenolic Acids on Host Metabolic Health"

The 2025 John Bell Merit Award Recipient

Samipa Patek

"The Absorption of Anthocyanins Through a Semi-Permeable Membrane"

The 2025 John Bell Special Mention Award Recipient

Elias Sharifi

"Non-Invasive Molecular Classification of Gliomas Using Explainable AI and Radiomic Features from Multi-Sequence MRI"

John Bell Memorial Award Past Recipients:

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 Monica Sberna	Gabe Jakubisin Scott Brigeman
2003	Zenon Mural	Cecilia Michel Monica Benedikt	Matthew McPheeters Christina Beall
2004	Kevin Rinz	Emily C. Wirtz Sarah Lynn Martin	Gabrielle L. Petrie Zack Puskar
2005	Christine Debaz	Simone Duval Sara Yacyshyn	
2006	Ellen Napoli	Patrick Rinz Julia Juster	Brittney Williams Derek Poindexter
2007	Anna Faist	Mary Ryan Jennifer Haag	Rebecca Rabinovich Margarat Sivit
2008	Jonathan Sender	Shrey Shah Johnathan Ungvarsky	Daniel Kernan Peter Suwondo
2009	Katherine Reading	Johnathan Ungvarsky Morde Khaimov	Daniel Krentz
2010	Maddie Mooney	Katrina Feldkamp	Samuel Stroebel Leat Perez
2011	Kevin Yang	Emily Peterson	Sara Mann Jane Kim
2012	Jane Kim	Dongham Kim Maurice Ware	Paige Rogozinski Noah Nicholas
2013	Grace Gamble	Justin Boes	
2014	Alison Jin	Claire Chalkin Anjali Prabhakaran	Morgan Fink 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		
2024	Will Northup	Henrik Burda	Quinn Conley
2025	Lila Morley	Samipa Patel	Elias Sharife

The 2025 Microscopy Society of Northeast Ohio NEOSEF Award Recipients

Yuvha Karthikeyan

First Place

Christian Hammer

Second Place

Tristane McDermott

Third Place

The 2025 Microscopy Society of Northeast Ohio Regional Science Day Special Awards Recipients

Tristane McDermott

Kamil Balci

Bryan Shin

Poster Session

Biological Sciences Section

1	**Gracie Crnjak** Lorain County Community College	"Tiny Earth: Course-Based Undergraduate Research Experience to Isolate Novel Antimicrobial Product"
2	**Aliya Ali** Lorain County Community College	"Targeting CCR5 function as a Therapy for AIDS"
3	**Colin Ely** Penn State Behrend	"Fungal Degradation of Plastic Waste"
4	**Alena Espinosa Alvernia** Lorain County Community College	"Development of Therapies to Target Neuroinflammation"
5	**Anuvi Gupta** Case Western Reserve University	"Characterization of an Aerosol Jet Printed Circuit used in a High-density Implantable Connector for Neuroprosthetics"
6	**Prachi Karanjkar** University of Akron	"Optical Properties of Different Chemistry of Natural and Synthetic Melanin"
7	**Wren Hoertdoerfer** University of Akron	"Surface Structures Act as an Optical Grating in Xenopeltis Unicolor Iridescence"
	Kamil Balci Solon Middle School	"How does Extracellular pH Affect Phagocytosis in Macrophages"
	Tristane McDermott Athens High School	"The camouflage capacity of young squid"

Physical Sciences Section

8	**John Kim** Case Western Reserve University	"XPS and ToF-SIMS Depth Profile Analyses of Battery Cathode Material, $LiCoO_2$ (LCO)/$SrRuO_3$ (SRO)"
9	**Abbey Boyer** University of Dayton	"Design and Testing of CubeSat Radiator Prototype"
10	**Peyton Mann** Youngstown State University	"Dynamic Control of a Polymer-Dispersed Liquid Crystal Film for Use in Smart Greenhouses"
11	**Nabeel Liaqat** Case Western Reserve University	"Microstructural and Mechanical Impact of Carbonated Slag Aggregate in Mortar"
12	**Desiree Mae Prado** Case Western Reserve University	"Breakthrough Conductivity Enhancement in Deep Eutectic Solvents via Grotthuss-type Proton Transport"
13	**Jocelyn Mateo** Lorain County Community College	"Detecting Hydrogen Emission from the Galactic Plane Using a Feedhorn Telescope"
14	**William Chang** Case Western Reserve University	"Applying a Plasma Activated Silver Salt Ink to Aerosol Jet Printing"
15	**Hamza Shaili** Case Western Reserve University	"Photophysical Properties of Perovskite Nanocrystals for Light Emitting Applications"
16	**Aidan Selkirk** Case Western Reserve University	"Image Analysis for Optimizing Aerosol Jet Printed Circuits"
17	**Rahul Singh** Case Western Reserve University	"Wireless Heterogeneous Electrocatalysis: Redox-Mediated Selenite Reduction"
18	**Shubhendu Kumar** University of Akron	"Direct Measurement of Molecular Contact Area Using Sum Frequency Generation Spectroscopy"
19	**Nikesh Bajracharya** Youngstown State University	"Microstructural Assessment of Concrete Under Cyclical Conditions"

Keynote Presentation

From Inner Space to Outer Space: A Journey in Electron Microscopy Applications

Cheri Hampton

Air Force Research Laboratory
Wright-Patterson Air Force Base

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As a biologist and biophysicist trained in cryoEM, tomography, single particle analysis, and 3D reconstruction techniques, I came to the Air Force Research labs to work on soft and biological materials. I could not imagine at the time the breadth of projects I would be called on to characterize. We've studied biosensors for monitoring our airmen in-flight, synthetic biology and protein products, bacterial cell morphologies and functions, to computational methods, and radiation damage of polymers used in space coatings. I have relied on our Materials Characterization Facility TEMs to provide detailed insight into the structural details of materials for unique applications.

Presentation IA-1

Ohmic Microscopy of Electrochemically Induced CO Oxidation

Arvind Singh Heer, Marc Rubin and Daniel Scherson

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Cleveland, OH

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In this study, ohmic microscopy and electrostatic stimulation of electrochemical interfaces were implemented to achieve spatially and temporally resolved images of CO monolayers adsorbed on Pt(poly), CO|Pt(poly), surfaces. Whereas electrostatic stimulation makes it possible to induce localized changes in the interfacial composition, ohmic microscopy allows, in certain cases, local images of such interfaces to be created by using microreference electrodes to monitor the flow of current in the solution in the immediate vicinity of the electrode. In our experiments, we successfully triggered the oxidation of CO|Pt(poly) via electrostatic stimulation at the center of a Pt(poly) disk electrode creating a circular region virtually devoid of adsorbed CO, and halted its propagation along the electrode surface by stepping the potential down to the double-layer (DL) region. As is well known, the double layer capacity of bare Pt surface is markedly larger than that of a CO covered Pt surface; hence, the local current flowing toward the two areas, would be proportional to the local potential measure between the two microreference electrodes. Efforts are underway to create images of the electrode surface by using an XY computer control table to raster the entire electrode surface. This tactic will allow monitoring the ingress of CO molecules from the annulus to the central bare disk as time progress, or, equivalently, determine their surface diffusion coefficient.

Presentation IA-2

Thermodynamic Water Activity Explains the Unusual Electrochemical Stability of Aqueous Deep Eutectic Solvents

Aaron Niño Gonzaga, Desiree Mae Prado, Brady Carter, Clemens Burda

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Cleveland, OH

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The presence of water in nonaqueous deep eutectic solvent (DES) electrolytes has been debated in recent years, with efforts ranging from its complete removal to willful addition. It was shown that controlled amounts of water can be beneficial, as it not only enhances the physicochemical properties of these electrolytes but also has no significant detrimental effect on their electrochemical stability. Despite these advantages, there is still limited understanding of how water interacts with DES systems at the molecular level. This study examines the water activity in ethylene glycol and glycerol, as well as their binary mixtures with choline chloride to form the DESs ethaline and glyceline, respectively. In this work, we show that the high electrochemical stability of glyceline is related to its lower water activity compared to ethaline and can be attributed to the robust H-bonding network formed by the three hydroxyl groups of glycerol. Its three-dimensional H-bond network effectively integrates water molecules within its solvent structure, reducing degradation and maintaining stability at higher water contents. The deviations from the ideal Raoult's law behavior are reflected in the water activity and activity coefficients, which highlight the intricate hydrogen-bond interactions within DES-water mixtures. Water acts like a lubricant within the more viscous DES. mixtures without being detrimental to their electrochemical performance. The presented results emphasize the necessity of customizing DES-water compositions to enhance their performance as electrolytes, especially in flow battery applications where electrochemical stability, ionic conductivity, and fluidity are of utmost importance.

Presentation IA-3

Investigation of the Effect of H Atom Precursor on the Yield of the C6H7 Radical in an Argon Matrix Using Matrix Isolation Infrared Spectroscopy

Jay C. Amicangelo, Lia Totleben, Jacob Oslosky,
Yen Jui Su, Nicole Orwat, Timothy Lehman

School of Science (Chemistry), Penn State Erie
Erie, PA

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The C6H7 radical was observed in argon matrices with matrix isolation infrared spectroscopy. The C6H7 radical was produced from the reaction of hydrogen (H) atoms with C6H6 in the argon matrices. The H atoms were produced by either VUV photolysis or direct microwave discharge of a precursor molecule 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 H atom precursor molecules investigated were H_2, H_2O, H_2S, NH_3, and SiH_4. Using the VUV photolysis source, H_2O and H_2S were investigated as the H atom precursors, and it was found that the C6H7 radical yield was ~ 60% larger with H2S as compared to H2O. H2S was then initially used to investigate the C6H7 radical yield with the direct microwave discharge source, and it was found that the yield of the C6H7 radical was ~ 40% larger with the direct microwave discharge versus the VUV photolysis source. H_2S, H_2, NH_3, and SiH_4 were investigated as the H atom precursors using the direct microwave discharge source, and it was found that the C6H7 radical yield was the largest with SiH_4 and smallest with NH_3. The relative yield was found to increase in the order of NH_3 (22%).

Presentation IB-1

Advancing Integrative Cryo-EM to Study in-situ Crystalline Structure of the Human Eosinophil Major Basic Protein-1

Jae Yang

University of Wisconsin
Madison, WI

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Eosinophils (EOS) are white blood cells named for large secretory granules that stain with the acidic dye eosin. Upon activation, EOS release basic cytotoxic proteins from these granules, including major basic protein (MBP-1). However, it remains unknown how the nanocrystals are formed, stabilized, and mobilized in response to activation. Here, we developed a single-granule profiling workflow to probe these nanocrystals on a single-cell, single granule level by combining cryo-light and electron microscopy (cryo-CLEM), cryo-FIB milling, micro-electron diffraction (MicroED), and montage cryo-ET. We resolved the *in-situ* crystalline structure of MBP-1 in its native crystalline form at 3.0 Å. The structure revealed a mechanism by which intragranular MBP-1 uses the canonical calcium-binding carbohydrate loop to stabilizes intragranular crystals via intra- and inter aromatic-cis-proline monomer-monomer interactions. Correlating real-space three-dimensional volumes from montage cryo-ET and reciprocal pace structural information, we see activation-dependent crystal expansion and extrusion of expanded crystals from secretory granules. Collectively, this research demonstrates the importance of *in-situ* macromolecular structural determination.

Presentation IB-2

Optimizing the Optical and Therapeutic Performance of Indocyanine Green for Cancer Imaging and Treatment

Zoey A. Lockwood[1], Ethan Walker[2], Michael R. Jirousek[1]*
James P. Basilion[2]*, Clemens Burda[1]*

[1]Department of Chemistry, College of Arts and Sciences,
[2]Department of Radiology, School of Medicine,
Case Western Reserve University,
Cleveland, OH

zal15@case.edu

Although the U.S. cancer death rate has declined by 34% since 1991, cancer remains the second leading cause of death. Molecular imaging and targeted phototherapies offer more precise cancer visualization and treatment compared to conventional methods. Indocyanine green (ICG) is a near-infrared dye widely used in the medical field for visualizing blood vessels, assessing tissue perfusion, and tumor imaging. In the first part of this work, we systematically investigated the solvent-dependent optical properties of ICG. By analyzing the effects of polarity, viscosity, and water content on ICG's absorbance, emission, quantum yield, and fluorescence anisotropy, we established a comprehensive framework for how chemical environments influence ICG's performance. In addition to its imaging capabilities, ICG can act as a photothermal agent by converting absorbed light into heat for therapeutic applications. The second project is focused on enhancing photothermal therapy (PTT) by conjugating ICG to gold nanoclusters (AuNCs). The resulting AuNC–ICG complexes demonstrated improved photothermal conversion efficiency compared to free ICG and AuNCs, highlighting their potential for effective cancer treatment. In a separate approach, we utilized 6QC–ICG, a quenched activity-based probe that selectively targets tumor-associated cysteine cathepsins. 6QC–ICG enabled precise fluorescence image-guided surgery (FIGS) followed by PTT to eradicate residual tumor tissue. Together, these projects demonstrate how tuning the chemical environment and utilizing molecular targeting strategies can improve optical imaging and photothermal therapeutic outcomes. This work builds on over two decades of research in the Burda Lab at Case Western Reserve University, which has explored the use of light-activated small molecules and nanomaterials for imaging, diagnostics, and cancer therapy.

Presentation IB-3

Empirical Insights into Fungal Sensory and Communication Abilities

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Fibrous fungi form complex networks of interlinked hyphae called mycelium, which act as pathways for communication between cells. These networks allow signals to travel over long distances, enabling fungi to respond collectively to environmental changes and resource availability. This study explored the sensory abilities of both live and deactivated fungi by examining their fluorescence responses to different stimuli. The fungi were exposed to chemical, light, and mechanical inputs, and their responses were measured using fluorescence radiation.

To investigate the mechanisms of signal transmission, fungi samples were tested under conditions with either connected or isolated air channels. The findings revealed that fungi generated distinct electrical signals in response to various stimuli. Specifically, changes in electrical potential across the mycelium indicated sensitivity to light (on/off), hand movement, mechanical pressure, and chemical presence.

Additionally, fluorescent responses were triggered when chemicals were placed near the fungi, suggesting potential airborne communication. Live fungi showed significantly stronger responses compared to deactivated ones. Both types, however, released ethanol gas when excited by fluorescent light at 480 nm, though in varying amounts. These results suggest that fungi may use volatile organic compounds (VOCs), such as ethanol, as part of their environmental sensing and communication system.

Presentation IC-1

Fluid Atomization

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Many industrial fluids exhibit weak elasticity due to the presence of small concentrations of dissolved polymers. This weak elasticity can be observed only on the timescale of milliseconds, which has become accessible thanks to advancements in ultrafast imaging with sufficient resolution to study elastocapillary thinning and rotary fluid atomization. Here, we demonstrate how visualizing capillary thinning can be used to quantify the viscoelasticity of engine oils, and how this information can help estimate increases in fuel economy.

The process of fluid atomization using the rotary cup technique captures complex fluid behaviors controlled by hydrodynamic and material parameters. Using ultrafast imaging, we demonstrate the formation of fluid ligaments and their subsequent breakup into smaller droplets. The differences between Newtonian and viscoelastic fluids are discussed in terms of the critical conditions for ligament formation and droplet size distributions.

Presentation IC-2

Quantifying Antioxidants in Non-Alcoholic Beers

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High-performance liquid chromatography has been used to quantify the antioxidant xanthohumol (XN) in nonalcoholic beers provided by industry partner Surreal Brewing, San Francisco. The flavonoid xanthohumol is a natural product originating in beer from the ingredient hops, and has recently attracted substantial attention regarding potential health benefits as an antioxidant. Under customary beer brewing techniques, however, the concentration of xanthohumol unfortunately diminishes as xanthohumol degrades to byproducts during standard brewing processes. In an effort to increase the concentration of xanthohumol in beer, Surreal Brewing has produced several non-alcoholic beers via a modified brewing technique. An existing analytical method which uses high-performance liquid chromatography (HP-LC) was applied to quantify the concentrations of xanthohumol in these experimental beers. The existing openly available HP-LC method was set up in-house, and a linear calibration curve for xanthohumol concentration over a range from 30 μg/L to 500 μg/L was obtained with an R2 value of 0.999848. Applying this calibration, various experimental beers produced by Surreal Brewing via modified brewing techniques were measured to range in concentrations of xanthohumol from 20 μg/L to 504 μg/L, or on a per can basis from 7 μg/can to 179 μg/can. The values herein determined for the concentration of xanthohumol in a can of nonalcoholic Surreal beer, ranging from 7 μg/can to 179 μg/can, are comparable to published values ofxanthohumol in dietary supplements which range from 50 μg/unit to 100 μg/unit.

Presentation IC-3

Multimodal Characterization at the Nanoscale with the TESCAN TENSOR Analytical 4D-STEM

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In materials characterization the crystalline structure, as revealed by diffraction patterns, and the ability to relate that information to a particular location in the image, is of great value. The power of 4D analytical STEM lies in its ability to acquire complete image, crystallographic and compositional information across large fields of view with nanometer-scale spatial resolution. Scientists and engineers who need this kind of information work in a variety of disciplines, including materials science, semiconductor manufacturing, pharmaceutical research, product development, and many more. Across these disciplines, practitioners were aware of the potential benefits of S/TEM but have historically been turned off by the perceived operational difficulty of the instrumentation. The TESCAN TENSOR analytical 4D-STEM provides a unique workflow interface to facilitate efficient chemical and structural analysis using EDX mapping, and precession-assisted phase and orientation mapping. The alignment and workflow automation enables effortless, automated switching between measurements optimized for STEM imaging, EDX analysis, or analytical 4D-STEM. With a result-centric design, TESCAN TENSOR's quality, throughput, and robustness of 4D-STEM acquisition, analysis, and processing has been optimized with state-of-the-art technologies, such as Precession Electron Diffraction (PED), 4D-STEM computing and visualization, electrostatic beam blanking, and ultra-high vacuum at the specimen area. Additionally, TESCAN TENSOR features real-time, automated data analysis and processing, which empowers an unprecedented level of system accessibility, utilization, and productivity.

Yeager Award Presentation

Water-Driven Enhancement of Electrochemical Mass Transport and Kinetics in Deep Eutectic Solvent Electrolytes with Grotthuss-Enhanced Proton Conductivity

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Deep eutectic solvents (DESs) have been identified as potential nonaqueous electrolytes for redox flow batteries due to their high electrochemical stability, low volatility, and non-toxicity. DESs are formed by mixing H-bond donor and H-bond acceptor molecules that form a mixture with a melting point significantly lower than that of the individual components. Despite their numerous advantages, they still suffer from challenges such as sluggish mass transport and electrochemical kinetics as well as limited ionic conductivity due to their H-bonding-induced viscosity. In this talk, I will present strategies to overcome these challenges.

In the first approach, we examined the influence of water addition on the electrochemical kinetics, mass transport, and ionic conductivity of DES ethaline (choline chloride:ethylene glycol in 1:2 molar ratio). Systematic water addition resulted in a three-fold increase in ionic conductivity, improved fluidity that facilitates mass transport and accelerates electrochemical kinetics, with minimal cost to the electrochemical stability of the DES.

In the second approach, we induced Grotthuss-type proton transport in ethaline by adding water and sulfuric acid. At sufficient water content, a continuous H-bonding network forms between water and ethylene glycol, enabling efficient proton transfer. This behavior is supported by a molar conductivity-to-fluidity ratio exceeding the ideal Walden relationship. Furthermore, ab initio molecular dynamics (AIMD) simulations revealed proton transfer between water and the DES component ethylene glycol, providing direct evidence of Grotthuss-type transport within the DES electrolyte.

Presentation IIA-1

Using Immunolabeling to Understand Proteins Involved with Biomineralization of Magnetite in Magnetotactic Bacteria

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Magnetotactic bacteria (MTB) are single-celled organisms that are able to biomineralize nano-sized magnetic crystals within their cells, which are primarily used for navigating within their aquatic habitat. Magnetospirillum magneticum AMB-1 is one type of MTB that produces a well-organized chain of specific-sized (~50 nm) magnetite (Fe3O4) crystals. Each crystal is surrounded by a lipid membrane, which contains many different types of proteins that are involved with the biomineralization process. To better understand the molecular mechanisms by which AMB-1 biomineralizes magnetite crystals, we investigated the localization and functional roles of two key magnetosome-associated proteins: Mms6 and Mms13. Both Mms6 and Mms13 have been implicated in regulating crystal morphology and size, with Mms13. In this study, we utilized complementary imaging modalities, transmission electron microscopy (TEM) confocal laser scanning microscopy (CLSM), to immunolabel and localize Mms6 and Mms13 at subcellular resolution. These techniques revealed that Mms13 is predominantly localized along the magnetosome chain, in close association with magnetite crystals or embedded within the MM, consistent with its proposed role in crystal shaping. Our approach underscores the value of using different microscopy strategies to resolve the spatial distribution of magnetosome proteins and deepen our understanding of protein-directed biomineralization in MTB.

Presentation IIA-2

Synthesis and Development of Water-stable All Inorganic Perovskite Quantum Dots for Multi-photon Fluorescence Bio-Imaging

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Non-invasive bio-imaging has attracted great interest in research due to the timely need in medicine to overcomes drawbacks of techniques like X-ray imaging and PET. Fluorescence bioimaging is one of the major approaches in non-invasive bio-imaging, especially for applications like fluorescence-guided surgeries. However, fluorescence imaging shows lackluster performance in deeper tissues due to their lower penetration. Multiphoton (MP) fluorescence imaging is emerging as a solution for this significant depth dependency of fluorescence imaging. Highly localized emission and near infra-red (NIR) excitation wavelengths enhance the image resolution and the depth reaching in this application. Additionally, variable focal length enables the tomographic imaging of tissues. The development of fluorescent probes for MP fluorescence imaging is an emerging research field. These imaging probes should have a high photoluminescence quantum yield (PLQY), high photostability, higher absorption cross-section, and low photo blinking for better performance. We study the synthesis and development of all-inorganic perovskite quantum dots (PQD) as a suitable candidate for this application. PQDs are well known for their exceptional PLQY owing to the direct band gap and composition-based wavelength tuning. All-inorganic PQDs suffer from significantly low stability in water and air. Subsequent ligand engineering is an emerging method to stabilize PQDs, and here, we study zwitterionic ligands to protect PQDs in water while maintaining their high PLQY. We have successfully synthesized a series of PQDs with significantly high stability and solubility over a five-day period in water. This ongoing study will further focus on increasing the stability, increasing the PLQY, studying non-linear optical properties, and application in deep tissue imaging.

Presentation IIA-3

Sulfur-doped MXene Quantum Dots for Pb2+ Detection Using Fluorescence Quenching

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Two-dimensional (2D) transition metal carbides, nitrides, and carbonitrides, collectively known as MXenes, are emerging materials with exceptional properties. Featuring a controllable layered structure, high hydrophilic surface terminations, and outstanding conductivity, MXenes have become potential multifunctional materials. MXenes can be transformed into quantum dots (MQDs), which gain fluorescent properties and retain the characteristics of the bulk MXenes. Due to their small size and quantum confinement effects, these MQDs exhibit strong fluorescence emissions within the 340-600 nm range. Owing to their notable biocompatibility, they are applicable in various fields, including bioimaging, photothermal heat conversion, and fluorescence imaging. In addition, the complex surface nature of MXene offers an opportunity to modify its optical and electrical properties by changing the band gap through heteroatom doping. Sulfur has a specific affinity towards different heavy metals, specifically Pb2+. As the structure of MXene is modified, its band gap will change accordingly. So, sulfur-doped MQDs will exhibit different optical properties than the pristine ones. Because of this change in the surface terminants, sulfur-doped MQDs will exhibit affinity towards Pb2+. Thus, it will show a specific fluorescence quenching mechanism for detecting Pb2+ among other ions. This ion-specific optical property can be tuned by engineering the surface chemistry of MXenes and their subsequent quantum dots for a series of heavy metal-detecting quantum dots. This will expand the horizon of Quantum dot sensors.

Presentation IIB-1

Unraveling the Dual Nature of a *C. trachomatis* Protein with NMR and Chromatography

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Chlamydia trachomatis is an obligate intracellular bacterial pathogen and the leading cause of sexually transmitted bacterial infections worldwide. It possesses a unique biphasic developmental cycle and employs a type III secretion system (T3SS) to invade host cells. The multifunctional protein Scc4 plays a dual role in this system: as a T3SS chaperone and as a transcription factor that regulates σ^{66}-dependent gene expression. Our research focuses on elucidating the high-resolution structure of Scc4 and characterizing its interactions with protein partners involved in both transcriptional regulation and secretion.

As a transcription factor, Scc4 binds the RNA polymerase holoenzyme at the interface between σ^{66} region 4 and the β-flap of the β subunit. In its role as a T3SS chaperone, Scc4 interacts with Scc1 to facilitate the secretion of the essential virulence factor CopN. Structural studies of Scc4 in isolation and in complex with Scc1 reveal significant conformational differences, supporting the hypothesis that Scc4 adopts a distinct structure when functioning in transcriptional regulation. Additionally, our findings suggest that Scc4 and Scc1 associate co-translationally at specific stages of the *C. trachomatis* developmental cycle, indicating tightly regulated temporal coordination of Scc4's dual functions.

Presentation IIB-2

X-Ray Photoelectron Spectroscopy Investigation of the Interaction between Oxidized Fullerene and Proteinogenic Amino Acids

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Fullerene (C60) is a hydrophobic molecule that can be functionalized with oxygen moieties to help increase water solubility, a property that is highly lucrative in biological applications. Previous work from the Krishna lab has found that Oxidized Fullerene stimulated growth in plants and extended longevity in animals, suggesting that an interaction between Oxidized Fullerene and biomolecules might persist. In this study, X-Ray Photoelectron Spectroscopy (XPS) was utilized to investigate the interaction between Oxidized Fullerene and the proteinogenic amino acids. Interaction was initiated by incubating equimolar mixtures of Oxidized Fullerene with an amino acid at 37ºC for 24 hours. The mixture was then flash frozen in liquid nitrogen and freeze-dried before XPS analysis. High resolution N1s, S2p, O1s, and C1s spectrums were acquired to observe changes in atomic binding energy as evidence of interaction. Pristine Oxidized Fullerene and amino acids were used as the baseline controls. Results show that only cysteine and serine seem to covalently bind to Oxidized Fullerene, whereas tryptophan appeared to interact via intermolecular π-π stacking. All other amino acids tested did not seem to interact with Oxidized Fullerene. Based on the XPS spectra for a thiazolidine standard (2-(3-pyridinyl)-1,3-thiazolidine-4-carboxylic acid), cysteine is proposed to form a thiazolidine ring on Oxidized Fullerene similar to its interaction with the bioactive form of vitamin B6 (pyridoxal-5-phosphate). Future experiments will focus on investigating the role of these interactions on Oxidized Fullerene's activity in a biological model in addition to Oxidized Fullerene's interaction with other biomolecules (i.e., carbohydrates, fats).

Presentation IIB-3

Experimental Design for In-Vitro Simulation and Evaluation of Cardiovascular Pacing Lead Failure

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Bipolar endocardial pacing leads are used in conjunction with pulse generators for long-term cardiac pacing. Complications may necessitate the removal of pacing leads for reasons including infection, dislodgement, impedance changes, or structural failure. During these extractions, a number of conditions including lead age, mechanical stress and fatigue, surgical instrumentation and procedure, scar tissue growth, and vascular calcifications, may complicate the procedure and compromise the integrity of the lead, requiring more invasive corrective surgery. To better understand the influences of these conditions, particularly lead aging and mechanical behavior in tension, it is necessary to unify bench testing methods for mechanical and chemical analysis with a clinical perspective of lead extraction. This work identifies and combines a chemical preconditioning regimen to subject leads to accelerated aging before simulated extraction using a mechanical testing design utilized in prior studies. A total of 30 specimens of FINELINE II Sterox EZ 4479 (n=10), CapSureFix Novus MRI SureScan 4076 (n=10), and CapSureFix Novus MRI SureScan 5076 (n=10) models were preconditioned for at minimum 30 days in a hydrogen peroxide and cobalt (II) chloride solution at 37°C to assess the influence of chemical degradation on subsequent uniaxial tensile testing. Digital optical microscopy, scanning electron microscopy, and Fourier transform infrared spectroscopy were then used to evaluate the degree of degradation present and analyze lead construction and modes of failure. This work is intended to establish a methodology for further and continued testing of additional models and extraction conditions.

Presentation IIC-1

Mechanical Evaluation and Characterization of Neuromodulation Electronics Connections

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The Cleveland Open-Source Modular Implant Innovators Community (COSMIIC) aims to create an open-source, modular platform for neuromodulation therapies. COSMIIC's system relies on conducting electrical stimulation between various modules (e.g. nerve excitation modules, biopotential recording modules, etc.). This work discusses mechanical testing for COSMIIC's Neural Open-Source Versatile Array (NOVA), which consists of an implantable 32-channel system that connects these modules for neural recording or stimulation. To represent NOVA's lead-to-feedthrough pin interface, witness specimens were fabricated using a platinum alloy pin encased in an epoxy cylinder. A stainless-steel ferrule containing a 1x7 arrangement of 35N LT silver-cored, drawn-filled tube insulated strands was welded to the pin. A second set of specimens enveloped this weld with silicone to simulate the backfill used to prevent fluid ingress. Both samples were tested in tension and fracture surfaces were evaluated using optical light microscopy and scanning electron microscopy. Data from the witness specimens were used to improve the lead-pin interface and inform future design.

Presentation IIC-2

Aerosol Jet Printing Challenges for an Instrumented Pressure Sensing Prosthetic Liner

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Aerosol jet printing (AJP) is a 'micro' additive manufacturing technique used for the fabrication of flexible electronics. One significant advantage of AJP compared to other direct-write methods is the ability to print on non-planar and textured surfaces while maintaining high feature resolution. While the application space for AJP is varied, one potential application includes printing circuits on stretchable fabric that can be embedded into a prosthetic liner creating a sensorized prothesis to monitor, for example, local strain or pressure at the region interfacing the skin and prosthetic socket. To achieve functional printed sensors, significant optimization and characterization is necessary. In this work, the challenges related to characterizing AJP sensors on textiles are explored. The techniques to qualitatively and quantitatively assess these micro-scale sensors are applied to textile substrates and include optical microscopy, profilometry, scanning electron microscopy, and electrical and mechanical testing. Limitations of the techniques are discussed as well as the difficulty in obtaining quantitative information about the deposition. Preliminary data for this work will be used as a foundation to seek new methods for understanding AJP deposition, particularly on textiles, and to ultimately aid in the development of sensorized liners for prosthetics.

Presentation IIC-3

Locating PSR B0904+77 Using Regional Spectral Data from Astronomical Surveys

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PSR B0904+77 is a pulsar with a spin period almost equivalent to pi/2 seconds. It was detected in 1970 but has disappeared in astronomical surveys. Using spectral data from astronomical surveys in the region, in particular from Low Frequency Array (LOFAR) and the Very Large Array VLA), we can test the hypothesis that this pulsar's location still corresponds to a steep spectrum source. We also propose various follow up techniques.

Presentation IIIA-1

Defect-Driven Fatigue Behavior in LPBF Ti-6Al-4V: Insights from Fractographic Analysis

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In a prior study, LPBF Ti-6Al-4V four-point bending (4PB) and axial fatigue specimens were fabricated using both optimized and sub-optimal process parameters to investigate the influence of process-induced defects on fatigue performance. Specimens were tested to failure under cyclic loading, and fractography was conducted using scanning electron microscopy (SEM) to quantify defects on the fracture surfaces and identify the 'killer' defect(s) responsible for fatigue crack initiation. The size, location, and type of initiating defects were analyzed in relation to processing conditions and resulting fatigue life. Volume sampling effects were also considered when comparing the fatigue behavior of 4PB and axial specimens produced under identical conditions. A key observation was that specimens with nominally identical processing conditions and initiating defect characteristics could exhibit fatigue lives differing by more than an order of magnitude (>10×). This finding suggests that evaluating the microstructural 'neighborhood' surrounding the initiating defect—using techniques such as electron backscatter diffraction (EBSD)—is a critical next step toward understanding and ultimately predicting fatigue behavior in as-built LPBF Ti-6Al-4V components.

Presentation IIIA-2

Azimuthally Resolved Scattering Morphology Resolved Total Internal Reflection Microscopy (SMR-TIRM) of Anisotropic Colloidal Particles

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Micrometer-scale anisotropic colloidal particles are essential to many technologies and products, and their behavior is often governed by interactions on the order of thermal energy (~kT). Measuring and predicting these interactions is key to designing complex fluid-based systems. Total Internal Reflection Microscopy (TIRM) has long been used to study such interactions by monitoring the fluctuating light scattered from spherical particles near a surface. From this, a potential energy profile can be extracted.

Building on this, the Wirth Lab are developing Scattering Morphology Resolved TIRM (SMR-TIRM), an advanced technique designed to extend TIRM to anisotropic particles. SMR-TIRM simultaneously captures both integrated light intensity and detailed scattering morphology, enabling determination of particle orientation. A key advantage of SMR-TIRM is its ability to analyze individual particles, greatly reducing noise and improving accuracy.

To interpret scattering morphology, we use two-dimensional Gaussian fitting, which yields parameters such as the orientation angle ($M\phi$) and aspect ratio (MAR). By combining these with light-scattering simulations, we derived an analytical expression linking to the in-plane azimuthal orientation of ellipsoidal particles. This was then used to experimentally determine the potential energy landscape for a single ellipsoid undergoing Brownian motion. These advancements position SMR-TIRM as a promising tool for probing nanoscale interactions in anisotropic colloidal systems.

Presentation IIIA-3

Analytical Strategies Using SEM and Correlative Software for Comprehensive Characterization

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Scanning electron microscopy (SEM) and its analytical techniques, including energy dispersive spectroscopy (EDS) and electron backscatter diffraction (EBSD) are widely used in the characterization of materials. EDS and EBSD are common analytical techniques in SEM used to provide more comprehensive material characterization. EDS analyzes elemental composition and EBSD enables the characterization of crystallographic structure, orientation and phase at the microscopic level. ThermoFisher ChemiSEM EDS & TruePix EBSD present a single, streamlined solution at the junction of SEM imaging and SEM analytical characterization. The tight integration into the SEM workflow lowers the energy barrier to implementation providing enhanced analytical depth without added complexity. This talk will highlight the key capabilities of ChemiSEM EDS and TruePix EBSD and will illustrate relevant functionalities through case studies.

Presentation IIIB-1

CARs Imaging to Understand Remyelination in Multiple Sclerosis

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Presentation IIIB-2

The Evolution and Development of Lipid Nanoparticles as Therapeutic Carriers

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Over the past 65 years, lipid nanoparticles (LNPs) have steadily gained prominence in the biomedical field as versatile carriers for small molecules, antibodies, and eventually, nucleic acids. Initially developed as liposomes to serve as a model for the cellular membrane, it has since been extensively modified for targeted drug delivery. Nowadays, LNPs are strategically designed using different lipid formulations and optimized synthesis procedures for the encapsulation of various therapeutic agents, with the purpose of increasing stability, biodistribution, and cellular uptake. Characterization of LNPs can be achieved with a plethora of optical and analytical techniques, of which dynamic light scattering (DLS) and electron microscopy (EM) have been commonly used. The regulatory approval of LNP-based therapeutics in anticancer medication and mRNA vaccines during the COVID-19 pandemic marked a huge breakthrough for LNP research, which highlights its successful translation into clinical applications. LNP research continues to dominate at a global scale, implying its importance and versatility for the development of next-generation therapeutics and further drug delivery platforms.

Presentation IIIB-3

Microscopy-Guided Analysis of Ligand-Dependent Gold Nanoparticle Binding on Human Kidney Stones

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Kidney stones affect approximately 10% of the U.S. population, with conventional treatments including laser lithotripsy and extracorporeal shock wave lithotripsy. Photonic lithotripsy is a novel, non-contact therapeutic approach that uses photonic nanoparticles activated by low-intensity lasers.

Presentation IIIC-1

A Simple, Effective Solution for Characterization and Quantification of Microplastics by PY-GC/MS

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As the use of microplastics is being phased out of consumer products, the need for continuous monitoring of their impact on the environment is even more crucial. The use of a pyrolizer attached to a GCMS has made this analysis quick and easy. With the addition of a few components to an already existing instrument a user can begin their analysis in a short period of time. This talk surrounds the current methodology for analyzing microplastics and how PY-GCMS gives another simple option for characterization and quantification.

Presentation IIIC-2

Surface and In-depth Characterization of Polymeric Materials Using X-ray Photoelectron Spectroscopy {XPS) Combined with Argon Cluster Ion Sputtering

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X-ray photoelectron spectroscopy (XPS) has evolved over the last 50 years into the primary analytical technique of choice for the qualitative and quantitative surface characterization of advanced solid materials. The ability to provide unique and important chemical state information with a nanometer scale sampling depth.

Presentation IIIC-3

Turning Minerals into Smartphones: FE-EPMA Advances Critical Materials Research

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In the energy and technology sectors, materials including lithium, neodymium, nickel and electrical steel are critical to advancing the development and production of US products. The increasing scarcity of these materials in combination with low domestic production means that products made from these critical materials need to be efficient, long-lasting and recyclable. However, microscopic defects or impurities in products can lead to decreased performance and longevity. Therefore, chemical and structural characterization at the micro- to nanoscale is important in both development and manufacturing. Scanning electron microscopes (SEM) are well suited to this analysis – they offer nm resolution and the flexibility to integrate various detectors including EDS and WDS to enable in situ chemical characterization. However, SEM-EDS and even SEM-WDS are often insufficient for robust quantitative analysis, especially of trace constituents and light elements. In these cases, electron probe microanalysis (EPMA) is preferred. In this presentation, we explore how recent technologic advancements in FE-EPMA are being leveraged to study critical materials from early exploration and mining to consumer product development and manufacturing. No longer the unapproachable, low-resolution analytical tools of the past, FE-EPMA offer cutting-edge insight into society's most precious resources with nanometer-scale resolution.

Poster Number One

Tiny Earth: Course-Based Undergraduate Research Experience to Isolate Novel Antimicrobial Product

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This research focuses on identifying soil bacteria capable of producing and secreting antibiotics effective against ESKAPE-safe pathogens. These pathogens, which include Staphylococcus aureus, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Escherichia coli, are known for their antibiotic resistance and pose significant challenges in medical treatment. Soil samples were collected from the Rocky River Metroparks and the wooded areas at Lorain County Community College. Bacterial colonies were isolated and screened for antimicrobial activity against ESKAPE-safe strains. Several isolates—specifically colonies #15, 16, 17, 20, and 21—showed promising signs of antimicrobial activity. DNA extractions were performed on selected isolates, and PCR amplification of the 16S rRNA gene was used for phylogenetic analysis. Additional metabolic tests were conducted for further characterization. To identify genes involved in antibiotic production, transposon mutagenesis will be used to generate loss-of-function mutants. These mutants will undergo arbitrary PCR and whole genome sequencing to identify disrupted genes, with the goal of discovering novel antimicrobial compounds.

Poster Number Two

Targeting CCR5 function as a Therapy for AIDS

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The cause of AIDS was shown to be the primate lentivirus Human Immunodeficiency Virus (HIV). Most individuals become seropositive 6 weeks after exposure, some individuals known as Exposed Seronegative (ESN) don't. Others become seropositive but don't progress to AIDS (LTANP). There are multiple explanations for both situations. HIV-1 infects a cell by interacting with CD4 and one of two co-receptors, CCR5 or CXCR4. A naturally occurring ccr5 mutation, known as ccr5delta32, encodes for a 32 base-pair frameshift. The CCR5delta32 truncated protein is not expressed on the membrane surface. The protein was shown to also down modulate full length CCR5 and CXCR4. Some ESN individuals are ccr5delta32 homozygous. Some LTANP are heterozygotes for ccr5 (ccr5delta32/ccr5 wild-type). Some individuals with HIV-1 and Leukemia were treated with bone marrow transplants from ccr5delta32 homozygous donors and subsequently have developed undetectable levels of HIV. Some LTANP and ESN have wild-type ccr5 genes yet have low levels of surface CCR5. A gene therapy that targets CCR5 surface expression was constructed. Ccr5delta32 gene was inserted into a lentiviral vector system (pLenti puro HA-Ubiquitin) and used to construct viral particles. This construct will be transfected into T-cell lines to determine the effect on CCR5 and CXCR4 surface expression.

Poster Number Three

Fungal Degradation of Plastic Waste

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Plastic waste in the environment is a rapidly increasing concern. Plastics can take anywhere from 20 to 1000 years to degrade in the environment completely. Alongside damaging the environment, recent studies have concluded that microplastics have been found in the body, including the brain. This alarming presence shows that plastics can cross into the blood barrier and affect human health, emphasizing the importance of eliminating waste. One promising method is to biologically degrade plastics via fungal digestion. When plastics are fed to fungi as their sole carbon source, the fungi are able to break down the carbon present in the plastic. This research focuses on low-density polyethylene (LDPE) and polyethylene terephthalate (PET or PETE). In an attempt to accelerate the rate of biodegradation, pretreatments are applied to plastics. These pretreatments include using nitric acid, sulfuric acid, hydrogen peroxide, heat, and microwave. Modifying the surfaces of plastics through these treatments aid in introducing more degradable functional groups on the plastic surface. The goal of this project is to determine if the pretreatment already established will work on everyday items that the public uses therefore having the capability of both widespread application as well as effective elimination of excess plastic waste.

Poster Number Four

Development of Therapies to Target Neuroinflammation

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Psychiatric disorders are biologically heterogeneous and often mischaracterized by subjective diagnostic frameworks that overlook underlying molecular drivers. This study investigates the role of microRNAs (miRNAs) in modulating neuropsychiatric phenotypes, with a focus on identifying biomarker signatures associated with self-medicating behaviors, neuroinflammation, and treatment response. Grounded in the self-medicating hypothesis, we propose that dysregulated miRNA expression may contribute to both symptom severity and the compensatory use of psychoactive substances.

To explore this, we established a small-scale biobank incorporating saliva samples, SNP genotyping, and behavioral data from individuals with diagnosed or suspected psychiatric conditions, including ADHD, substance use disorders, and affective disorders. Repeated saliva samples were collected longitudinally following first-time administration of psychiatric medications (e.g., stimulants), alongside detailed environmental, behavioral, and familial history. We conducted multivariate biomarker analysis, integrating miRNA expression profiles with SNPs in neuropsychiatric and inflammatory pathways, patient-reported experiences, and clinical outcomes.

Preliminary findings suggest individual-specific miRNA signatures may correlate with behavioral traits, drug response, and inflammatory status, supporting a model in which miRNAs mediate gene-environment interactions relevant to psychiatric vulnerability and resilience. This work highlights the potential of miRNA-based diagnostics and paves the way for personalized psychiatric interventions rooted in molecular precision.

Poster Number Five

Characterization of an Aerosol Jet Printed Circuit Used in a High-Density Implantable Connector for Neuroprosthetics

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Neuroprosthetics combines neuroscience, biotechnology, and engineering to provide rehabilitation options for amputees. These implantable systems help rehabilitate motor and/or sensory functions by recording from and/or stimulating existing, uninjured nerves. Components for the implantable systems consist for example of nerve cuff electrodes, electronics packages that stimulate or record from nerves and/or muscles, provide system power, and leads which interconnect system components. Commercially available lead technology and connectors are limited to 8 channels for signal transmission in a single connector. Increasing the number of channels to 32 has the potential to improve the resolution of neuroprosthetic systems, requiring a new way to think about traditional, wire-based implantable connectors.

Aerosol jet printing (AJP), a type of additive manufacturing, can be used to produce high-density circuits. In this work, AJP was used to deposit silver particle-free ink onto polydimethylsiloxane (PDMS). A Taguchi experimental design was used to explore the print parameter space, and the resulting print quality was evaluated by measuring electrical resistances, optical microscopy, and profilometry. Electrical resistance was measured using a 2-point probe method; pad-to-pad resistances less than 100 Ohms were considered passing, since modest internal resistance will not harm overall system performance. Conductive specimens were imaged using transmitted light to identify cracks and overspray. Ink deposition was quantified using laser profilometry. Parameters that resulted in high print quality were used to print the final circuit designs onto molded PDMS inserts that are employed within titanium housings that in turn connect to novel 32-channel implantable leads.

Poster Number Six

Optical Properties of Different Chemistry of Natural and Synthetic Melanin

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Melanin, a ubiquitous black pigment, consists of at least five different chemistries identified based on the starting monomers involved in its polymerization process. In addition, natural melanin may contain other components, such as lipids and proteins, that can affect its optical properties. Melanin is known for its high refractive index and broadband absorption. However, most observations of optical properties are based on measurements of eumelanin-based chemistry. In this study, using spectroscopic ellipsometry, we have measured the complex refractive index over a broad range in wavelength (between 380–1700 nm) for the three main melanin chemistries: eumelanin, allomelanin, and pheomelanin. We compare the complex refractive indices for these chemistries with those measured using UV absorption using an integrating sphere to reduce scattering. Our results show that melanin chemistry has profound implications for the optical properties. Pheomelanin has the least absorption and exhibits the lowest refractive index, while poly(L-3,4-dihydroxyphenylalanine) (PDOPA; a polydopamine-based eumelanin chemistry) has the highest refractive index and the highest absorption. These differences in optical properties impact both the optical and thermal properties of melanin and point to the importance of identifying the exact melanin chemistry in natural organisms to understand the impact of melanin on its function and performance.

Poster Number Seven

Surface Structures Act as an Optical Grating in Xenopeltis Unicolor Iridescence

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This study aims to get surface structural insights of the biophotonic structures of iridescent snake sheds to perform optical modeling. We will get experimental data from SEM, AFM, and UV-Vis-NIR to observe what type of structure the snake has that leads to the iridescent color. We will then implement those experimental findings as parameters into an optical model. The elucidation of the optical mechanism can lead to color engineering applications that range from paints to electronics to security. Ultimately this work plans to elucidate the biological function of snake iridescence.

Poster Number Eight

XPS and ToF-SIMS Depth Profile Analyses of Battery Cathode Material, LiCoO2 (LCO)/SrRuO3 (SRO)

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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 battery cathode materials (e.g. LiCoO2): low sensitivity to Lithium, peak overlap for Co, probe depth (5-10 nm), detection limit (0.1 atomic %). Such limitations do not provide reliable analysis of LCO material and its thickness. Another technique, Time of Flight – Secondary Ion Mass Spectrometry (ToF-SIMS), overcomes the limitations by offering reliable analyses for Li and Co with a higher detection limit (ppm-ppb) and shallower probe depth.

Poster Number Nine

Design and Testing of CubeSat Radiator Prototype

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As part of the NASA CubeSat Launch Initiative, this research consists of designing and testing a CubeSat satellite prototype. Primarily used for research purposes, a CubeSat is a cuboidal nanosatellite with side dimensions of 10 centimeters. Due to the harsh space environment, the CubeSat experiences rapid temperature fluctuations, leaving it susceptible to damage. As a result, only about 50% of current CubeSats complete their mission. Unfortunately, the current technology used to modulate temperature on typical spacecraft is too sizeable to be applied to a CubeSat. Therefore, the objective of this research within the NASA CubeSat Launch Initiative is to design an effective system to maintain the operating temperature of the CubeSat radiator.

As part of the current CubeSat design, a system of fins, coated with phase change material (PCM), has been created to actuate outwards when heat disperses from inside the radio. The fins are coated with phase change material (PCM). Phase change materials are exceptionally effective for their ability to store thermal energy and will remove heat from the CubeSat when its fins are exposed to the environment. We were able to achieve at least 45 degrees of actuation through the use of nickel-titanium wires. Nickel-titanium is a shape memory alloy, meaning it can be manipulated into any desired shape or form and can revert to its original form when heated. Within the CubeSat application, the heat applied to the nitinol wire drives the PCM-coated fin outward. We developed our plaster molds in the lab and used kilns to train the wires reaching temperatures over 800 degrees Celsius. We were able to test our prototype within a vacuum chamber using electrical feed-throughs, thermocouples, and polyamide heaters to see if our fin would actuate under conditions most similar to those of an actual CubeSat.

As verified through laboratory testing, the nitinol wire can be geometrically manipulated and then returned to its original configuration following exposure to heat. Additionally, the nitinol was strong enough to actuate the fins when excessive heat was applied. To conclude, the phase change material opens up endless opportunities for innovation within satellites and spacecraft innovations, supporting the actuation and movement of complex technology without the traditional equipment.

Poster Number Ten

Dynamic Control of a Polymer-Dispersed Liquid Crystal Film for Use in Smart Greenhouses

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Polymer-Dispersed Liquid Crystal-Film (PDLC) is a smart material that can change its transparency with the application of an electric current. Increasingly, research into technologies for smart greenhouses is becoming prevalent to help control the microclimate. In the current work, a PDLC is used to dynamically control shading in a greenhouse, which could allow for consistency of the light level, temperature, humidity and more. With the implementation of a control law, an in-situ control scheme with hardware was developed to adjust the transparency of the PDLC, allowing a specified amount of light to enter the greenhouse in real-time. This development is significant because the current state-of-the-art application of PDLC focuses merely on on/off states for the film. It does not take advantage of the continuous nature of the Liquid Crystals (LC) microdroplets. By implementing a continuous control law in real time, a continuous light setpoint can be achieved. Numerous mathematical models are presented to describe the behavior of the PDLC within the system. Experimental testing was performed in a controlled environment as well as under realistic dynamic light settings to validate the models. It is found that the control strategy is able to control the light level within a greenhouse with dynamic perturbations.

Poster Number Eleven

Microstructural and Mechanical Impact of Carbonated Slag Aggregate in Mortar

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This study investigates the effects of carbonated industrial byproducts—specifically carbonated slag aggregate, carbonated slag powder, and carbonated fly ash—on the mechanical performance and microstructural properties of mortar. The experimental program involves the use of carbonated and uncarbonated slag aggregates, along with 50% replacement of cement by carbonated slag powder and carbonated fly ash, to evaluate their role in improving the sustainability and performance of cementitious composites.

Compressive strength tests were conducted at various curing ages to compare the performance of mortars containing uncarbonated vs. carbonated materials. Results showed notable strength enhancement in mixes with carbonated components, attributed to the formation of carbonate reaction products and improved microstructural packing. High-resolution scanning electron microscopy (SEM) was used to analyze the microstructure of hardened mortar, with a focus on the interfacial transition zone (ITZ), pore refinement, and mineral deposition. SEM imaging revealed that carbonation led to denser matrices and increased formation of calcite and other carbonation products, especially in the presence of carbonated slag powder and fly ash.

The study highlights the potential of CO_2 mineralization as a dual-purpose strategy: reducing the carbon footprint of cement by utilizing waste materials and simultaneously improving the mechanical integrity and durability of concrete. These findings contribute to the growing body of knowledge on microscopy-driven insights for developing low-carbon, high-performance cementitious materials.

Poster Number Twelve

Breakthrough Conductivity Enhancement in Deep Eutectic Solvents via Grotthuss-type Proton Transport

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There is an increasing demand for the development of ion-conducting electrolytes for energy storage systems. Much attention has been directed at deep eutectic solvents as potential candidates. In the search for highly conductive systems, the possibility of designing deep eutectic solvents with Grotthuss-type mechanism proton transport has been widely overlooked. Herein, we used ethaline, a mixture of choline chloride and ethylene glycol in a 1:2 molar ratio, to induce a significant conductivity increase with the addition of water and sulfuric acid. The achieved breakthrough conductivity was analyzed experimentally and simulated with ab initio molecular dynamics (AIMD). At sufficient water content, an H-bonding network is formed that leads to a significant breakthrough conductivity based on H2SO4 -derived proton transfer following the long-established Grotthuss proton transport mechanism. This result is substantiated by the positive deviation from the ideal KCl line in the Walden plot. Specifically, the data series positioned above the reference line indicates a Grotthuss mechanism in action. The AIMD simulations demonstrate proton transfer between water and ethylene glycol, supported by simulation frames captured at various times.

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Poster Number Thirteen

Detecting Hydrogen Emission from the Galactic Plane Using a Feedhorn Telescope

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Through the Pulsar Science Collaboratory (PSC), students were educated on radio astronomy, specifically in detecting pulsar candidates. After completing the PSC workshop, an online course spanning approximately five weeks, students in the Student Teams of Astrophysics Researchers - Undergraduate Pathways (STARS-UP) program at Lorain County Community College became certified with the National Science Foundation (NSF) to grade pulsar data plots.

Using resources and technology provided by the PSC and the Digital Signal Processing in Radio Astronomy (DSPIRA) program, a feedhorn telescope was constructed using commercial, off-the-shelf materials as a part of a year-long project through the support of the NSF-funded Partnerships in Astronomy and Astrophysics Research and Education (PAARE) grant. The feedhorn would detect and map hydrogen emissions from the galactic center and other regions along the galactic plane. The construction process, configuration and troubleshooting of its spectrometer, and analysis of the data collected will be documented to determine the overall success, alongside the continuation and further development of this project. This evaluation will be shared by the STARS-UP program with other participating universities and community colleges with the intent of improving the rate of program completion across the nation. The hydrogen H1, 21 cm, 1420.4 MHz emissions data collected from the feedhorn will be analyzed and discussed to conclude the overall construction and data acquisition process from the feedhorn telescope.

Poster Number Fourteen

Applying a Plasma Activated Silver Salt Ink to Aerosol Jet Printing Aerosol

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Additive manufacturing is a promising method for fabricating conductive sensors in medical applications, primarily due to their ability to print on flexible and uneven substrates. Inkjet printing (IJP) and aerosol jet printing (AJP) are non-contact additive manufacturing methods capable of large-scale manufacturing of metal electrodes. However, common inks that utilize IJP and AJP contain metal nanoparticles that require thermal curing to remove solvents and sinter the particles, limiting compatibility with low temperature substrates and inhibiting sensor sensitivity. It was shown that a silver salt ink composed of AgNO3, ethylene glycol, and DI water printed with IJP can use plasma reduction instead of thermal curing. Low pressure plasma reduction converts Ag+ ions to Ag, forming a solid film while subjecting prints to less intensive temperatures and producing viable sensitivities to H2O2. However, it was found that the conversion is limited by print thickness, compromising print adhesion to the substrate. There is potential for more sophisticated sensors to be developed using AJP, which offers greater print resolution in thickness over IJP.

This project utilizes AJP and plasma activation to apply the silver salt ink from the previous study to a polyimide substrate in the form of dumbbell shaped circuits. The goal is to model conductivity over print thickness. Our hypothesis is that as thickness of prints increase, the conductivity will also increase but will lead to a lower conversion of Ag proportionally. Future work will involve identifying and maximizing the proportion of Ag in prints while within a desired conductivity range.

Poster Number Fifteen

Photophysical Properties of Perovskite Nanocrystals for Light Emitting Applications

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Perovskites are a class of materials that have attracted wide attention in the past decade due to their exceptional properties that allowed for a wide range of applications. However, in most devices, the hybrid organic-inorganic perovskite material has issues with instability, and device degradation, which affects their efficiency and the possibility of their commercialization. In our group we have huge interest in lead-free double perovskite nanocrystals that have been considered as a very promising alternative to the conventional lead-based perovskite, offering environmentally friendly and highly stable materials. They have tunable properties and exhibit high fluorescence, making them a very promising candidate for commercialization in the light emitting applications. In the research conducted in the group, we substantially enhanced their emission properties (PLQY>90%) and tested their stability in ambient conditions. In addition, we were able to tune their emission range by tuning their color through inducing dopants. Therefore, a huge emphasis on our group's research is to investigate more stable alternatives that will permit the fabrication of highly efficient and stable devices. My poster will give an overview of our recent findings in this field.

Poster Number Sixteen

Image Analysis for Optimizing Aerosol Jet Printed Circuits

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The ability to accurately characterize conductive ink deposition in aerosol jet printing (AJP) is paramount to understanding the impact of changing print parameters during optimization. Parameters such as atomizer voltage, sheath gas flow, aerosol gas flow, stage speed, and platen temperature can be optimized using a Bayesian model collecting data from the resulting prints and suggesting the next series of printing parameters to query the experimental space. One way to quantify the results of the deposition and to evaluate the quality of the print is through image analysis. Each AJP circuit was imaged using a Keyence VHX-7000 digital optical microscope under identical lighting conditions. The images were analyzed through a custom MATLAB script that utilizes a color mask to separate the print from the background. Next, measurements related to the printed circuit geometry and deposition were made via the MATLAB script including rectangularity, line edge roughness, overspray density, and average overspray distance. These values were standardized, weighted based on perceived importance, and compared using a final Visual Conformity Grade (VCG). This score represents print conformity to the intended print design. The VCG scores were plotted with circuit conductance to identify highly conformal, highly conductive print parameters. Data from this work will aid in the optimization of AJP parameters that will ultimately contribute to lifetime performance and stability of the additively manufactured circuits.

Poster Number Seventeen

Wireless Heterogeneous Electrocatalysis: Redox-Mediated Selenite Reduction

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The study of electrochemical systems traditionally depends on external electronic instrumentation, such as potentiates, to modulate the electrode potential and thereby control the rates of redox reactions. We introduce herein a novel framework termed Wireless Heterogeneous Electrocatalysis (WHE), which circumvents this requirement by using solution-phase redox couples to “pin” the potential of an electrode. This redox-mediated control enables electron transfer processes to occur without conventional wiring or external power sources.

To demonstrate this concept, we selected the reduction of selenious acid (H_2SeO_3) on gold (Au) electrodes as a representative system. In this configuration, a $V^{4+}|V^{3+}$ redox couple serves as a wireless mediator to stabilize the potential of the Au electrode at a value favorable for the targeted transformation. This approach enables investigation of redox reactivity in a setting where the working electrode is not directly connected to a potentiostat, opening new pathways for decentralized and instrument-free electrochemical applications.

The wireless strategy explored in this study offers a compelling platform for extending electrochemical control to environments where traditional methods are impractical or economically unfeasible. This work lays the foundation for broader implementation of wireless approaches in electrocatalysis, sensing, and environmental remediation, where scalability and simplicity are paramount.

Poster Number Eighteen

Direct Measurement of Molecular Contact Area Using Sum Frequency Generation Spectroscopy

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The molecular interactions between two solid surfaces at a subnanometer-length scale can control phenomena such as adhesion, friction, and wetting properties. These interactions, which comprise the actual contact area at the molecular scale between two materials, have historically been a challenge to measure. Here, we show the use of surface-sensitive sum frequency generation spectroscopy to probe the molecular contact between two solid surfaces that vary in roughness and modulus. The molecular interactions are measured by a shift in the vibrational energy of surface hydroxyl groups (OH) on sapphire substrates after interacting with rough poly(methyl methacrylate) sheets. We relate the shift of the OH peak to the contact area and find a dramatic drop in the contact area with increases in roughness and modulus. In contrast, softer sheets were able to deform and create a complete mechanical contact. Interestingly, we find that complete mechanical contact alone was insufficient to maximize the molecular contact. Instead, the molecular rearrangement of interfacial molecules was necessary to enhance the interaction energy.

Poster Number Nineteen

Microstructural Assessment of Concrete Under Cyclical Conditions

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The aim of this research is to measure changes in the pore size of concrete exposed to cyclical environments such as alkali-silica reaction (ASR), freezing-thawing, and wetting-drying. The literature reveals gaps in understanding how microstructural alterations caused by seasonal variations affect concrete performance. In this study, three pore size analysis techniques were used: nitrogen adsorption and desorption (NAD) for 2 to 50 nm pores, scanning electron microscopy (SEM) for 1 to 10 μm pores, and microCT (μCT) for 35 μm to 5 mm pores. The research methodology included sample preparation, exposure to one of nine cyclical environments, pore size analysis, and comparison of the pore size distributions. Preliminary results indicate that combined ASR and freeze-thaw conditions lead to an increase in total pore volume as compared to the controls. The research spans 180 days of data collection and final conclusions will be drawn upon completion of the 540-day of cyclic exposure, providing deeper insights into long-term effects of coupled environmental stressors on concrete microstructure.

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