66th ANNUAL
MAY CONFERENCE

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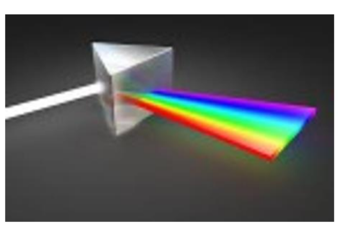
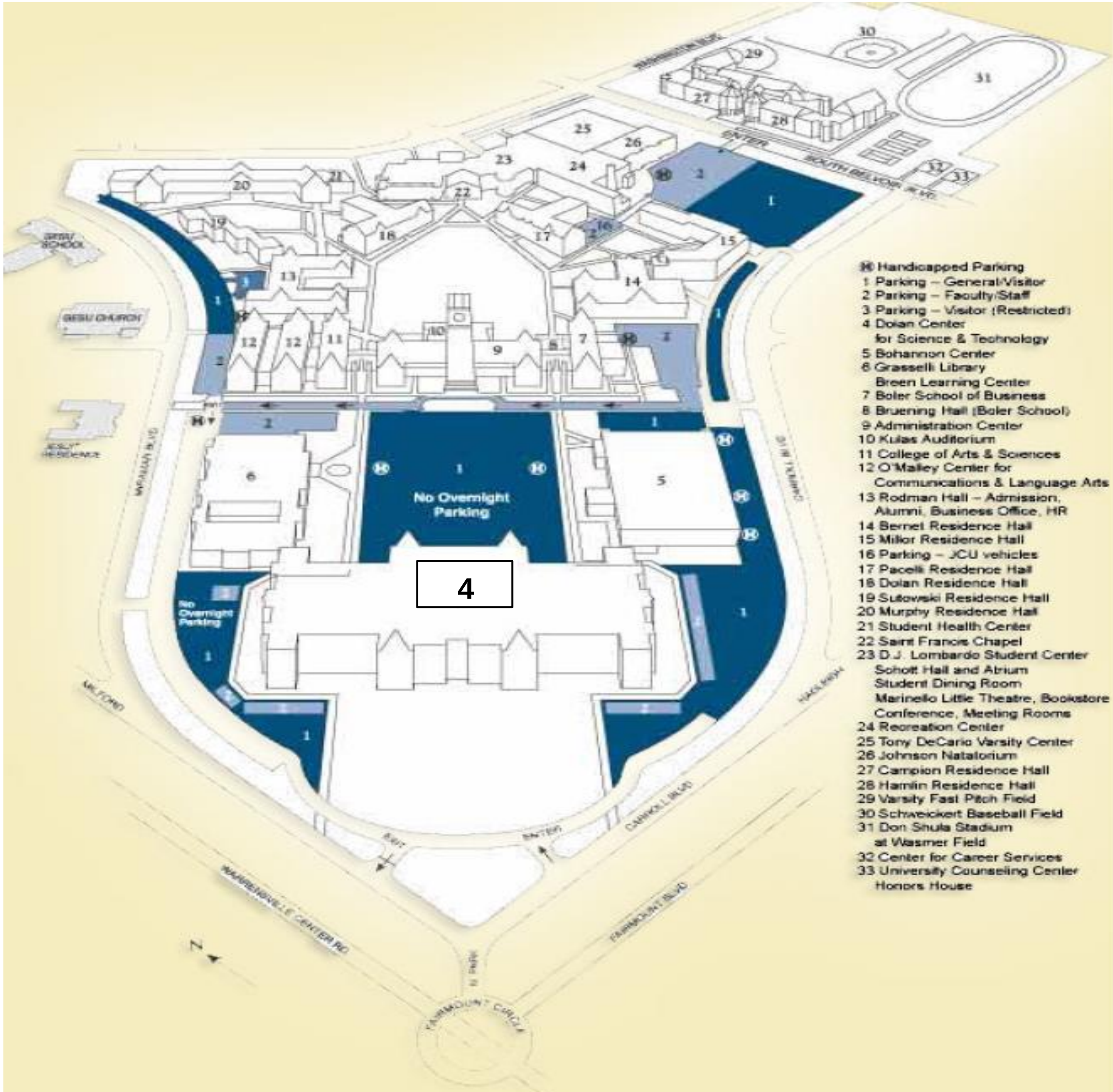


May 22, 2024
Dolan Science Center
John Carroll University
University Heights, Ohio

John Carroll University Campus Map



66th Annual
SAS / MSNO / ACESS / ACS - Akron
May Conference

May 22, 2024
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* Andrew Shoffstall, Case Western Reserve University "Fibers, Fascicles and Nerves, Oh Mi(croscopy)"
9:35 a.m.	**Break (15 minutes):** (Edward M. & Ann Muldoon Atrium)

Presentation Session I

	Session IA Dolan E138 Chair: Jemila Edmond	Session IB Dolan E228 Chair: Emily Benson	Session IC Dolan E134 Chair: Abigail Jarosz
9:50 a.m.	IA-1 Zachary Harris "Leveraging Correlative Microscopy to Understand Hydrogen Environment-Assisted Cracking in Additively Manufactured 17-4PH Stainless Steel" *The University of Pittsburgh*	IB-1 Rengasayee (Sai) Veeraraghavan "Unlocking the Investigative Power of High-Resolution Microscopy through Computational Image Analysis" *The Ohio State University*	IC-1 Hamza Balci "Investigating the Role of G-quadruplex Structures in Transcription Control and Telomere Protection Contexts Using Single Molecule Fluorescence Approaches" Kent State University
10:15 a.m.	IA-2 Soumya Chandrasekhar "Structure Determination of Membrane Proteins using DNA-based Nanodiscs" *Kent State University*	IB-2 Dylan Wood "Advancing Research in Energy Production and Storage Using In Situ Liquid-Phase TEM" *Protochips, Inc.*	IC-2 Hope Zehr "Using Spectroscopy to Engineer Carbon Nanomaterials for Skin Cancer Prevention" Cleveland Clinic / Cleveland State University
10:40 a.m.	IA-3 Janet Gbur "Characterization of Corrosion in Percutaneous Leads used in Neuromodulation Applications" *Case Western Reserve University*	IB-3 Min Gao "Building a Toolbox for Direct and Indirect Electron Microscopy Imaging of Liquid Crystals and Other Complex Molecular Fluids" *Kent State University*	IC-3 Yang Yang "A Novel Catalyst for Pheomelanin Inhibition to Prevent Melanoma" *Lerner Research Institute*

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*

Diego Zubieta Sempertegui, *Case Western Reserve University*

"Si Photovoltaics for Terawatts Power"

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

12:45-1:45 p.m. **Poster Session:** (Second Floor Hallway)

Presentation Session II

	Session IIA **Dolan E138** Chair: Jeffrey Pigott	**Session IIB** **Dolan E228** Chair: Kim Fraser	**Session IIC** **Dolan E134** Chair: Emily Graves
2:00 p.m.	IIA-1 Caleb Holyoke “Melt Segregation Mechanisms During Syndeformational Partial Melting of an Amphibolite" *University of Akron*	IIB-1 Weinan Xu “Advanced Polymer Nanocomposites and their Structure-Property Relationship” *University of Akron*	IIC-1 Utkarsh Patil “Measurement of Nanoscale Interfacial Contact Area Using Vibrational Spectroscopy” *University of Akron*
2:25 p.m.	IIA-2 Samantha Semmler “Identification and Characterization of Filamentous Fungi for Degradation of Pre-treated Plastic Films” Penn State-Erie	IIB-2 Heather Everson “Purification of DNA Nanoparticles using Photocleavable Biotin Tethers” *Case Western Reserve University*	IIC-2 Jay Amicangelo “Characterization of a Hydrogen Peroxide-Benzene Complex Using Matrix Isolation Infrared Spectroscopy” *Penn State - Erie*
2:50 p.m.	IIA-3 Praneetha Sundar Prakash “DNA Origami Barcodes for Immunostaining” *Kent State University*	IIB-3 Yindong Ge “The Effect of Carbon black on the Morphology and Mechanical Characteristics of Synthetic Rubber Blends” *Parker Hannifin Corporation*	IIC-3 Veebha Havaldar “Characterization of Pheomelanin and Eumelanin with Experimental and Computational FTIR Spectroscopy” *Case Western Reserve University / Lerner Research Institute*

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

Presentation Session III

	Session IIIA Dolan E138 Chair: Mike Fricke	Session IIIB Dolan E228 Chair: Laura Wilson	Session IIIC Dolan E130 Chair: Mike Dowell
3:30 p.m.	IIIA-1 Xiong Gong "Wireless Self-Charging Powered Packs/Electronics" University of Akron	IIIB-1 Sylvie Crowell "Investigation of Process-Property Relationships of Aerosol Jet Printing with Silver Nanoparticle Ink for Flexible Electronics" *Case Western Reserve University*	IIIC-1 Nilanthi Haputhanthrige "Liquid Crystalline Structures Formed by Rigid Sphere-Rod Macromolecules" *Kent State University*
3:55 p.m.	IIIA-2 Lei Liu "Bulk Heterojunction Perovskite Solar Cells Incorporated with Conjugated Polyelectrolytes" University of Akron	IIIB-2 Jinyu Bu "Integration of Low-melting-point Alloys and Thermoplastic Elastomers for 3D Printing of Multifunctional Composites" *University of Akron*	IIIC-2 David Bialas "Insight Into the Optical Properties of Organic Dye Aggregates" *Penn State - Erie*
4:20 p.m.	IIIA-3 Jason Bennett "Fabrication of Flexible Microelectrodes Coated with Poly(3,4-ethylenedioxythiophene) and Electrochemically Reduced Graphene Oxide" *Penn State - Erie*	IIIB-3 Daniel Rakowsky "Image Processing and Analysis Methods for Assessing Aerosol Jet Printed Traces" *Case Western Reserve University*	IIIC-3 Jeanpun Antarasen "Cross-correlation Increases Sampling in Diffusion-Based Super-Resolution Optical Fluctuation Imaging" *Case Western Reserve University*

4:45 - 7:00 p.m. Program/ Reception

Chair, Brian Perry, *ParkerLORD* (Edward M. & Ann Muldoon Atrium)

Recognition of Meeting Sponsors
Rick Kus, *Treasurer, MSNO*
Bell Award Presentation
Brian Perry, *ParkerLORD*
Best Student Poster Awards
Emily Graves, *ParkerLORD*
MSNO Student Award
Jeffrey Pigott, *Case Western Reserve University*
Best Student Paper Awards
Regan Silvestri, *Lorain County Community College*

Closing Comments
Brian Perry, *ParkerLORD*

2024 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* Jemilia Edmond, *Case Western Reserve University* Ricardo Monge Neria, *Case Western Reserve University*
Corporate Sponsors	Jeffrey Pigott, CWRU Swagelok Center for Surface Analysis of Materials Emily Graves, *ParkerLORD*
Technical Program	Min Gao, *Kent State University* Brian Perry, *ParkerLORD* Jeffrey Pigott, *Case Western Reserve University* Rick Kus, *SAS/MSNO* Regan Silvestri, *Lorain County Community College* Janet Gbur, *Case Western Reserve University*
Publicity	Kim Fraser, *Lubrizol* Min Gao, *Kent State University* Janet Gbur, *Case Western Reserve University* Jeffrey Pigott, *Case Western Reserve University* Laura Wilson, *NASA-Glenn*
Finance	Bob Williams, *SAS* Rick Kus, *SAS, MSNO*
E. B. Yeager Award	Melanie Knowlton, *ParkerLORD* Rick Kus, *SAS/MSNO* 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* Yindong Ge, *ParkerLORD* Emily Benson, *The Cleveland Clinic*
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, *Godfrey & Wing, Inc.*
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Treasurer	Robert Williams

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Student Committee	Ricardo Monge Neria, *Case Western Reserve University*

Akron Council of Engineering and Scientific Societies (ACESS)

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Chair	Katherine Huisinga, *Malone University*
Chair Elect	Walter Salamant *Bridgestone*
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Councilor	Michael Fricke
Councilor	Daryl Stein

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	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 and 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		

2024 Ernest B. Yeager Award Recipient

Diego Zubieta Sempertegui

Case Western Reserve University

"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 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	Conley Quinn

The 2024 John Bell Memorial Award Recipient

Will Northup

“Prototyping a Cheaper Alternative for LIBS IR Spectroscopy”

The 2024 John Bell Merit Award Recipient

Henrik Burda

“Dependent Solvatochroism of Betaine 30 Dye”

The 2024 John Bell Special Mention Award Recipient

Conley Quinn

“The Diving Bell Spider”

Poster Session

Biological Sciences Section

1	**John Kim** Case Western Reserve University	“Analysis of Waxy Plant Surface on Rudbeckia Fulgida Leaf”
2	**Akeshi Aththanayake** Case Western Reserve University	“Enhancing Energy Transfer Efficiency with ENZ Platforms: Quantum Emitters in DNA Beacons”
3	**Tim Socash** Penn State Erie	“Exploring the Use of Hypervalent Iodine to Aid in the Selective Electrochemical Detection of THC and CBD”
4	**Tom Chrzanowski** Penn State Erie	“Determining if Pretreatment Aids in Facilitating Fungal Degradation of Plastic Films”
5	**Mehdi Ali** Lorain County Community College	“Targeting CCR5 function as a Therapy for AIDS”
6	**Janan Alfehaid** Kent State University	“Resetting Single Molecule Microfluidic Sample Chambers by Using UV Light or High pH”
7	**Min Gao** Kent State University	“Cryo-based Microscopy Sample Preparation”
8	**John Martin** Lorain County Community College	“Evaluation of Growing Rod Surgical Implants Used in the Treatment of Pediatric Scoliosis by Finite Element Analysis”
9	**Sineth Kodikara** Kent State University	“Detecting Secondary Structure Formation with FRET-PAINT”
10	**Soumya Chandrasekhar** Kent State University	“Polyethylene Glycol-Modified DNA-based Nanodiscs for Incorporation and Characterization of Membrane Proteins”
11	**Aftab Mollah** Kent State University	“Unveiling the Sequence-specific Recognition of N6-methyladenosine (m6A) in Eukaryotic RNAs”

Physical Sciences Section

12	**Tugce Karakulak Uz** Case Western Reserve University	"TSEM-EDS Study of Nanoprecipitates in Oxide-Dispersion-Strengthened (ODS) 14YWT Ferritic Alloys"
13	**Suraj Pathak** Kent State University	“Xeuss 3.0: Unveiling X-ray Scattering at Our State-of-the-Art SAXS Facility”
14	**Ricardo Monge Neria** Case Western Reserve University	“Super-resolution imaging reveals resistance to mass transfer in functionalized stationary phases”
15	**Peter McPike** University of Akron	“Machine Learning for Bond Classification: An Undergraduate Chemistry Student Exercise”
16	**Nathan Rothacker** The Ohio State University	“Multiscale quantification of nanostructure across extended sample volume”
17	**Gabriel Gemadzie** University of Akron	“Application of Machine Leaning to Single-Entity Electrochemical analysis”
18	**Eric Trout** Case Western Reserve University	“MATLAB Algorithm to Analyze XPS Data of Functionalized Surface”
19	**Zechariah Pfaffenberger** Case Western Reserve University	“Sensing and mapping metal corrosion in-situ via a fluorescence spectroscopy and single-molecule microscopy”
20	**Shubhendu Kumar** University of Akron	“Impact of Nanometer-Thin Stiff Layer on Adhesion to Rough Surfaces”
21	**Lexi Miskey** Case Western Reserve University	“Creating an Instrumented Pressure Sensing Prosthetic Liner using Aerosol Jet Printed Electronics”
22	**Tyler Vu** Case Western Reserve University	“Development Aerosol Jet Printing on PMMA for of Sensorized Contact Lenses”
23	**Olivia Bogna** Lorain County Community College	“Analysis of AGN through Spectroscopy”
24	**Jemila Edmond** Case Western Reserve University	“Kinetics of Iron Oxide Reduction at High Pressures”

Keynote Presentation

Fibers, Fascicles and Nerves

Andrew Shoffstall

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The vagus nerves connect to the brainstem and innervate most viscera, including the heart, airways, lungs, pancreas, and gastrointestinal tract. Given this widespread innervation, electrical stimulation of the vagus nerve offers therapeutic potential for many diseases: vagus nerve stimulation (VNS) has been applied to treat epilepsy, rheumatoid arthritis, and heart failure, among many other conditions. However, insufficient anatomical data are available to map the ~100,000 fibers of the human vagus nerve to their end organs for development of improved VNS therapies, with increased efficacy and decreased side effects.

Our team has been charged with a project to dissect 50 human cadavers and quantify the gross anatomy of their 100 vagus nerves (50 left, 50 right) with a 3D position sensor and with 3T MRI. We will quantify fascicle pathways along the whole nerve length with microCT. We will pioneer microscopy-based tractography of the vagus nerve with ultraviolet surface excitation (MUSE), a novel imaging technology developed at Case Western Reserve University. These multimodal, multiscale imaging data will be co-registered, segmented, visualized, and shared publicly. We will leverage these imaging data by validating and demonstrating their end-use in anatomically-realistic, biophysical, validated computational models of human vagus nerve stimulation.

Mapping the vagus nerve with the latest high resolution imaging modalities has tremendous potential to improve the safety and efficacy of existing therapies applied to the vagus nerve. By performing the most comprehensive imaging analysis of the human vagus nerve and its branches ever completed, and establishing a neuroanatomical repository for the vagus nerve, this work will seed and accelerate the development of novel neuromodulation therapies for autonomic regulation.

Presentation IA-1

Leveraging Correlative Microscopy to Understand Hydrogen Environment-Assisted Cracking in Additively Manufactured 17-4PH Stainless Steel

Zachary Harris

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The hydrogen environment-assisted cracking (HEAC) behavior of additively manufactured (AM) and wrought 17-4PH stainless steel heat treated to exhibit similar microstructure and yield strength is quantified through fracture mechanics-based testing conducted in 0.6 M NaCl at an applied potential of -1.1 VSCE (vs. saturated calomel). Results demonstrate that the HEAC susceptibility of AM 17-4PH is notably increased relative to the wrought material. These data are coupled with measured hydrogen-metal interaction parameters and correlative electron microscopy-based observations for each alloy to understand the origins of the increased susceptibility. Results collectively demonstrate that sub-micrometer porosity present in the AM material is providing a primary contribution to the degradation in HEAC resistance. The mechanistic basis for the influence of porosity is considered in the context of an existing model for HEAC. The implications of these findings on the broader AM community are then discussed, particularly from the perspective of implementing AM materials into service where aggressive environments are expected.

Presentation IA-2

Structure Determination of Membrane Proteins using DNA-based Nanodiscs

Soumya Chandrasekhar[1,5], Christopher Maffeo[2,3], Aleksei Aksimentiev[2,3,4], Thorsten-Lars Schmidt [5]

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Kent, OH
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Urbana, IL
[3]Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign
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Urbana, IL
[5]Department of Physics, Kent State University
Kent, OH

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Membrane proteins (MPs) are central to life processes and constitute about a third of all human proteins. Characterization of the structure of MPs has been challenging due to altered or loss of activity and function outside a native phospholipid environment. Single-particle cryo-EM has become the method of choice for membrane protein structure determination as it provides unprecedented resolution with atomic precision and provides structures in a hydrated, native environment while crystallographic studies often involve detergents that perturb native protein structure.

Several bilayer mimetics have been developed in order to simulate a native surrounding to understand the structure of membrane proteins. However, they suffer from inherent drawbacks associated with lack of control over size and disruption of native protein structures. Our lab created the first DNA-based nanodiscs where we modified DNA with hydrophobic alkyl groups in order to enable interactions with phospholipids. Using a real-time qPCR cycler, we found that DNA modified with alkyl groups no longer hybridized with complementary nucleobases. In the current study, we constructed custom-sized DNA minicircles consisting of amphiphilic PEG molecules (characterized by HPLC and ESI-mass spectrometry) in order to interact efficiently with a phospholipid bilayer to create a lipid-DNA nanodisc. Atomic Force Microscopy (AFM) and negative-stained Transmission Electron Microscopy (TEM) were used to successfully characterize the formation of DNA minicircles and nanodiscs. All-atom molecular dynamics simulations also show that the PEG chains predominantly interact with lipid headgroups and hold the bilayer stably within the DNA-ring. Next, we would perform protein reconstitution and characterize by cryo-EM.

Presentation IA-3

Characterization of Corrosion in Percutaneous Leads used in Neuromodulation Applications

Janet L. Gbur[1], Richard Johnston[2], Dustin J. Tyler[3]

[1]Case Western Reserve University, Materials Science and Engineering
Cleveland, OH
[2]Advanced Imaging of Materials (AIM) Facility, College of Engineering, Swansea University
Swansea, Wales, UK.
[3] Biomedical Engineering Department, Case Western Reserve University
Cleveland, OH

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Percutaneous leads, components in neuromodulation systems that connect electrodes and implantable electronics, are an important part of peripheral nerve stimulation. These leads exit the body through the skin and lead failure by chemical and / or mechanical mechanisms is rare. When failures do occur, characterization of the leads and respective subcomponents is important for understanding root cause and to help inform possible routes of mitigation. In this work, small discolored sections of percutaneous lead were removed from regions outside the skin and evaluated with non-destructive and destructive microscopy and microanalysis techniques. Digital optical microscopy and X-ray microscopy were used to characterize the full specimen (i.e., internal wires and outer insulation) capturing discoloration and regions of failure without disturbing the delicate internal wires. Scanning electron microscopy was used to look at the detail of failed wires while energy dispersive X-ray spectroscopy and time-of-flight secondary ion mass spectrometry (ToF SIMS) characterized the regions after the outer insulation was removed. Pitting corrosion was identified as the source of the discoloration, and a series of environmental studies were performed to identify potential causation. A summation of the data and mitigation strategies will be presented.

Presentation IB-1

Unlocking the Investigative Power of High-resolution Microscopy through Computational Image Analysis

Rengasayee (Sai) Veeraraghavan

Dept. of Biomedical Engineering, Nanocardiology Lab, Ohio State University
Columbus, OH

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Emerging microscopy approaches, specifically super-resolution light microscopy (SRLM) and correlative light and electron microscopy (CLEM) stand to revolutionize the life sciences. However, for this promise to be realized, unbiased and efficient computational image analysis tools are needed to capture multiscale structural heterogeneities and subtle changes from microscopy data. While the lack of such tools limits repeatability and reproducibility in life science research, their development is challenged by factors such as unprecedented data volume, novel data formats, and physical constraints imposed by ever-increasing image resolution. Thus, a significant part of my lab's efforts has been oriented towards the development of such tools with particular emphasis on designing them to be 1) computationally efficient, 2) agnostic to specific imaging modalities, 3) independent of user-defined parameters or hyperparameters, and 4) insensitive to cursory image properties. By drawing upon concepts from such diverse fields as spatial statistics and stochastic geometry, we have developed a modular analysis pipeline to robustly quantify spatial organization from both discrete (digital images) and continuous (single molecule localizations) input data. In turn, this analysis has helped us uncover various mechanisms underlying the physiology of the heart and the brain in both health and disease.

Presentation IB-2

Advancing Research in Energy Production & Storage Using In-Situ Liquid-Phase TEM

Dylan Wood, Jennifer McConnell, and Madeline Dukes

Protochips Inc
Morrisville, NC

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In situ transmission electron microscopy (TEM) can reveal the dynamic mysteries of materials at the level of their origin: the nanoscale. Material properties and operational performance are completely dependent upon a material's behavior at the nanoscale; however, on any given day, we typically only see macroscale behavior, which is simply an aggregation of millions of nanoscale processes occurring simultaneously. In situ TEM is commonly used to study clean fuel production, energy production & storage, and materials design. In this seminar, learn how Protochips' Poseidon AX system is empowering chemists, engineers, and physicists in the discovery of robust and cost-efficient materials for lithium-ion batteries, solid-state batteries, and hydrogen fuel-cells. Poseidon AX enables this by allowing observation of nanoscale dynamic behavior under relevant operating conditions, such as a wide range of organic and aqueous liquid media, a miniaturized electrochemical cell with standard electrode materials, and an ultra-sensitive electrochemical framework, all within the TEM. There will be a review of the most recent publications utilizing the Poseidon AX system, an overview of what makes Poseidon AX unique, and an introduction to the Protochips machine vision in situ workflow.

Presentation IB-3

Building a Toolbox for Direct and Indirect Electron Microscopy Imaging of Liquid Crystals and Other Complex Molecular Fluids

Min Gao

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Complex molecular fluids (CMFs, e.g., liquid crystals and crude oil) are the foundation of several major modern industries and exhibit complicated dynamic nanostructures, for example, mesophases, micelles, and vesicles. These nanostructures are often loosely bonded and are highly sensitive to electron beam, surface, mechanical turbulence, etc. Thus, CMFs impose unique “real-world” challenges to transmission electron microscopy (TEM) techniques in both specimen preparation and imaging. In this paper, we use liquid crystals (LCs) as an example to summarize the efforts to build a comprehensive yet accessible toolbox to preserve native structures in CMFs for direct and indirect TEM imaging.

In addition to a cryo-TEM, the hardware in our assembled toolbox mainly consists of cryo-based sample preparation setups for plunge freezing, high pressure freezing, and cryo-ultramicrotomy, which enable direct cryo-TEM imaging of LC specimens. A traditional indirect technique, namely freeze-fracture TEM (FFTEM), is also an important piece in our toolbox due to its high surface sensitivity. Besides building an initial toolbox, our efforts may open ways to a wide range of modern TEM techniques (cryo, in situ, tomography, high-speed recording, etc.) and suggest that TEM, in general, is a promising part of the solution to probe LCs and CMFs at the molecular scale.

Presentation IC-1

Investigating the Role of G-quadruplex Structures in Transcription Control and Telomere Protection Contexts Using Single Molecule Fluorescence Approaches

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We present single molecule FRET and FRET-PAINT studies that probe the folding patterns and accessibilities of telomeric overhangs of physiologically relevant lengths. In particular, we investigate the impact of shelterin complex and POT1 on the accessibility and protection of these otherwise vulnerable genomic regions. In addition to length-dependent periodic accessibility patterns, our studies illustrate the junction between single and double stranded telomeres to be highly accessible in the absence of shelterin. We present our ongoing work in which we focused on this junction region to understand the minimum requirements to attain effective protection by Shelterin and POT1. In a separate line of work, we illustrate our recent studies in which we targeted G-quadruplex forming sequences at promoters with CRISPR/dCas9 to regulate transcription.

Presentation IC-2

Using Spectroscopy to Engineer Carbon Nanomaterials for Skin Cancer Prevention

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Skin cancer is the most common cancer worldwide and has cost the United States alone nearly 8.1 billion dollars in medical treatments. The primary cause for skin cancers is ultraviolet (UV) exposure from the sun. UV absorbers are present in commercial sunscreens to absorb the damaging UV light from the sun and thus, can be engineered using spectroscopy. Current commercial sunscreens contain multiple UV absorbers that absorb different wavelengths of UV light. Since 2021, the Food and Drug Administration removed 12 out of 14 UV absorbers from the Generally Recognized as Safe and Effective list due to safety concerns. Therefore, there is an urgent need for UV absorbers that absorb the full UV spectra, are long-lasting, safe, and prevent UV-induced skin cancers. The goal of this project is to develop a novel sunscreen formulation using carbon nanomaterials to prevent skin cancers including melanoma. The PerkinElmer Lambda 1050 UV/Vis/NIR Spectrophotometer was utilized to measure and compare photophysical properties—sun protection factor, ultraviolet-A protection factor, and photostability—between carbon nanomaterials and current commercial UV absorbers. Additionally, quantum chemical computations were performed using time dependent density functional theory to predict UV absorption properties of carbon nanomaterials.

Presentation IC-3

A Novel Catalyst for Pheomelanin Inhibition to Prevent Melanoma

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Melanoma is a lethal skin cancer that is responsible for the majority of deaths from skin cancer. People with lighter skin color have a higher incidence of melanoma than darker skin. A major reason for the differences lies in the eumelanin-to-pheomelanin ratio. While eumelanin is ultraviolet (UV) protective, pheomelanin has weakened UV protection and causes melanoma. Although the synthesis of eumelanin and pheomelanin shares the same intermediate, the pheomelanin synthesis requires the participation of cysteine in later steps. I propose to prevent melanoma development by inhibiting pheomelanin using a nanocatalyst that breaks down cysteine.

To evaluate the ability of the nanocatalyst to break down cysteine, the proton nuclear magnetic resonance is used to track the decrease in characteristic peaks of cysteine. Developing a reliable method to distinguish eumelanin versus pheomelanin synthesis can be achieved by using different spectroscopies or microscopes. One of the intermediates in eumelanin synthesis has distinct absorbance and can be captured by UV-visible spectroscopy. This feature can be used as an indication that the reaction proceeds into the eumelanin synthesis. Besides, the energy-dispersive X-ray in combination with a scanning electron microscope has the potential to capture differences in sulfur content between eumelanin and pheomelanin in extracted melanosomes.

Yeager Award Presentation

Leveraging Spectroscopic Methods to Develop a Rapid-Screening Process for Silicon Photovoltaic Reliability

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Photovoltaics have accounted for over 50% of the new installations for electricity production in the United States in 2023. These long-term investments rely on the longevity of the installed modules. Technologies such as silicon heterojunction and passivated contact cells are expected to dominate the market in the next decade. In these new cell architectures, new materials combinations have resulted in record solar cell efficiencies. However, the introduction of new materials have also introduced the potential for new degradation and failure modes. This project seeks to develop a systematic approach to performing accelerated aging and evaluation of reliability of different technologies of silicon photovoltaics. By exposing unencapsulated cells to different combinations of accelerated aging conditions, we can start to simulate the degradation of panels in the field, and evaluate the stability of cells in a short time frame. By combining material analyses such as spectroscopic ellipsometry, x-ray photoelectron spectroscopy (XPS) and glow-discharge optical emission spectroscopy (GD-OES), electrical performance metrics and statistical modeling, we develop a more comprehensive picture of material changes in the cells and the degradation pathways in cells. These methods can then be applied by photovoltaic manufacturers to swiftly assess new architectures and their long term reliability.

Presentation IIA-1

Melt Segregation Mechanisms During Syndeformational Partial Melting of an Amphibolite

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Partial melting reactions between hydrous phases such as amphibole, biotite, and muscovite and other minerals in rocks occur during mountain building events. This process differentiates the composition of the crust by forming buoyant Si-rich melts which migrate toward the upper crust and leave dense, Fe and Mg-rich restites in the lower crust. The mechanism that allows these viscous, Si-rich melts to segregate from the source is generally thought to be pore-pressure induced fracturing. This process occurs at low (<5%) melt fractions in laboratory deformation experiments performed on crustal rocks at rapid strain rates (10-4/s to 10-5/s), which are too fast for melts to migrate along grain boundaries to relieve local pore pressures, resulting in brittle deformation. However, field evidence suggests that crystal plastic processes, not brittle fracturing, may be dominant during syndeformational partial melting. To investigate grain-scale melt segregation mechanisms in a common lower crustal protolith, we performed a suite of axial compression experiments on a common lower crustal source rock, amphibolite, as partial melting reactions occurred at T = 800-975°C, Pc = 1.5 GPa, and a strain rate of 2 x 10-6/s. The amphibolite deformed homogeneously at all conditions; no evidence of intragranular brittle deformation was observed. Melt lenses formed along grain boundaries parallel to subparallel to the compression direction but did not become interconnected until melt fractions were greater than 15%. These results indicate that significant melt volumes may reside in the lower crust prior to forming the networks necessary to migrate from the source.

Presentation IIA-2

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. The objective of this project is to determine the amount of degradation done to LDPE film when using optimal pretreatment and fungi combination. Low-density polyethylene (LDPE) contains hydrocarbon backbones that can be degraded using fungal strains. To increase the rate of biodegradation, the following pretreatments were applied to the LDPE samples: nitric acid, sulfuric acid, hydrogen peroxide, heat, microwave and ultraviolet radiation to introduce more readily degradable functional groups into the polymer. The best pretreatment methods were determined and the solutions from these methods will be analyzed for the presence of microplastics. Results will be analyzed using carbonyl and hydroxyl index to measure the degradation status of the LDPE films.

Presentation IIA-3

DNA Origami Barcodes for Immunostaining

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In histology, immunostaining of biological samples is a gold standard for studying cellular processes such as expression of cell surface markers or the cellular uptake of proteins and drug molecules. Immuno-Gold labelling is a commonly used technique, but simultaneous visualization of multiple antigens in parallel is an unresolved challenge. Herein, we demonstrate a DNA nanotechnology-based approach to label antigens in electron micros-copy images of tissue sections with high contrast patterns. For this, we attached gold nanoparticles to designated binding positions on DNA origami structures that act as visual ‘barcodes’. These barcodes are then hybridized to complementary strands of DNA-modified antibodies that are bound to their respective antigens on ultrathin tissue resin sections. As a proof of concept, we demonstrate several types of barcodes and two differ-ent antibody labelling techniques that will expand the multiplexing abilities of immunostaining in a highly modular way.

Presentation IIB-1

Advanced Polymer Nanocomposites and their Structure-property Relationship

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The current research in my group focuses on advanced polymer nanocomposites that integrate novel organic-inorganic components or are generated by green and unconventional approaches. For instance, we recently demonstrated that soft and stretchable polymer nanocomposites with unique optical properties can be generated by integrating perovskite quantum dots and thermoplastic elastomers. In another work, we developed a sustainable and microbial biosynthesis-based approach for the creation of 3D bone-mimetic biocomposites. For systematic characterization of those polymer nanocomposites, electron microscopies and atomic force microscopy are important tools. The high atomic and mechanical properties contrast between the organic and inorganic components make it feasible to achieve high-resolution imaging of the internal structures of those nanocomposites. We demonstrated that those functional polymer nanocomposites have promising applications in electronics, biomedicine, and additive manufacturing.

Presentation IIB-2

Purification of DNA Nanoparticles using Photocleavable Biotin Tethers

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DNA-origami nanoparticles (DNA NPs) are advantageous for their ability to cover a vast breath of applications in the realm of biological nanotechnology. DNA NP are composed of a single-stranded DNA (ssDNA) scaffold, known as the scaffold strand, that is held into a desired shape by scaffold-complimentary oligonucleotides called staple strands. Assembling DNA NP involves a one-pot process containing the scaffold strand mixed with at least five-fold-excess staple strands. While the presence of excess staple strands promotes successful assembly, DNA NPs require purification from the crude assembly mix for applicational purposes. Unfortunately, isolation of DNA NPs containing a custom-scaffold involves a multi-step process. Here we focus on a one-step purification process by incorporating photocleavable biotin tethers to DNA NPs containing a M13 or custom scaffold. This simplistic process entails the use of a UV lamp and streptavidin-coated magnetic beads yielding up to 90% in purified DNA NP. Adaptability of our purification technique is shown by isolating a wire-frame structure and two different multi-helix bundle structures.

Presentation IIB-3

The Effect of Carbon Black on the Morphology and Mechanical Characteristics of Synthetic Rubber Blends

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Carbon black reinforced compounds made of rubber blends are widely used to build hydraulic hoses, which are required to remain flexible over a wide range of environmental temperatures while bearing hydraulic pressures in the order of MPa. In this paper, we studied a series of NBR and SBR blends with different ratios between the two rubbers. Compounds filled with carbon black were investigated and compared to unfilled compounds. Morphology and nanomechanical measurements available using atomic force microscopy (AFM), and dynamic viscoelastic characterization conducted by rubber process analyzer (RPA), elucidate how carbon black interacts with the rubber blends and how it affects compatibility between NBR and SBR. The influences of NBR/SBR blend composition and carbon black reinforcement on bulk physical properties will also be discussed.

Presentation IIC-1

Measurement of Nanoscale Interfacial Contact Area Using Vibrational Spectroscopy

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The real contact area between two surfaces is a crucial parameter with direct relevance to the fields of contact mechanics and tribology. The understanding of the reduced contact with increasing magnification down to the molecular scale has a significant influence on the macroscopic properties of adhesion and friction. However, the current understanding of the real contact area is limited by the sensitivity of the techniques to characterize contacts at molecular scales.

In this paper, we use two complementary vibrational spectroscopic techniques of Sum Frequency Generation (SFG) and attenuated total reflectance infrared (ATR-IR) spectroscopy coupled with an imaging detector for characterizing the nature of the contact interface. PMMA-based systems with varying modulus and roughness were used to create surfaces of varying conformability. Using the surface sensitive SFG to analyze the shift of the free hydroxyl peak at the sapphire contact interface, we show that the extent of molecular contact can be determined. Further, the information gained from the ATR-IR spectroscopy complements SFG by measuring the spatial distribution of air gaps present between the contacting surfaces with nanometer sensitivity. The understanding gained regarding these techniques will enable a much deeper understanding of contacts at the molecular scale.

Presentation IIC-2

Characterization of a Hydrogen Peroxide-Benzene Complex Using Matrix Isolation Infrared Spectroscopy

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Matrix isolation infrared spectroscopy was used to characterize a 1:1 complex of hydrogen peroxide (H2O2) with benzene (C6H6). Co-deposition experiments with H2O2 and C6H6 were performed at 20 K using argon as the matrix gas. New infrared peaks attributable to the H2O2-C6H6 complex were observed near the O-H stretching vibrations and the OH bending vibrations of the H2O2 monomer and near the hydrogen out-of-plane bending vibration of the C6H6 monomer. The initial identification of the newly observed infrared peaks to those of a H2O2-C6H6 complex was established by performing several concentration studies in which the sample-to-matrix ratios of the monomers were varied between 1:100 to 1:1600, by comparing the resulting co-deposition spectra with the spectra of the individual monomers, and by matrix annealing experiments (30 – 35 K). Co-deposition experiments using isotopically labeled hydrogen peroxide (D2O2 and HDO2) and benzene (C6D6) in argon were also performed and the analogous peaks for the isotopically labelled complexes were observed. Quantum chemical calculations were performed for the H2O2-C6H6 complex with the MP2, M06-2X, and ωB97X-D levels of theory using the aug-cc-pVDZ basis set to obtain optimized complex geometries and predicted vibrational frequencies of the complex, which were compared to the experimental infrared spectra.

Presentation IIC-3

Characterization of Pheomelanin and Eumelanin with Experimental and Computational FT-IR Spectroscopy

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Melanoma is a type of skin cancer that begins with the abnormal growth of melanocytes in the skin tissue. Melanocytes produce two major types of melanin: eumelanin and pheomelanin. An increase of pheomelanin has been correlated to a decrease in cellular antioxidants, leaving cells susceptible to oxidative stress and DNA damage. Though it is carcinogenic, the structure of pheomelanin has not been consistently characterized. We have synthesized eumelanin and pheomelanin from levodopa analogs, tyrosinase, and cysteine analogs. These melanins were analyzed with Fourier Transform Infrared Spectroscopy (FTIR) Attenuated Total Reflection spectroscopy, which provided preliminary insights into surface–sensitive properties. Current efforts have transitioned towards exploring the potential of FTIR Transmission and Diffuse Reflectance Infrared Fourier Transform spectroscopy, enabling comparative analysis of individual components of pheomelanin through peak analysis, identifying shared functional groups and structural properties among precursors and the final polymer. Additionally, we are using Gaussian software on a High-Performance Computing cluster to simulate vibrational spectra. These quantum chemical computations offer another avenue for characterizing eumelanin and pheomelanin and enabling the prediction of spectral signatures for various molecular structures. Comparison between simulated vibrational spectra and experimental FTIR can provide valuable insights into the structural properties and chemical behaviors of the synthesized compounds.

Presentation IIIA-1

Wireless Self-Charging Powered Packs/Electronics

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Self-charging powered packs possess great potential applications in the micro-systems, but these electric circuits are required to be portable, lightweight, and even wireless connected for practical applications, in particular, in wearable and portable electronics. In this study, we report wireless portable lightweight solution-processed self-charging power packs by tandem solar cells integrated with solid-state asymmetric supercapacitors through the solution-processed electrical conductive polymeric thin film. Toward the end, we first develop solution-processed tandem solar cells by perovskite solar cells combined with ternary organic solar cells for achieving large operational voltage. We then develop solid-state asymmetric supercapacitors by both novel positive electrodes and solid-state polymeric electrolytes for enhancing energy density and cycling stability. After that, we integrate tandem solar cells with solid-state asymmetric supercapacitors through the solution-processed electrical conductive polymeric thin film to build wireless portable lightweight solution-processed self-charging power packs. These novel self-charging powered packs not only possess advanced features such as portable, lightweight, and wireless connection but also exhibit excellent electric-circuit device performance, such as with an overall efficiency of 12.43% and an energy storage efficiency of 72.4% under white light illumination. All these results demonstrate that the wireless portable light-weight self-charging power packs through the utilization of tandem solar cells as the renewable energy source and solid-state asymmetric supercapacitors as the energy storage device connected with the solution-processed electrical conductive polymeric thin film, for the first time, are developed.

Presentation IIIA-2

Bulk Heterojunction Perovskite Solar Cells Incorporated with Conjugated Polyelectrolytes

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Perovskite solar cells (PSCs) have attracted great attention in the past years, but their commercial scalability is hampered by the poor stability of lead halide perovskites. The commonly used preparation method for fabricating perovskite films introduces extensive defects and weak interfacial contacts, leading to non-radiative recombination and ion migration, which in turn, reduces the devices' efficiency and stability. In this study, we report PSCs based on a bulk heterojunction (BHJ) composites, which is composed of n-type perovskite Cs0.1FA0.9PbI2.7Br0.3 mixed with p-type conjugated polyelectrolytes, poly[(9,9-bis(3'-((N,N-dimethyl)-N-ethylammonium)-propyl)-2,7-fluorene)-alt-2,7-(9,9-dioctylfluorene)]dibromide (PFN). It is found that PFN not only could improve the crystalline quality but also effectively reduces the density of defect states in the BHJ composite thin films, resulting in boosted stability of solar cells. On the other hand, photo-induced charge transfer that occurred in the BHJ composites could increase photocurrent. As a result, the BHJ PSCs exhibit enhanced power conversion efficiency and stability compared with the PSCs based on pristine perovskites.

Presentation IIIA-3

Fabrication of Flexible Microelectrodes Coated with Poly(3,4-ethylenedioxythiophene) and Electrochemically Reduced Graphene Oxide

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Carbon-based microelectrodes are widely used for electrochemical detection of a variety of physiological analytes. These microelectrodes generally utilize carbon fibers that are sealed in a glass capillary and polished. This results in fragile electrodes that are both fragile and not widely commercially available. Additionally, these electrodes are not flexible, which inhibits the ability to maneuver the electrode into place when studying a particular physiological process in vivo.

Electrochemically Reduced Graphene Oxide (ERGO) is a sp2-hybridized carbon material that has attracted attention as an electrochemical material due to its relative simplicity, speed, potential for controllability, and benign environmental impact. However, most electrodes that utilize ERGO, do so by reducing it onto a glassy carbon or Pt electrode.

This presentation will present our attempt to electrochemically reduce graphene oxide onto the etched tip of a Teflon-coated PtIr wire. The Teflon was removed at the tip of the PtIr wire, which was then etched to create a conical electrode shape. After etching, ERGO was deposited onto the wire either directly or in conjunction with polymerizing 3,4-ethylenedioxythiophene. The latter method showed a more stable coating and exhibit a high quality electrochemical response to several redox probes.

Presentation IIIB-1

Investigation of Process-Property Relationships of Aerosol Jet Printing with Silver Nanoparticle Ink for Flexible Electronics

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Aerosol jet printing (AJP) is an additive manufacturing technique capable of microscopic feature resolution, rapid prototyping, and printing on curved surfaces. Thus, it provides solutions to microelectronic device fabrication challenges. However, AJP has a complex set of process parameters which must be carefully adjusted to achieve desired print properties. A series of studies were conducted to investigate the effects of AJP processing parameters on properties of silver nanoparticle ink flexible electronics, and to define an optimized set of parameters to achieve desired performance metrics. Specimens were characterized via optical microscopy, profilometry, and electrical testing. Focused ion beam sectioning with scanning electron microscopy was utilized to study microstructural effects of thermal processing on AJP silver nanoparticle ink. Ink particle size properties were investigated via transmission mode scanning electron microscopy. An orthogonal array optimization study was conducted to arrive upon a set of optimized printing parameters including aerosol and sheath gas flow, atomizer voltage, print speed, and platen temperature. A custom image analysis script was utilized to extract quantitative print quality measurements. Findings of these studies can hasten the adaptation of aerosol jet printing to microelectronic device applications such as implantable connectors, embedded sensors, and wearable electronics.

Presentation IIIB-2

Integration of Low-melting-point Alloys and Thermoplastic Elastomers for 3D Printing of Multifunctional Composites

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The incompatibility, in terms of the processing conditions, between metal and polymer poses a significant barrier to the advances of metal-polymer hybrid 3D Printing. This work addresses this issue by creating a composite material comprising low-melting-point alloy (Field’s metal, FM), thermoplastic elastomer (TPE), and graphene. Various microscopic (AFM, SEM, TEM) morphological investigations were performed and evidenced the printed structure showed good FM dispersion in the polymer matrix while the TPE showed a typical micro-phase separated morphology. Such hybrid material—employed as the feedstock and made possible to be 3D printed on most FFF printers—demonstrated good printability, excellent shape fidelity, and versatile functionality. Featured with widely tunable internal structures and mechanical, thermal, and electrical properties, this novel hybrid metal-polymer material system could enable advancements in soft electronics, robotics, and energy storage fields.

Presentation IIIB-3

Image Processing and Analysis Methods for Assessing Aerosol Jet Printed Traces

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Aerosol Jet Printing (AJP) is a manufacturing process in which a metallic nanoparticle or particle-free precursor ink is aerosolized, transported and focused through gas flows, and deposited onto a substrate on a temperature-controlled platen. The printed traces are cured to promote densification and increase conductivity. AJP is compatible with many combinations of inks and substrates, prints on curved or textured substrates, and can be used to prototype designs quickly and cheaply. AJP devices can vary key process parameters over a wide range. Small changes to these parameters can significantly affect characteristics of the resulting traces including quantity of deposition, trace width, edge roughness, and overspray. Optimal parameters for various ink and substrate combinations can differ significantly, so some amount of investigation is necessary for each new pairing. An image processing and analysis method was developed in MATLAB to determine critical measurements of printed traces more efficiently, including trace width, edge roughness, overspray density, and rectangularity of printed pads. This process was used to analyze 125 images and can be used to accelerate efforts to characterize and optimize combinations of process parameters for new combinations of inks and substrates.

Presentation IIIC-1

Liquid Crystalline Structures Formed by Rigid Sphere-rod Macromolecules

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Self-assembly of amphiphilic macromolecules is an important phenomenon attracting a broad range of research. In this work, we study the liquid crystalline structures formed by amphiphilic rigid sphere-rod macromolecules. Specifically, we focus on Keggin-TOF4 (KTOF4) macromolecules, which consist of hydrophilic spherical Keggin-type clusters and hydrophobic rod-like oligofluorenes (OFs), displaying a distinctive rigid sphere-rod geometry. Through a comprehensive analysis using transmission electron microscopy (TEM), we observed self-assembled structures of KTOF4 in solvents representing mixtures of dioxane and water. We observed the formation of layered structures, including concentric onion-like layers and flat layers within spherical condensates. The morphologies depend on the solvent composition. Our study reveals the presence of edge and screw dislocations within these structures, which are common structural defects in layered liquid crystal phases. Moreover, allowing KTOF4 to slowly evaporate in a solvent mixture of dioxane and water resulted in the formation of a bulk liquid crystal phase with distinct birefringence colors. These findings contribute to our understanding of the structure of self-assembled layers and the liquid crystalline properties in materials comprised of amphiphilic rigid sphere-rod macromolecules. This work was supported by NSF grant DMR-2215191.

Presentation IIIC-2

Insight Into the Optical Properties of Organic Dye Aggregates

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In the last two decades, organic dyes have gained tremendous research interest due to their potential for application in organic photovoltaics, electronics and bioimaging. For the majority of applications, the optical properties of the active material play a crucial role as they determine the performance of the devices. Therefore, it is of prime importance to understand the spectral changes of organic dyes upon aggregation.

In this talk, the synthesis and aggregation studies of perylene bisimide dyes will be presented. Traditionally, the optical changes upon aggregation have mainly been attributed to a long-range Coulomb interaction between the chromophores. However, in these studies the optical features of the aggregates cannot be rationalized by this traditional exciton coupling model. Instead, the close spatial proximity of the dyes leads to significant orbital overlap causing a short-range coupling as revealed by quantum chemical calculations. This short-range coupling can significantly alter optical signatures and the properties of materials. To conclude the talk, I show the first experimental proof of a perylene bisimide “null-aggregate”, in which the long- and short-range exciton coupling fully compensate each other, deceptively resembling a monomer absorption spectrum.

Presentation IIIC-3

Cross-correlation Increases Sampling in Diffusion-based Super-resolution Optical Fluctuation Imaging

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Correlation signal processing of optical three-dimensional (x, y, t) data can produce super-resolution images. The second order cross-correlation function XC_2 has been documented to produce super-resolution imaging with static and blinking emitters but not for diffusing emitters. Here, we both analytically and numerically demonstrate cross-correlation analysis for diffusing particles. We then expand our fluorescence correlation spectroscopy super-resolution optical fluctuation imaging (fcsSOFI) analysis to use cross-correlation as a post-processing computational technique to extract both dynamic and structural information of particle diffusion in nanoscale structures simultaneously. We further show how this method increases sampling rates and reduces aliasing for spatial information in both simulated and experimental data. Our work demonstrates how fcsSOFI with cross-correlation can be a powerful signal-processing tool to resolve the nanoscale dynamics and structure in samples relevant to biological and soft materials.

Poster Number One

Analysis of Waxy Plant Surface on Rudbeckia Fulgida Leaf

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Cuticular waxes on the surface of plant leaves serve multiple functions and are known to comprised of long carbon chain compounds. Some application areas include food industry, cosmetics, pharmaceutical, and furniture. This study investigates the species, Rudbeckia fulgida, to build on the limited surface studies on the plant wax material. The goals of the study are to: (1) probe the type of information that can be attained using surface analysis tools (XPS, TOF-SIMS), (2) compare acquisition sources for TOF-SIMS (Ga+, C60+), and (3) investigate the effect of exposure to UHV environment. XPS provided elemental composition information and the carbon chemical state information (top 5-10 nm); both sides showed the presence of C, O, Si, N with the top side having more O and Si (less C, N) compared to the bottom side. C1s analysis confirmed the presence of the expected carbon chemistry (C-C/C-H, C-O, C=O, O-C=O). Complementary technique, TOF-SIMS, provided molecular structure information (top ~3 nm); C60+ source led to increase in molecular fragment yield and spectra analysis revealed that the wax layer was found to consist of C28-C36 fatty acids. UHV environment exposure study (2 hours, 24 hours) showed that no drastic differences were observed with respect to the surface morphology (SEM) or elemental composition and carbon chemical state information (XPS). However, the longer exposure in UHV environment led to a change in the very top layer (3 nm), affecting the secondary ion generation and consequently the ability to detect the molecular fragments.

Poster Number Two

Enhancing Energy Transfer Efficiency with ENZ Platforms: Quantum Emitters in DNA Beacons

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In this study, we investigate Forster energy transfer between quantum emitters tethered to a DNA molecular beacon (MB) and positioned near an Epsilon Near Zero (ENZ) metamaterial. ENZ materials, with unit cells smaller than incoming light wavelengths, offer precise manipulation of light-matter interactions. Employing MBs with a fixed 2 nm distance between fluorescent dye units, we utilize ENZ platforms to enhance energy transfer efficiency. Rhodamine Green and Cyanine 3 chemically linked to the ends of the MB DNA strand serve as the donor-acceptor pair, ensuring optimal spectral overlap. Thin film preparations, incorporating MBs with the dye pair in PVA, are fabricated via spin coating. Characterization employs photoluminescence time decay and transient absorption spectroscopy to assess energy transfer efficiency. We compare two ENZ platforms: a multi-stack configuration and a photonic crystal design, to evaluate light-matter interaction effectiveness. This work aims to advance energy transfer mechanisms through ENZ platforms while maintaining a constant FRET distance, crucial for next-generation photonics applications.

Poster Number Three

Exploring the Use of Hypervalent Iodine to Aid in the Selective Electrochemical Detection of THC and CBD

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The use of THC and CBD is growing throughout the United States as it becomes legal in many states recreationally and medically. This brings the need for regulation when operating vehicles and large machinery and therefore a quantitative test is then needed to accomplish this. Electrochemical detection is a promising method for onsite sensing due to its simplicity, high sensitivity, and the lack of extra reagents. Many electrochemical methods use the oxidative properties of these compounds for detection, however since the non-psychoactive chemical CBD has a similar structure to the psychoactive compound THC, selectively detecting THC over CBD is problematic. This project aims to use the reductive properties of THC and CBD to selectively detect them following initial chemical oxidation. Model compounds were first tested as proof of concept to understand the oxidation/reduction mechanism and detection limit. Since THC and CBD are phenolic compounds, this project began by studying simple hydroquinones and phenols in the presence of a hypervalent iodine complex to initially chemically oxidize the analyte of interest and then studying their electrochemical reduction. This presentation will investigate the mechanism involved in oxidizing model compounds such as hydroquinone and phenol, as well as other similar compounds synthesized to model functional groups on THC and CBD. 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.

Poster Number Four

Determining if Pretreatment Aids in Facilitating Fungal Degradation of 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 low-density polyethylene (LDPE), which contains hydrocarbon backbones that can be degraded using fungal strains. To increase the rate of biodegradation, the following pretreatments will be applied to the LDPE samples: nitric acid, sulfuric acid, hydrogen peroxide, heat, microwave and ultraviolet radiation to introduce more readily degradable functional groups into the polymer. The objective of this project is to find the optimal pretreatment and fungi combination that degrades LDPE most efficiently.

Poster Number Five

Targeting CCR5 function as a Therapy for AIDS

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HIV-1 infects a cell by interacting with CD4 and one of two co-receptors, CCR5 or CXCR4. A naturally occurring mutation in ccr5, known as ccr5delta32, encodes a 32 base-pair frameshift mutation. That mutation encodes a truncated CCR5 protein that is not detected on the membrane. The truncated protein was shown to also down-modulate full length CCR5 and CXCR4. Some Exposed Seronegative (ESN) individuals are ccr5delta32 homozygous. Some Long-Term AIDS Non-Progressors (LTANP) are heterozygotes for ccr5 (ccr5delta32/ccr5 wild-type). Some Individuals with Leukemia and HIV-1 have undetectable levels of HIV after receiving bone marrow transplants from ccr5delta32 homozygous donors. Some LTANP and ESN have wild-type ccr5 genes yet have low levels of surface CCR5. These individuals produce antibodies to the first extracellular loop (ECL1) of CCR5, causing CCR5 endocytosis[1].

Ccr5delta32 will be evaluated as a gene therapy to reduce viral burden. A lentiviral vector system (pLenti puro HA-Ubiquitin) was used to construct viral particles containing ccr5 wildtype, ccr5delta32, and ccr5delta33. ccr5 wild-type and ccr5delta32 were constructed by amplifying the genes of a heterozygous individual. The gene ccr5delta33 was constructed by PCR mutagenesis. The packaging cell line HEK293-ft was co-transfected with pLenti-ccr5wildtype, pLenti-ccr5delta32, or pLenti-ccr5delta33 and helper plasmids psPAX2, pMD2.G. Pseudotyped viral particles were used to infect H9. The presence of ccr5delta32 in transducted H9 cells was verified by PCR. If ccr5delta32 can downmodulate wildtype CCR5 and CXCR4 in vivo, an effective AIDS therapy can be evaluated. This therapy could be combined with antibodies to ECL1.

[1]CCR5-Reactive Antibodies in Seronegative Partners of HIV-Seropositive Individuals Down-Modulate Surface CCR5 In Vivo and Neutralize the Infectivity of R5 Strains of HIV-1 In Vitro, Lucia Lopalco; . et. al., J Immunol (2000) 164 (6): 3426–3433.
https://doi.org/10.4049/jimmunol.164.6.3426

Poster Number Six

Resetting Single Molecule Microfluidic Sample Chambers by Using UV Light or High pH

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Maintaining a uniform surface quality in single molecule fluorescence measurements is a challenging task that requires a laborious surface cleaning and passivation process. However, even after such elaborate processes, it is typical to observe variations in terms of non-specific binding and fluorescence impurities among different sample chambers. Being able to use the same sample chamber while testing different assay conditions would be an effective and practical way to remedy such variations. However, this often requires being able to remove an otherwise immobilized DNA construct from the surface and introduce a new one for performing the comparative tests. In case of single molecule FRET measurements, the DNA constructs typically include a strand that is attached to the surface via a linker (such as biotin-strepatividin) and another strand that is partially complementary to this strand and often forms an overhang that contains the sequence of interest. In this study, we present two methods which can be used to remove either the entire DNA construct by breaking its link to the surface by exposing it to the UV-light or just the strand that forms the overhang by exposing the sample to a high enough pH that breaks the hydrogen bonds between the complementary strands. The first approach requires using photocleavable biotin which is a commercially avaialble tag that could be incorporated into 3’ or 5’ end of DNA. The second approach requires exposing the sample to 50 mM LiOH using a multi-step approach. We demonstrate reproducibility of the recycling process in both methods.

Poster Number Seven

Cryo-Based Microscopy Sample Preparation

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In this poster, we are going to summarize several cryo-based microscopy sample preparation techniques and their usage in a variety of materials. Plunge freezing, high pressure freezing, cryo-ultramicrotomy, and freeze fracture will be introduced. These techniques increasing applications in studying biological, polymer, liquid crystal, and nano structure materials. The prepared samples can be used in cryo-transmission electron microscopy, scanning electron microscopy, atomic force microscopy, light microscopy, etc.

Poster Number Eight

Evaluation of Growing Rod Surgical Implants Used in the Treatment of Pediatric Scoliosis by Finite Element Analysis

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A significant problem with addressing pediatric scoliosis (unnatural spine curvature) in children and adolescents is that these patients are growing. This challenges those designing treatments, as any brace or implant created must grow with the patient.

This project used a program called Abaqus CAE to test digital models of surgical growing rod constructs. These programs were compiled in the 3D CAD design software called SolidWorks and imported as an assembly into Abaqus. Abaqus uses finite element analysis to determine stress distribution in a simulated job using mathematical algorithms. Many variables are specified such as what materials are used, what sections contain what materials, how the load(s) are defined, how each part interacts with surrounding parts, how the mesh geometry is created, and what the boundary conditions are. The simulation tells where the stress is located under the inputted conditions.

The greatest benefit of finite element analysis is that one can see how a model may behave under specified conditions, allowing one to redesign the model if Abaqus identifies a significant defect. This allows one to fix design problems before creating a large, expensive, and time-consuming model. Ideally, designing with Abaqus requires fewer of these costly and timely prototypes to develop a working product, saving time and money.

Poster Number Nine

Detecting Secondary Structure Formation with FRET-PAINT

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We present single-molecule studies demonstrating the capabilities of the FRET-PAINT method to detect secondary structures that would be challenging to detect with alternative methods, particularly single-molecule FRET (smFRET). Instead of relying on the change in end-to-end separation as in smFRET, we use the change in accessibility to a small probe as the criterion for secondary structure formation and relative stability. As a model system, we study G-triplex formation by human telomeric repeat sequences in different structural contexts.

Poster Number Ten

Polyethylene glycol-Modified DNA-based Nanodiscs for Incorporation and Characterization of Membrane Proteins

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Membrane proteins (MPs) are central to life processes and constitute about a third of all human proteins. Characterization of the structure of MPs has been challenging due to altered or loss of activity and function outside a native phospholipid environment. Single-particle cryo-EM has become the method of choice for membrane protein structure determination as it provides unprecedented resolution with atomic precision and provides structures in a hydrated, native environment. Several bilayer mimetics have been developed in order to simulate a native surrounding to understand the structure of membrane proteins. However, they suffer from inherent drawbacks associated with lack of control over size and disruption of native protein structures. Hence, alternate tools for the creation of custom-sized nanodiscs would be necessary. Our lab created the first DNA-based nanodiscs where we modified DNA with hydrophobic alkyl groups in order to enable interactions with phospholipids. Soon, we found that DNA modified with alkyl groups no longer hybridized with complementary nucleobases. In the current study, we constructed custom-sized DNA minicircles consisting of amphiphilic PEG molecules in order to interact efficiently with a phospholipid bilayer to create a lipid-DNA nanodisc. PEG-chains of different lengths were grafted onto the DNA bases and this method was shown to efficiently recruit lipids depending on the length and number of PEG chains used, by density gradient ultracentrifugation methods. All-atom molecular dynamics simulations also show that the PEG chains predominantly interact with lipid headgroups and hold the bilayer stably within the DNA-ring. Next, we would perform protein reconstitution and characterize by cryo-EM.

Poster Number Eleven

Unveiling the Sequence-Specific Recognition of N6-Methyladenosine (m6A) in Eukaryotic RNAs

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The prevalence of N6-methyladenosine (m6A) as the primary nucleotide modification in eukaryotic RNAs underscores its pivotal role in post-transcriptional regulation of gene expression. However, the intricate molecular mechanisms governing m6A recognition by various readers remain elusive. To address this gap, we conducted phage display experiments aimed at deciphering the essential sequence requirements for m6A binding. Strikingly, the same peptide (MP1) was selected for several RNA constructs harboring m6A, emphasizing the significance of specific protein sequence motifs in m6A recognition. Complementary RNA pulldown assays coupled with mass spectrometry revealed proteins with that bind specifically to methylated RNA that showed sequence similarity to peptides enriched in phase display experiments suggesting the importance of protein sequence in m6A recognition. These enriched proteins shared sequence and structural similarities with established m6A readers. Further validation through calorimetric methods highlight the importance of distinctive sequence features of proteins that govern the recognition of N6-methyl modifications. Our study contributes valuable insights into the molecular basis of m6A recognition, with potential implications for understanding broader regulatory networks in gene expression.

Poster Number Twelve

TSEM-EDS Study of Nanoprecipitates in Oxide-Dispersion-Strengthened (ODS) 14YWT Ferritic Alloys

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TSEM is widely used to characterize nano-scale structures in materials where the optimal sample thickness ranges from approximately 50 to 100 nanometers. Here, we present the characterization results of the ODS 14YWT sample by using TSEM and energy-dispersive spectroscopy (EDS). TSEM lift-out samples were prepared on a Thermo Fisher Helios 650 Nanolab SEM/focused ion beam (FIB) microscope. Then, TSEM characterization of precipitate and matrix compositions was performed using a Thermo Scientific Apreo 2S SEM microscope equipped with an UltraDry 60 mm2 EDS detector. The results showed the formation of a chromium (Cr)-enriched surface oxide shell on the outer layer of the alloy. High-angle annular dark-field (HAADF) TSEM images showed the distribution of these dispersoids inside the alloy. Ti elemental map showed that Ti-containing dispersoids are formed in various sizes in the metallic matrix. Due to their low concentration, the elemental maps for Y and Zr did not indicate apparent detection in these precipitates. For this reason, a more extended acquisition map was collected and reprocessed with the COMPASS built in Thermo Scientific Pathfinder X-ray Microanalysis Software. Among seventeen components found, only one showed clear Y and Zr peaks. This component was selected to construct the Y and Zr-rich phase map.

Poster Number Thirteen

Xeuss 3.0: Unveiling X-ray Scattering at Our State-of-the-Art SAXS Facility

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Xeuss 3.0 revolutionizes X-ray scattering with its GeniX 3D X-ray beam delivery system, featuring a monochromatic Cu Ka high-intensity X-ray beam and versatile 2D detector. Variable detector positions enable access to q-values from 4.7 $Å^{-1}$ in WAXS mode to approximately 10^{-4} $Å^{-1}$ in ESAXS mode and up to 10^{-5} $Å^{-1}$ in USAXS mode, enhancing experimental flexibility. Our SAXS Facility offers state-of-the-art Multienergy Source capabilities, Interlocking system, and two Detectors for simultaneous SAXS/WAXS & USAXS analysis. Sample diversity spans Capillaries, Gels, Solids, and advanced GiSAXS techniques, with in-situ environments and 3D Bioprinter integration. Led by Dr. Suraj Kumar Pathak and Dr. Torsten Hegmann, our facility fosters groundbreaking research. Visit here (https://www.kent.edu/amlci/saxs-facility) for usage and pricing details. Explore scientific frontiers and innovate with the SAXS Facility, shaping the future of research and discovery.

Poster Number Fourteen

Super-Resolution Imaging Reveals Resistance to Mass Transfer in Functionalized Stationary Phases

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Chemical separations are costly in terms of energy, time, and money. Separation methods are optimized with inefficient trial-and-error approaches that lack insight into the molecular dynamics that lead to the success or failure of a separation and, hence, ways to improve the process. We perform super-resolution imaging of fluorescent analytes in four different commercial liquid chromatography materials. Surprisingly, we observe that chemical functionalization can block over 50% of the material's porous interior, rendering it inaccessible to small molecule analytes. Only in situ imaging unveils the inaccessibility when compared to the industry-accepted ex situ characterization methods. Selectively removing some of the functionalization with solvent restores pore access without significantly altering the single-molecule kinetics that underlie the separation and agree with bulk chromatography measurements. Our molecular results determine that commercial "fully porous" stationary phases are over-functionalized and provide a new avenue to characterize and direct separation material design from the bottom-up.

Poster Number Fifteen

Machine Learning for Bond Classification: An Undergraduate Chemistry Student Exercise

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Computational methods and machine learning (ML) have quickly become powerful tools in data science and are increasingly seen in chemical applications from analyzing large datasets to predicting properties of new materials. However, little coursework in the standard undergraduate chemistry curriculum offers students an opportunity to get hands-on experience in data analysis or ML models. Here, a computational exercise targeted at general chemistry students introduces classification algorithms to predict bond types of diatomic molecules and regression algorithms to predict ionic character percent. Students must upload, process, and organize data before training and evaluating different model types. The best-performing algorithms are further evaluated by changing model parameters. These exercises are meant to teach Python coding, data preprocessing, basic ML algorithms, performance evaluation, and parameter selection. Students are asked to complete surveys before and after the exercises to better understand how developed the average chemistry undergraduate student's skills in these areas are, and how effective their learning is.

Poster Number Sixteen

Multiscale Quantification of Nanostructure Across Extended Sample Volume

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Fluorescence microscopy is widely used in the life sciences field to assess structure and function. Typically, nanostructural properties are evaluated at discrete, random regions of interest (ROIs) within a larger sample, overlooking potentially important spatial variation in structural data within the sample. This precludes quantification of spatial heterogeneity over length scales larger than the ROIs. This is a critical barrier to progress towards early detection of disease, especially where pathological remodeling is focal, and to understanding how spatial heterogeneity of structure modulates function. Therefore, we are developing novel workflows for rapid confocal imaging of extended sample volumes with low light load to facilitate collection of large image data, and a novel image analysis pipeline to enable high throughput quantification of local nanostructure properties throughout extended image volumes. Within this pipeline, we will identify discrete ROIs based on structural criteria and, using our recently published image analysis approach, which utilizes the point-pattern analysis paradigm to quantify spatial relationships between signals, and thereby, create a heat map of nanostructural properties through the extended image volume. This approach will enable structural analysis over all length scales contained within a sample, thus drastically enhancing detection pathological remodeling during disease progression.

Poster Number Seventeen

Application of Machine Leaning to Single-Entity Electrochemical Analysis

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Single-entity electrochemistry (SEE) methods for detecting polymer microbeads offer a promising approach to analyzing microplastics. However, conventional methods for determining microparticle size face challenges due to non-uniform current distribution across the sensing disk microelectrode surface. In this study, we demonstrate the utility of the framework of deep learning, and in particular the neural network (NN) analysis, to evaluate the electrochemical data in SEE blocking collision experiments. The number of collision events per experiment is limited to 20 to avoid possible formation of multilayers on microelectrode surface. The neural network analysis extracts size information from single-entity electrochemical data (current steps). A fully connected regression NN model capable of predicting microparticle radii based on experimental parameters and current-time data is developed. Once trained, the model provides near-real-time predictions with high accuracy and a loss function as mean squared error (MSE) of 0.0018. The model has also been adapted to measure the average size of two different-sized microparticles with similar electrophoretic mobilities. Potential future applications include analyzing various bioparticles, such as viruses and bacteria of different sizes and shapes.

Poster Number Eighteen

MATLAB Algorithm to Analyze XPS Data of Functionalized Surface

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To develop a synthetic ligament, we grew collagen nanofibrils covalently bound to glass and titanium surfaces. Optical and electron microscopies provided characterization of these fibrils which projected along the surface normal. Fibril surface density was controlled by the density of a silane linker, 11-(aminooxy)undecyl trimethoxysilane, covalently bonded to the surface. X-ray photoelectron spectroscopy (XPS) analysis of silane surface coverage was done to quantitatively assess functionalization. This work shows that using only the nitrogen signal to determine surface coverage underestimates coverage by an order of magnitude.

XPS depth penetration reaches a few nanometers on a carbon polymer surface. The silane molecules used were 1.5 nm long. Thus, the XPS detected core electrons include the 11 carbon chain, silicon and oxygen atoms in the silane, and the penultimate oxygen atom, not solely the terminal amine. The nitrogen atom is 1 of 19 atoms in the analysis volume plus any detected silicon and oxygen atoms in the glass substrate. Hence, a 100% surface coverage should yield not a 100% nitrogen signal but only a 5% nitrogen signal.

To provide a more accurate quantitative analysis, an algorithm was devised that used XPS signals including chemical shifts to predict molecular surface coverage. This algorithm was written into MATLAB creating a tool that can quickly and accurately compare collected XPS data with proposed surface coverage percentages. The tool showed a much more robust surface treatment, consistently finding 40% surface coverage from what was previously thought to be a 2% surface.

Poster Number Nineteen

Sensing and Mapping Metal Corrosion in-situ via a Fluorescence Spectroscopy and Single-molecule Microscopy

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Corrosion detection mitigates the detrimental effects of corrosion by detecting the degradation of an asset over time, allowing problems to be addressed before reaching a critical point. Yet, common methods, such as electrochemical and ultrasonic testing, are unable to be applied in non-conductive solvents and cannot detect early stage corrosion due to the limitation of sensitivity and resolution (~ 1 μm). Fluorophores that are sensitive to metal ions or electron transfer can indicate metal corrosion in both aqueous and non-aqueous solvents in real-time. We developed a fluorescence-based methodology to quantify the corrosion rate of carbon steel in both ethanol-based and water-based solutions over 24 hours via fluorescence spectroscopy. Two fluorophores, including Phen Green-SK (PGSK) and resazurin are employed in this fluorescence-based method. PGSK experiences fluorescence quenching after chelating with Fe(II), monitoring the anodic iron dissolution reaction (Fe → Fe(II) + 2e-). Weakly fluorescent resazurin can be reduced to highly fluorescent resorufin (fluorescence “turn-on”) as resazurin + 2e- → resorufin, detecting the electron transfer during corrosion. In addition to real-time corrosion sensing in bulk solution, the electron transfer induced fluorescence “turn-on” of resazurin is detected by single-molecule localization microscopy (SMLM) to monitor the nucleation of pits and provide both spatial and temporal information of localized corrosion at ~10 nm and ~10 ms resolutions. We complement our fluorescence observations of corrosion with other commonly used techniques, including electrochemical polarization, SEM-EDS, and XPS. The consistency between these common techniques and fluorescence-based approaches verifies the efficiency of our novel methodology in corrosion monitoring.

Poster Number Twenty

Impact of Nanometer-Thin Stiff Layer on Adhesion to Rough Surfaces

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Thin polymer coatings have significant implications for enhancing surface characteristics such as adhesion, friction, and wear resistance. The ability to precisely control and tailor these surface properties offers experimentalists and designers a wide range of options for developing solutions for applications such as antibiofoulants, sealants, and adhesives. In this study, we thoroughly investigated the adhesive behavior of poly(methyl methacrylate) (PMMA) layers of varying thicknesses applied over a soft poly(dimethyl siloxane) (PDMS) elastomer, using a sapphire lens. Our findings indicate that even a PMMA layer as thin as 90 nm can significantly reduce macroscopic adhesion to nearly zero during the loading cycle. This reduction in adhesion is elucidated through the conformal model proposed by Persson and Tossati, which suggests that the elastic energy required for creating conformal contact is dependent on both the thickness and mechanical properties of the bilayer. This in-depth study illuminates the pathway for controlling adhesion through the strategic application of thin polymer films, engineered with specific surface energies and moduli, to tailor adhesion characteristics on various substrates.

Poster Number Twenty-One

Creating an Instrumented Pressure Sensing Prosthetic Liner using Aerosol Jet Printed Electronics

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The fit of a prosthetic socket defines the comfort and usability of the device. An ill-fitting socket can lead to skin breakdown. High-pressure areas may correlate with an increased likelihood of damage to the residual limb. Thus, an instrumented prosthetic liner that can identify high-pressure regions within the socket can improve fitting. Instrumentation of the liner requires that the thin and flexible electronics are robust to sustain the donning and doffing of the liner. Aerosol jet printing (AJP) offers a novel approach to creating custom flexible sensors. The first step of the optimization was to analyze the surface texture of the sensor's substrate. The success of AJP and the adhesion of the metallic ink to the substrate is highly dependent on surface texture and the ink's wettability to the surface. Commercially available silicone liner materials and Evolon fabric were characterized with laser profilometry and digital optical microscopy to understand the surface roughness and general surface quality. Data collected will be used to develop an optimization protocol for AJP and fabricate sensors for integration into prosthetic liners that can provide real-time pressure measurements, providing a valuable tool for prosthetic patients.

Poster Number Twenty-Two

Development Aerosol Jet Printing on PMMA for of Sensorized Contact Lenses

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Real-time health monitoring through wearable technologies represents an approach to daily personal health management. The ability to detect signs of conditions such as diabetes, high blood pressure, and thyroid disease directly through the eye fluid holds the promise of revolutionizing preventive healthcare. To achieve this goal, we are developing sensorized contact lenses leveraging aerosol jet printing (AJP). This technique allows for the precise application of conductive and dielectric inks onto various contact lens platforms, setting the stage for the integration of prototype sensors, circuits, and sensor encapsulation within the lens structure. Current efforts are focused on using polymethyl methacrylate (PMMA), a transparent thermoplastic which was the material used to fabricate early contact lenses. A key aspect of this work is understanding how well the ink, and printed circuits adhere to the PMMA substrate as well as the material and ink characteristics, both physical and electrical, after sintering at different times and temperatures. Efforts included evaluating electrical resistance of the printed traces to assess their conductivity, ensuring the sensors' effectiveness and reliability. This study investigated the optimization of printing parameters such as atomizer voltage, aerosol and sheath flows, platen temperature, and print speed. Future work will include translating the AJP parameters onto a curved, contact lens-like substrate, and determining the ideal sintering parameters. Data from this work will establish a proof-of-concept technique for sensor fabrication on contact lenses.

Poster Number Twenty-Three

Analysis of AGN through Spectroscopy

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Active Galaxies a category of galaxy determined by their active galactic nucleus. In comparison to non-active galaxies, active galaxies have a powerful supermassive blackhole at their center which often emits light across the electromagnetic spectrum, along with high amounts of radiation. There are many categories AGN fall into, with some of the more prominent ones being: Seyfert galaxies, quasars, blazars, BL Lac objects and radio galaxies. What category a galaxy falls into is determined by their emissions across the electromagnetic spectrum, variability, polarization, luminosity, and angle at which their relativistic jets are pointed towards earth. This project will focus on analyzing spectra of different AGN to determine redshift, as well as the implications of AGN spectra and the data collected from them.

Poster Number Twenty-Four

Kinetics of Iron Oxide Reduction at High Pressures

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Banded iron formations (BIFs), iron-rich rocks made up of alternating layers of hematite (Fe_2O_3), magnetite (Fe_3O_4) and chert (SiO_2), were common deep ocean sedimentary deposits and a key component of the deep iron cycle during Earth's early history. However, the fate of BIFs upon their subduction into the Earth is poorly constrained. It has been suggested that under the high-temperature, high-pressure and reducing conditions of the mid to lower mantle, the hematite and magnetite in BIFs reduced to wüstite, and that this could explain the thin seismically distinct structures called ultra -low velocity zones (ULVZs) that are now present just above the core-mantle boundary (Dobson and Brodholt 2005). The critical question is how quickly these reduction reactions proceed at high pressure. We performed experiments to determine the reduction rate of hematite to wüstite as a function of temperature (600-1200 oC) and pressure (1.5-15 GPa). The results are consistent with iron diffusion across the wüstite layer controlling its rate of growth. We present calculations on the reaction progress during subduction, and find that a 200 m thick BIF would be expected to fully transform to wüstite before reaching the lower mantle.

Dobson, D. P., & Brodholt, J. P. (2005). Subducted banded iron formations as a source of ultralow-velocity zones at the core–mantle boundary. Nature, 434(7031), 371-374.

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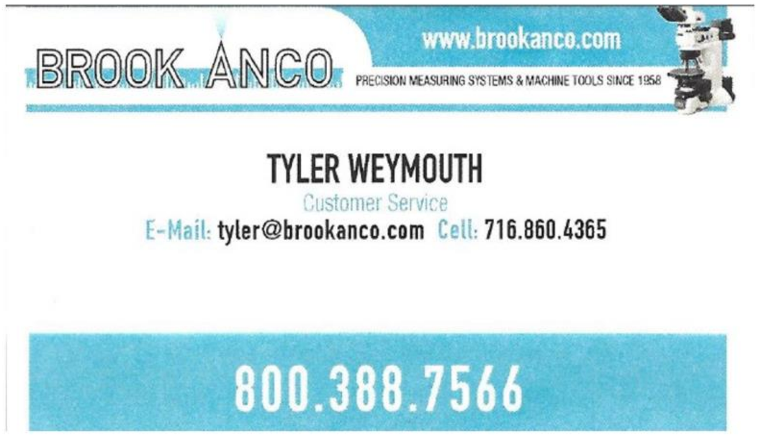

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