# 2024 MID-AMERICA REGIONAL CONFERENCE


HOSTED BY
THE UNIVERSITY OF ARKANSAS

# Conference Program

AIChE
The Global Home of Chemical Engineers

UNIVERSITY OF ARKANSAS
College of Engineering
Ralph E. Martin Department of Chemical Engineering

# Welcome to The Hill!

Welcome to Fayetteville, Arkansas! The University of Arkansas is proud to host the 2024 Mid-America Regional Student Conference for the American Institute of Chemical Engineers.

The schedule of events, campus maps, presenter abstracts, and information about fun things to do in Fayetteville can be found in this guide.

For more information, contact our Conference Chair Courtney at cjwilmot@uark.edu or via the GroupMe linked below.

In case of an emergency, you can reach campus police by calling (479) 575-2222 or by calling 911.

Join the conference GroupMe to receive live updates, ask questions to the conference committee, and socialize with other visiting universities!

# EXPERIENCE FAYETTEVILLE

## food

Hammontree's Grilled Cheese
Hugo's
Crepes Paulette
Rick's Bakery
Plomo Quesadillas
Geraldi's
Wrights BBQ
Chickenhead's

## coffee

Onyx
7Brew
Arsaga's
Hail Fellow Well Met
Doomsday

## nightlife

Dickson Street
Tin Roof
Yee Hawg
21st Amendment
Whiskey 101
Pinpoint

## outdoors

Mount Sequoya
Yellow Rock Trail
Devil's Den State Park

## activities

Crystal Bridges Museum of American Art
Arkadia Retrocade

**FOR MORE INFORMATION VISIT WWW.EXPERIENCEFAYETTEVILLE.COM**

# SCHEDULE OF EVENTS

## FRIDAY APRIL 5TH

**2:00 - 5:00 PM**

**CHECK IN**

**Bell Engineering Rm. 2255**

**INDUSTRY TOURS**
All tours require additional advance registration

**Dr Spicer's Wind Tunnel**
800 W Research Center Blvd,
Fayetteville AR, 72701
3:00pm - 3:45 pm
4:00pm - 4:45 pm

**Flyaway Brewing**
1550 E Zion Rd #1,
Fayetteville, AR 72703
3:00 pm - 3:30 pm
3:30 pm - 4:00 pm
4:00 pm - 4:30 pm
4:30 pm - 5:00 pm

**5:30 - 8:30 PM**

**CHEM-E-CAR SAFETY & POSTER**

**Barnhill Arena**
University of Arkansas Campus

*Sponsored by FutureFuel*

**8:00 - 10:00 PM**

**SOCIAL EVENT**

**Ozark Bowling Lanes**
2300 N College Ave,
Fayetteville, AR 72703

Bowling will occur in two sessions:
8:00 pm - 9:00 pm
9:00 pm - 10:00 pm

# SCHEDULE OF EVENTS

## SATURDAY APRIL 6TH

| | | |
|---|---|---|
| **ALL DAY** | **JUDGE LOUNGE**<br>**STUDENT LOUNGE** | **Champions Hall Rm. 421**<br>**Bell Engineering Rm. 2255** |

| | | |
|---|---|---|
| **7:00 - 10:00 AM** | **CHEM-E-CAR PREP** | **Barnhill Arena**<br>University of Arkansas Campus |

7:00 am Chemicals Available
7:00 am Safety Meeting
9:00 am Running Order and Distance Announced
9:55 am Call to Starting Line

*Sponsored by FutureFuel*

| | | |
|---|---|---|
| **10:00 - 12:00 PM** | **CHEM-E-CAR COMPETITION** | **Barnhill Arena**<br>University of Arkansas Campus |

*Sponsored by FutureFuel*

| | | |
|---|---|---|
| **12:00 - 1:00 PM** | **LUNCH** | **White Engineering Hall** |

| | | |
|---|---|---|
| **12:00 - 1:00 PM** | **PRESIDENTS LUNCH** | **Champions Hall Rm. 421**<br>Invite only to Chapter Presidents & Faculty advisors<br><br>Please collect your lunches beforehand to eat during the meeting. |

# SCHEDULE OF EVENTS

## SATURDAY APRIL 6TH

**12:00 - 1:30 PM** — **NETWORKING FAIR**

**White Engineering Hall Rm. 339**
Company booths will be set up

**1:00 - 3:30 PM** — **STUDENT TECHNICAL PAPER COMPETITION**

**Bell Engineering Hall**

**Bell Rm. 2269**
1:00 pm - 1:30 pm Josiah Power
1:30 pm - 2:00 pm Jacob Castaneda
2:00 pm - 2:30 pm Jared Noel
2:30 pm - 3:00 pm Samantha Glidewell
3:00 pm - 3:30 pm Aditi Gali

**Bell Rm. 2267**
1:00 pm - 1:30 pm Colin Houts
1:30 pm - 2:00 pm Sable Phillips
2:00 pm - 2:30 pm Zoe Ostrowski
2:30 pm - 3:00 pm Kaitlin McKenzie

**1:30 - 2:30 PM** — **POSTER PRESENTATION COMPETITION**

**Champions Hall Rm. 326**
Presenters listed below

Della Melton
Ryan Dahl
Mara Manolescu
Sarah Dixon
Keshawn Wallace
Chris Lollis
Luke Wilson
Harold Ly

Aoife Cleary
Klaertje Hesselink
Emma McDougal
Marissa Moore
Liam Horan
Miah Hoppens
Katie Kersten
Noah Sparks

Lily Towery
Aaron Bal
Ian Popp
Abaigeal Aydt
Bruce Baker
Andrea Phan
Aditi Gali
Bram Sueppel

Maryann Melendrez Cuadros

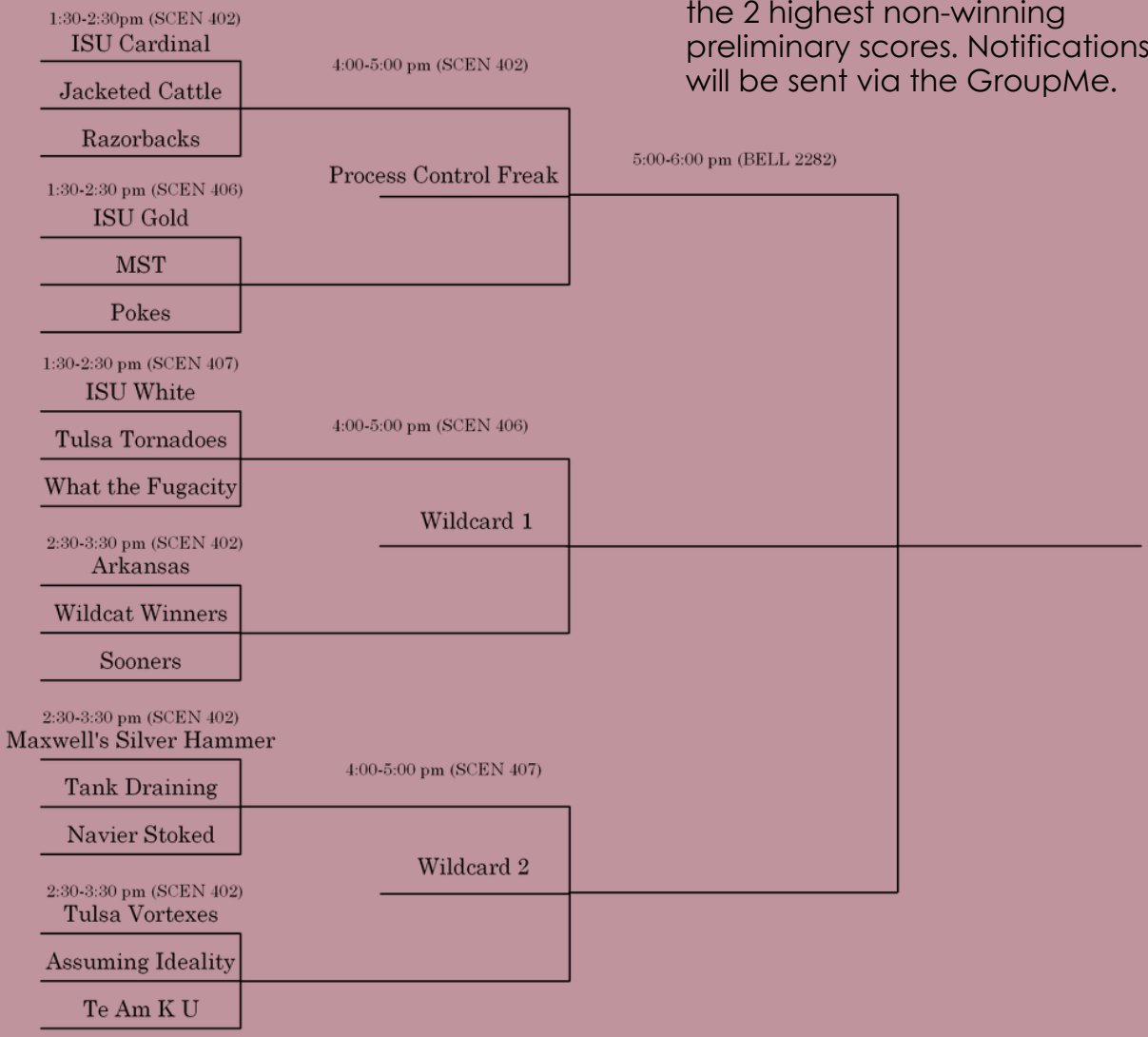
# SCHEDULE OF EVENTS

## SATURDAY APRIL 6TH

### 1:30 - 6:00 PM — CHEM-E-JEOPARDY

**Science Engineering Hall**

Wildcards are chosen based on the 2 highest non-winning preliminary scores. Notifications will be sent via the GroupMe.




### 7:00 - 9:00 PM — AWARDS BANQUET

**Mount Sequoyah Bailey Center**

150 N Skyline Dr,
Fayetteville, AR 72701

Serving "A Taste of Arkansas"

# PARKING

## HARMON PARKING GARAGE

**Location:**

South campus on South Duncan Avenue
See map below for more information.

FlowBird App Icon

**How to pay:**

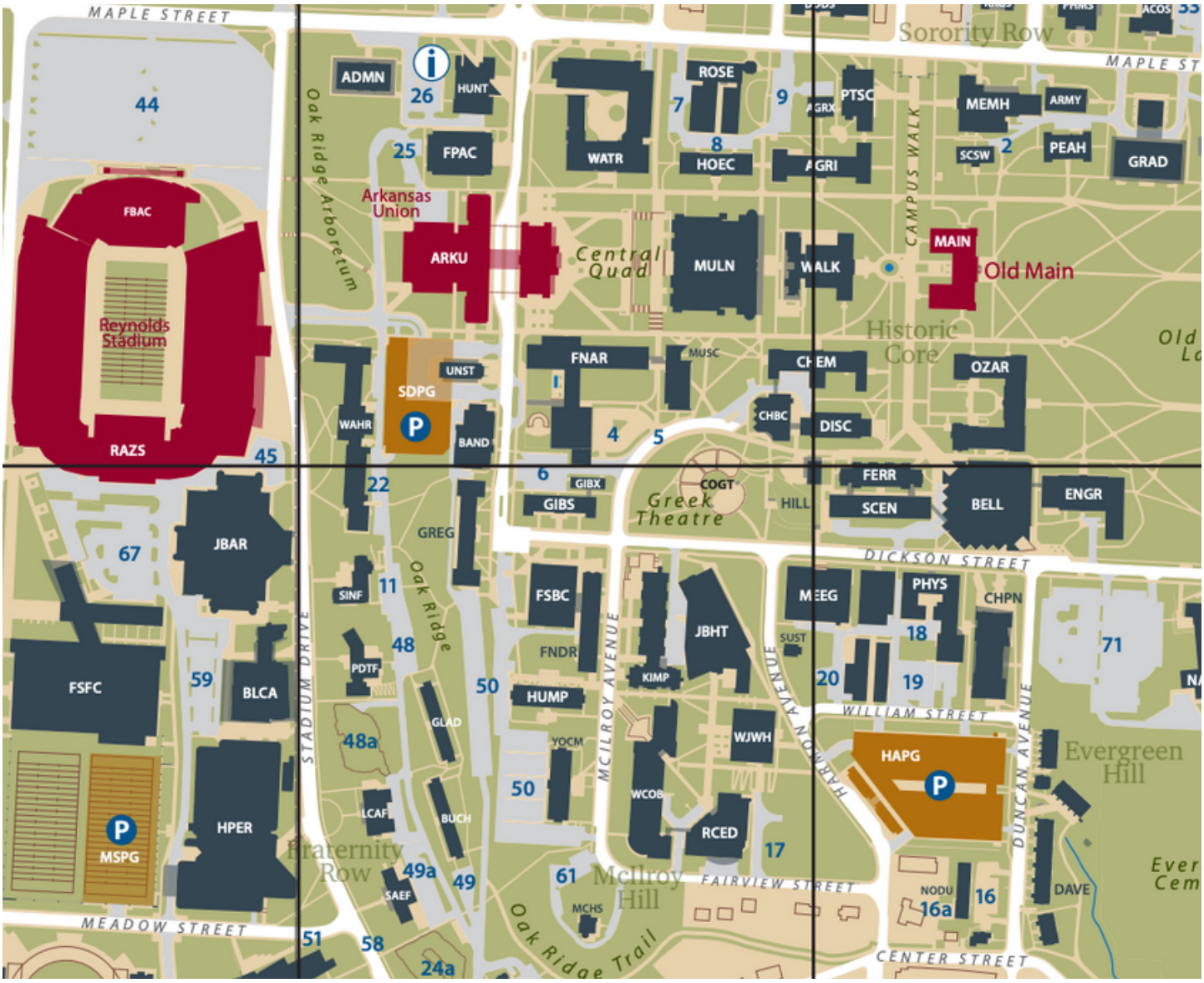
All on campus garages operate using meters located at the exits and entrances of the garages and the FlowBird parking app.

1. Download FlowBird Parking App
2. Park in Harmon Parking Garage Levels 1 or 2
3. Note your license plate number to use in the FlowBird app
4. Use the University of Arkansas code (given during registration) for 1 complimentary hour of parking on Friday.
    a. This code is valid for Levels 1 and 2 of the Harmon Parking Garage only.
    b. Volunteers at the Registration Booth can troubleshoot parking issues

Note: Saturday parking in Harmon Parking Garage is free.

# MAPS

## UNIVERSITY OF ARKANSAS CAMPUS




**HAPG** - Harmon Parking Garage

**BELL** - Bell Engineering Center

**ENGR** - White Engineering Hall

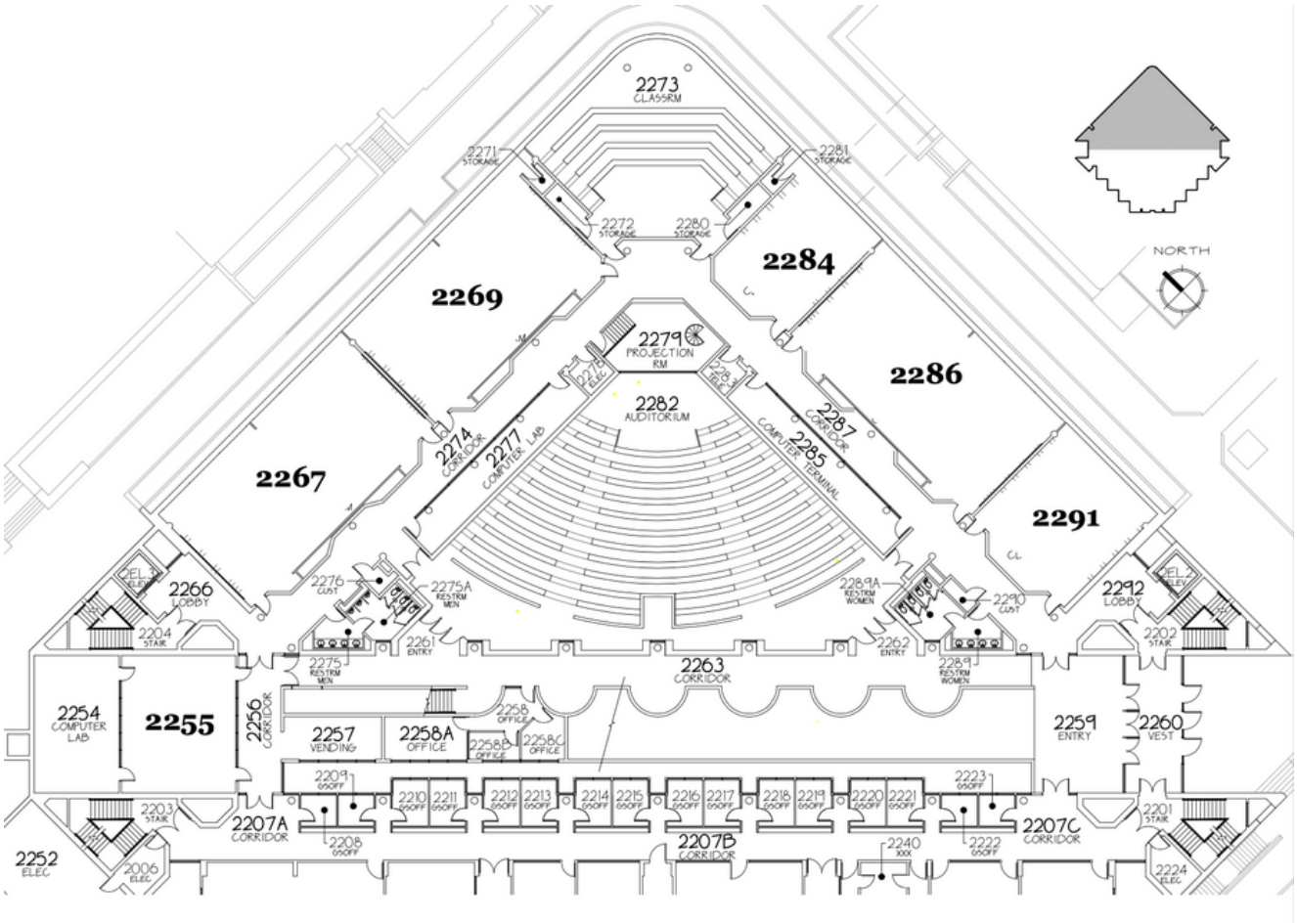
**SCEN** - Science Engineering Hall

**CHPN** - Champions Hall

**JBAR** - Barnhill Arena

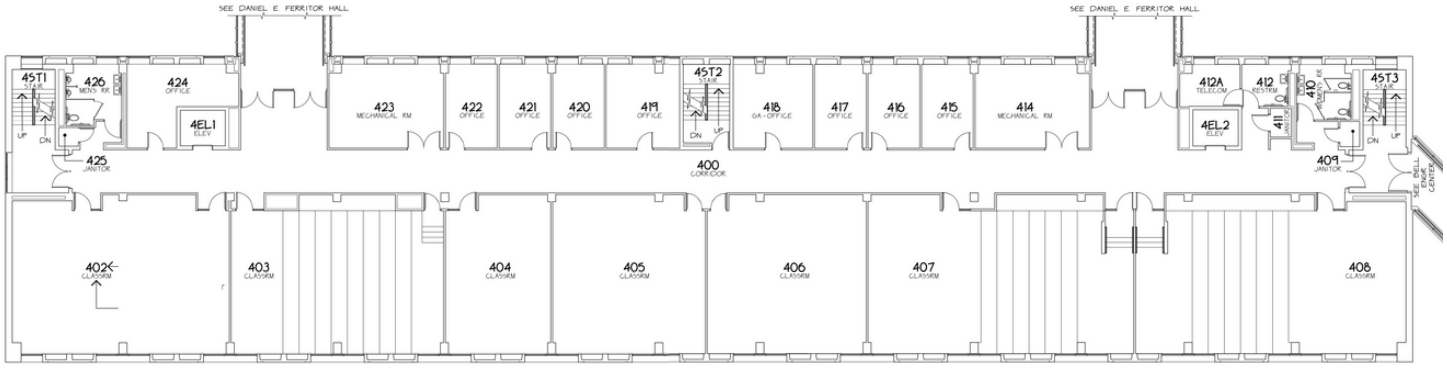
# MAPS

## BELL ENGINEERING CENTER FLOOR 2



# MAPS

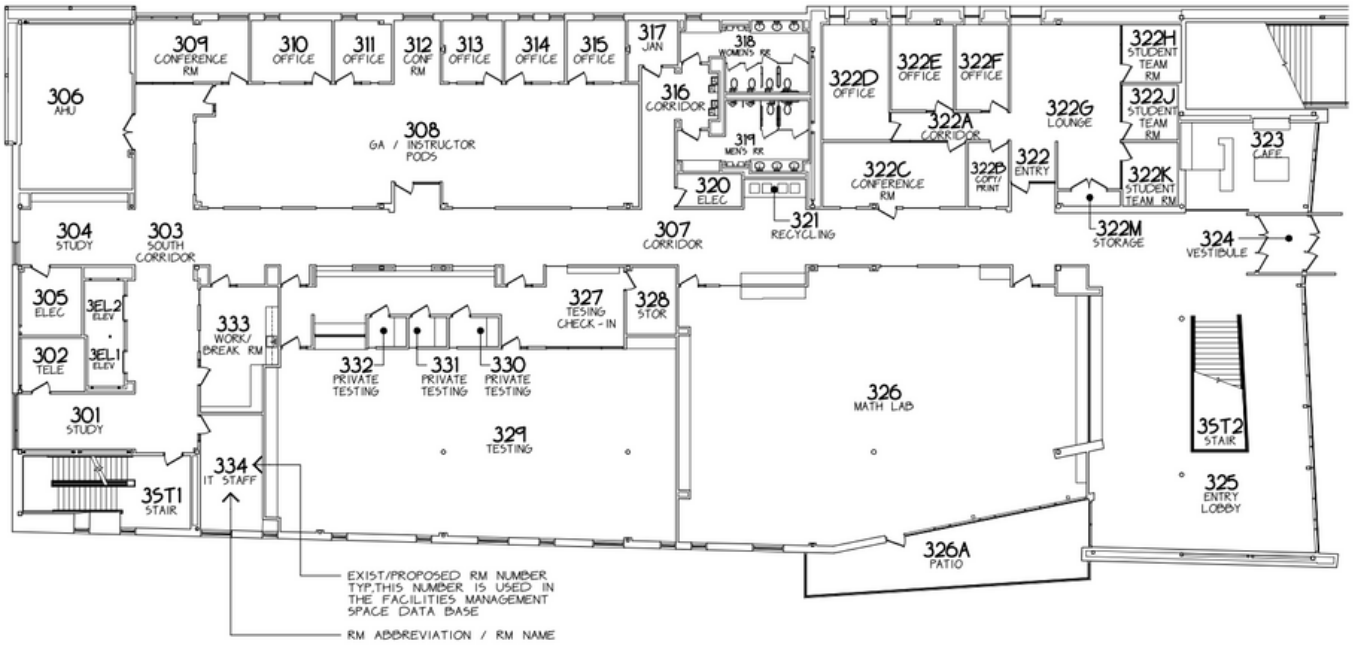
## SCIENCE ENGINEERING HALL FLOOR 4

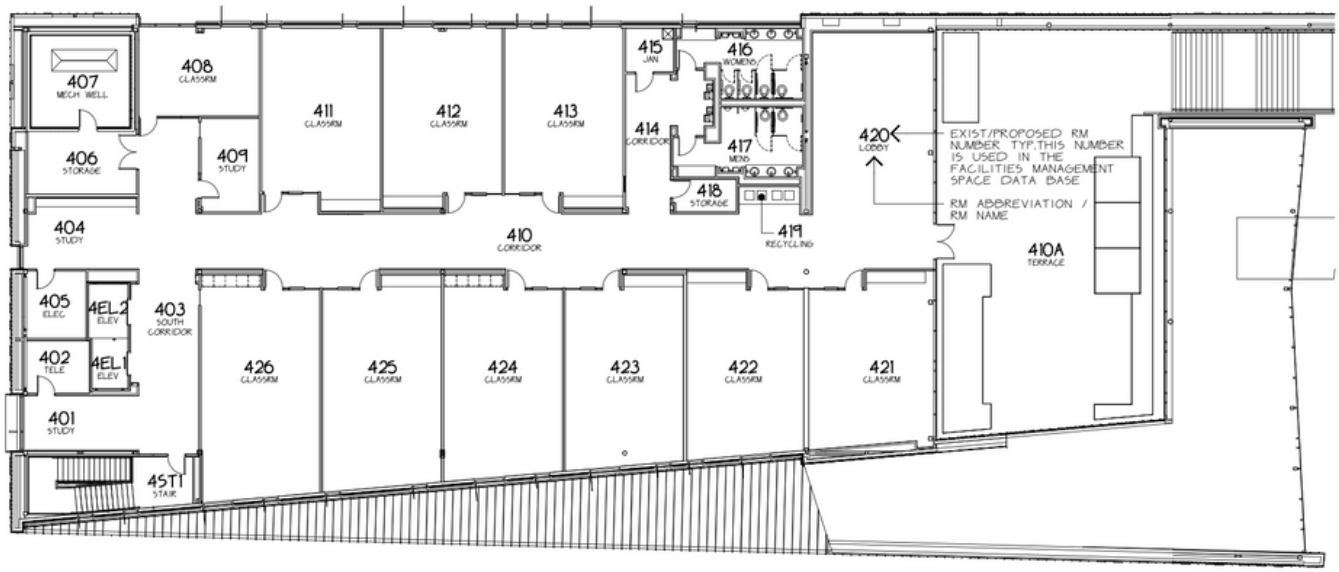



## WHITE ENGINEERING HALL FLOOR 3

# MAPS

## CHAMPIONS HALL FLOORS 3 & 4



2024 MID-AMERICA REGIONAL CONFERENCE


POSTER PRESENTATION

# Abstracts

**Revisiting experimental techniques and theoretical models for estimating the solubility parameter of rubbery and glassy polymer membranes**

Harold G. Ly, Matthew T. Webb, Lucas C. Condes, William J. Box, Sepideh Razavi, Michele Galizia
University of Oklahoma, Norman, Oklahoma

Abstract

The Hildebrand solubility parameter, δ, is used to predict miscibility among low molecular weight compounds and polymers, affecting practical applications of coatings, drug delivery, material formulation, and membrane separations. Estimation of the Hildebrand solubility parameter (δ) of polymers and small molecules is accomplished experimentally and numerically. Intrinsic viscosity and swelling measurements are commonly used to study polymer interactions with solvents and determine polymer δ values. These experimental routes require viscosity data in numerous solvents at various concentrations, which may be problematic when working with non-commercial, expensive polymers. Dynamic light scattering offers a quicker solution that consumes less material, by correlating δ to the hydrodynamic diameter of polymers in various solvents. Rubbery and glassy polymers, including a microporous polymer and a high fractional free volume polymer are samples included in this study. Secondly, in an attempt to enhance the accuracy of numerical estimate of polymer solubility parameters via the group contribution method, we provide updated group contribution parameters, along with their uncertainty. These updated group contribution parameters result in a mean absolute relative error of 9.0% in predicting the solubility parameter on a test set of 40 polymers, which is on par with the average 10% error reported previously. We also show that augmenting the group contribution model with extra parameters or non-linear relationships does not improve its accuracy. Results of the updated group contribution technique and dynamic light scattering measurements were compared to experimental viscometry on four test polymers, and the difference between the three techniques is discussed.

**High Shear Rate SAXS of Complex Fluids**

Chris Lollis
The University of Tulsa, Tulsa, Oklahoma

Abstract

This project has consisted of development of a high-pressure micro fluidic system to be paired with a Small Angle X-ray Scattering (SAXS) instrument. This setup has the capability to serve many applications, but our focus was on evaluating the system's RheoSAXS capabilities with complex fluids by pumping fluids through micro capillaries. To test these two apparatuses, we are using a model fluid consisting of the polymer carboxymethyl cellulose (CMC) in water, we have also used other model samples including suspensions of Bentonite Clay in water and a surfactant micelle solution. We have been able to use SAXS to characterize all these fluids under static conditions and in shear cell experiments, however, we have not yet conducted tests in the micro-capillary flow system. Beyond using SAXS, the solutions are first run in a rheometer to gather the rheological data of the solution. The scattering data is analyzed using software specific to X-ray scattering and to observe any alignment in the scattering and to determine if the shear scattering in the capillary reflects with the shear cell data.

**Electrokinetic Remediation of RDX and TNT in the Vadose Zone: A Microfluidic Study**

Miah Hoppens, Aaron Daigh
University of Nebraska-Lincoln, Lincoln, Nebraska

Abstract

In the United States, over 15 million acres of soil are contaminated with munitions (Tauqeer et al 2021) including the high explosives Royal Demolition eXplosive (RDX) and trinitrotoluene (TNT), both of which are known carcinogens with a range of other deleterious health effects. Moreover, RDX is highly mobile and likely to leach to lower depths in the vadose zone, affecting groundwater quality. Electrokinetic remediation (EKR) is a fast, cost-effective remediation strategy for heavy metals and inorganic salts with low environmental impact (Han et al 2021). However, knowledge gaps exist in regards to EKR's effect on organic contaminants. Microfluidic or "lab-on-a-chip" devices are useful for studying soil processes at microscale via highly controlled conditions (Zhu et al 2022). The scope of this study is to investigate both the efficacy of electrokinesis as a remediation technique for both RDX and TNT contamination, as well as the consistency of modeling results obtained via a microfluidic device with those obtained from a soil column. This research will be performed by first fabricating three microfluidic devices similar to the "two-compartment" setup developed by (Cameselle 2021). The influence of electric current magnitude on migration of RDX or TNT will be assessed through fluorescent detection. Migration of RDX and TNT (separately) will also be assessed with and without the addition of a surfactant, with the migration of either compound in the absence of an applied current serving as a control. It is expected that for increasing current magnitude and density, the migration of either contaminant from the cathode to the anode end of the device will increase.

**Designing Neuroprotective Biomaterials for Spinal Cord Injury Mitigation**

Marissa Moore, AJ Hemmerla, Bret D Ulery
University of Missouri-Columbia, Columbia, Missouri

Abstract

The prognosis for spinal cord injuries (SCIs) can vary greatly depending on the severity and location of impact, with additional host responses exacerbating the damage and complications beyond those caused by the primary injury. Current SCI treatment approaches do not adequately address secondary damage, necessitating novel systems be developed specifically for neuroprotection. This project focuses on creating and evaluating biocompatible polymers capable of releasing simple signaling molecules (SSMs) to facilitate cytoprotection and complement existing treatment options. N-acetyl cysteine (NAC), known for its antioxidant properties, was initially formulated into a diacid monomer through disulfide dimerization and methylation to allow it to be readily polymerized. Specifically, polyesters were chosen as the polymer platform to synthesize since they possess tunable sustained release kinetics and allow for the potential incorporation of a therapeutic diol as well. The present study examines the cytotoxic effects and range of the NAC dimer monomer in neuronal stem cells to help define the desired release kinetics and potential diol choice for NAC-incorporated polyesters. Future efforts will focus on fabricating hydrogel matrices from this polymer to be leveraged as a versatile drug delivery platform.

**Intermolecular Analysis of Ionic Liquid Mixtures Using Kamlet-Taft Parameters**

Ryan Dahl, Karim Al-Barghouti, Dr. Aaron Scurto
University of Kansas, Lawrence, Kansas

Abstract

The American Innovation and Manufacturing Act of 2020 initiated the phase-out of hydrofluorocarbon (HFC) refrigerants for more environmentally friendly hydrofluoroolefin (HFO) refrigerants. In response, Project E.A.R.T.H (Environmentally Applied Research Towards Hydrofluorocarbons) and our collaborators are actively pursuing methods of recycling HFC refrigerants that will no longer be usable. However, widely used mixtures of HFC refrigerants often form azeotropes which are not separable through conventional separation techniques like distillation. Thus, new separation methods are necessary and ionic liquids are proposed as entrainers in extractive distillation for the separation of HFC refrigerant mixtures. To design these complicated new systems, thermophysical data for ionic liquids and ionic liquid mixtures are necessary but uncommon. Our group aims to elucidate the complex behavior of ionic liquid mixtures with respect to their thermophysical properties in hopes to examine potential correlations between thermophysical properties and Kamlet-Taft parameters. Kamlet-Taft parameters $\pi^*$, $\alpha$, and $\beta$ represent polarizability, hydrogen bond donating ability, and hydrogen bond accepting ability respectively. We hypothesize that the molecular characteristics described by Kamlet-Taft parameters are related to viscosity, density, and thermal conductivity. In which case, the necessary thermophysical data needed to design HFC separation systems could be derived from Kamlet-Taft parameters. This correlation would aid the effort to integrate ionic liquids as an entrainer in extractive distillation systems for the separation of hydrofluorocarbon refrigerant mixtures.

**Bouncing Droplets: Effect of Surface Temperature and Roughness on Water Droplet Impact**

Katie Kersten, Bruce Baker, Nicholas Wayman, Syed Ibrahim Gnani Peer Mohamed, Siamak Nejati
University of Nebraska-Lincoln, Lincoln, Nebraska

Abstract

Hydrophobic surfaces have a wide range of applications, from anti-icing coatings to water-repelling technologies. Previous studies have shown that the contact time of a droplet is drastically decreased on rough surfaces. However, there is little research into the effects of surface temperature on water droplet impact. The goal of this work was to measure the efficiency of different textured hydrophobic surfaces at a range of temperatures, from room temperature to below freezing. This presentation covers results from multiple impact trials of two iCVD-coated surfaces: Silicon with smooth poly(perfluorodecyl acrylate) (pPFDA) coating, and Aluminum with uniformly rough pPFDA coating. Due to the difference in surface textures, each substrate had different effects on droplet impact dynamics. The droplets had a higher tendency to adhere to the smooth surface, while the droplets split apart and bounced dramatically on the rough surface. The contact time and the contact length of the droplets on both surfaces were compared at different temperatures.

**Formosa Plastics Vinyl Chloride Explosion**

Liam Horan
University of Iowa, Iowa City, Iowa

Abstract

On April 23rd, 2004, a catastrophic release and explosion occurred at the Formosa Plastics polyvinyl chloride (PVC) plant in Illiopolis, Illinois, killing five and injuring three others. The explosion destroyed the plant, while the resulting fire covered the surrounding community in a cloud of smoke and triggered an evacuation. The facility was ruled a total loss and did not reopen. The explosion was caused by the release of a reacting mixture of vinyl chloride monomer (VCM) from the bottom of a vessel, creating a flammable vapor cloud that soon detonated. The Chemical Safety Board (CSB) later found that an operator had inadvertently opened a reacting vessel by manually overriding a safety bypass. In its investigation, the CSB identified the presence of a single safeguard to prevent a release as the main cause of the incident. The bypass of the interlock relied only on verbal supervisor permission, which was not obtained. Furthermore, it was found that the previous operator of the plant failed to implement findings of severe consequences for opening the interlock. Upon acquiring the plant, Formosa failed to complete hazard analysis and did not act after several near misses. In response, the CSB issued recommendations to Formosa and relevant regulatory bodies. Primarily, it called for an audit of Formosa's plants to establish procedures and authorization for safeguards, implementing a new safety philosophy, promptly correcting risks found in hazard analysis, utilizing layers of protection, and reworking emergency protocols. The CSB also called for a revision of NFPA deluge standards, and it issued warnings to both the EPA and Vinyl Institute to prevent future incidents.

**Structure-Sensitivity of Nitrate Reduction on Bimetallic Surfaces**

Aaron Bal, Eli Shopbell, Deep M. Patel, Luke T. Roling
Iowa State University, Ames, Iowa

Abstract

Excess nitrate (NO3) leaching into groundwater from agricultural runoff poses significant environmental hazards. Electrocatalytic NO3 reduction reactions (NO3RR) provide a sustainable route to environmentally benign (N2) or value-added chemicals (NH4) for further applications. However, due to challenging reaction kinetics for NO3 to NO2 and N-N coupling at low H* coverage on transition metal-based monometallic catalysts, the low selectivity and high overpotential of NO3RR towards these chemicals inhibit its large-scale application. Recent work has demonstrated that the catalyst surface geometry plays a significant role in NO3RR performance. 1,2. This presentation will use density functional theory (DFT) to generate a database of key reaction intermediates on Pd, Cu, Au, and Ag monometallic and bimetallic surfaces. We further consider the structure sensitivity by utilizing (111) and (100) facets. We establish linear scaling relations between the binding energy of the adsorbate and that of the binding site.3 Our data showed that NO adsorption is well-described, with mean absolute errors of 0.002-0.07 eV. We use these relations to understand the structure-sensitive nature of NO3RR reaction steps. These scaling relations will be used to evaluate reaction energetics as a function of catalyst structure and composition to determine the ideal catalysts for high selectivity.

**Unraveling the Stability of Trimetallic Nanoparticles with Machine Learning**

Klaertje Hesselink[1], Maya Salem[2], Dr. Giannis Mpourmpakis[2]
[1]University of Iowa, Iowa City, IA
[2] University of Pittsburgh, Pittsburgh, PA

Abstract

Metal nanoparticles have gained immense interest due to their wide application in various fields spanning from catalysis to nanoelectronics and drug delivery. With the vast configurational space of multimetallic nanoparticles, it is difficult to implement Density Functional Theory calculations to find the most thermodynamically stable chemical ordering for a specific nanoparticle. Here, we apply the Bond Centric Model (BCM) coupled with an in-house developed Genetic Algorithm (GA), which can accurately and efficiently capture the stability of nanoparticles of any size, shape, and metal composition. We use a proof of concept on how the BCM + GA captures trimetallic nanoparticle stability of PdPtAu, to extend its usage to four more trimetallic nanoparticles of AgPdPt, AgAuPd, AgAuPt, and AgCuPd made up of 2869 atoms, of cuboctahedral symmetry, with varying metal compositions. Our study reveals the total chemical ordering and, importantly, the surface composition of the nanoparticles resulting in the lowest cohesive energy (most thermodynamically preferred). We observe that for AuPdPt, Au tends to segregate to the surface, whereas Pd and Pt tend to reside in the bulk and subsurface. Similar trends were observed for AgPdPt. AgAuPt and AgAuPt showed trends that Ag and Au segregate to the surface while Pt and Pd occupy the bulk and subsurface layers. Similar patterns were observed for AgCuPd which was in agreement with experiments. Our work demonstrates the feasibility of using the BCM and the developed GA to reveal the exact chemical ordering of highly thermodynamically stable trimetallic nanoparticles and reveals the importance of metal cohesion and bimetallic bond strength in the overall chemical ordering trends.

**Dupont Belle Phosgene Release**

Aoife Cleary
University of Iowa, Iowa City, Iowa

Abstract

The phosgene release incident at the DuPont Belle plant in January 2010 underscores the critical importance of process safety management systems in chemical facilities. This poster examines the incident's causes and effects, shedding light on the contributing factors that led to the fatal release of this highly toxic substance. By delving into the intricacies of the plant's processes and operational procedures, key shortcomings and vulnerabilities in the safety protocols employed are identified and evaluated. Central to the analysis is the comparison to the Process Safety Management (PSM) system established by the Center for Chemical Process Safety (CCPS). Through a review of the PSM framework implemented at the DuPont Belle plant. Furthermore, the poster identifies the specific failures within the PSM system that allowed the phosgene release incident to occur, offering insights into areas for improvement and reinforcement.

**The Effect of Cholesterol Content on the Interfacial Behavior of Model Myelin Lipid Membranes**

Mara Manolescu, Prajnaparamita Dhar, Estephanie Escoba
University of Kansas, Lawrence, Kansas

Abstract

The myelin sheath is a multilamellar lipid membrane wrapped around axons of neurons in the central nervous system (CNS) that facilitates rapid nerve impulse transmission, which is essential for the proper functioning of the CNS. Myelin destruction, called demyelination, causes Multiple Sclerosis (MS), a neurodegenerative disorder that results in the loss of sensory and motor functions due to nerve impulse leakage. In healthy subjects, the amphipathic lipids that compose myelin form a remarkably stable membrane. Changes in lipid ratio have just recently been identified as a signature of demyelination; however, the details of these changes and the role they play in MS are not currently understood. Previous research on the effect of cholesterol in myelin has led us to hypothesize that changes in the composition of cholesterol impact the packing of the film, which in turn impacts its stability. This work addresses the function of cholesterol in the myelin sheath to develop a biophysical model of the myelin sheath. Using a Langmuir-Pockels trough, we measured the surface pressure (SP) exhibited by lipid films with various cholesterol contents when subjected to dilatational interfacial stresses. Major lipid components of myelin were used in this work: L-alpha-phosphatidylcholine (Brain PC), L-alpha-phosphatidylethanolamine (Brain PE), L-alpha-phosphatidylserine (Brain PS), and cholesterol. Myelin lipid films were experimentally modeled by varying cholesterol content and adjusting the phospholipid ratio accordingly. Two control models were based on the specific lipid profile found in "healthy" and "sick" mice brain extracts. Varying cholesterol content promoted major differences in the mechanical properties of the interfacial film. The "healthy" model exhibited the highest SP values, suggesting any deviation from the "healthy" amount of cholesterol results in an overall less stable film. This work confirms the "healthy" amount of cholesterol results in a more stable myelin lipid film.

**The Effects of Varying Nickel and Iron Concentrations In Catalyst Generation**

Della Melton
University of Kansas, Lawrence, Kansas

Abstract

The role of catalysts is to increase the rate of a chemical reaction without undergoing any permanent chemical change. The purpose of this research was to find a catalyst that had the best stability, the lowest activation energy, and the highest peaks to try and create hydrogen into an efficient fuel source. Three catalysts were made (1:5 NiFe Sulfate Sulfite, 3:1 NiFe Sulfate Sulfite, and NiFe CC Ice), deposited, and tested. It was found that the 1:5 NiFe Sulfate Sulfite performed the best and had the best stability over time.

**Investigating the Immiscibility between Perfluoropolymer Blended Membranes for Helium Extraction from Natural Gas**

Aditi Gali, Lucas C. Condes, Bryce A. Goodin, Shivam D. Patel and Michele Galizia
University of Oklahoma, Norman, Oklahoma

Abstract

Approximately 30,000 tons of Helium is consumed per year, yet its extraction process demands significant energy input. Perfluorinated polymers have exceptional performance in Helium separation from light gases compared to hydrocarbon-based materials; however, common commercial perfluoropolymers lack the selectivity required to efficiently recover helium at the dilute concentrations of 0.1% - 7% occurring in natural gas. The perfluorinated polymer poly(PFMMD-co-CTFE) exhibits a high He/CH4 permselectivity up to 900 but is extremely brittle, whereas Teflon AF2400, a commercially available perfluoropolymer, demonstrates a high permeability with better mechanical stability. Therefore, in this study, we investigated the miscibility between poly(PFMMD-co-CTFE) and Teflon AF2400 blended membranes for He extraction from natural gas. Differential scanning calorimetry (DSC) and high-resolution light microscopy were performed to evaluate the miscibility between the two. It was discovered that the dipolar nature of the chlorotrifluorethylene (CTFE) comonomer in poly(PFMMD-co-CTFE) makes the two polymers totally immiscible in the entire composition range. Moreover, He, H2 and CH4 permeability was measured at 35°C in blends of varying composition, and a tunable selectivity-permeability behavior lying on the 2008 Robeson upper bound was observed. Mixing-rule models, permeation, and microscopy were utilized to build structure-property correlations and reason how poly(PFMMD-co-CTFE) and Teflon AF2400 interact under a variety of casting conditions. Additionally, contact angle measurements on neat poly(PFMMD-co-CTFE) and neat Teflon AF2400 confirm the complete immiscibility behavior displayed as their interfacial surface energies are vastly different.

**Lead Sequestration in Perovskite Materials**

Andrea Phan, Dr. Yinsheng Guo and Bo Zhang
University of Nebraska-Lincoln

Abstract

Perovskite materials offer a high tolerance to defects while having wide light absorption, allowing for a low-cost, scalable semiconducting alternative to silicon and gallium compounds at a lower levelized cost of efficiency. The most efficient perovskites encompass the formula MAPbX3 (X = halide,) to which the concern pivots towards the toxicity of the lead component, where if introduced to the environment could be fatal towards nervous systems. For scaled manufacturing of this lab-synthesized semiconductor to occur, we must find a solution to sequester lead. Our work encompasses halometallate ionic liquid chemistry, and the reaction series of metals towards the lead complex in different solvents. Using an internal metal within the device structure allows for inexpensive, long-term stability and ease of scalability with preexisting deposition methods.

**Tuning Lipid Content to Modulate Peptide Amphiphile Micelles for Drug Delivery Applications**

Emma O. McDougal, Agustin T. Barcellona, Megan C. Schulte, and Bret D. Ulery
University of Missouri-Columbia, Columbia, Missouri

Abstract

Current cancer treatments are known for their cytotoxicity and undesirable off-target effects. To address these significant shortcomings, new classes of therapeutics need to be developed to improve treatment efficacy and patient comfort. Peptide-based therapeutics are a promising alternative to traditional chemotherapies, but *in vivo* delivery of peptides is challenging due to their low membrane permeability, loss of secondary structure, and low local therapeutic concentration. Conjugating hydrophilic peptides comprised of therapeutics and bioactivity modulating components (*e.g.*, cell penetrating peptides – CPPs) with hydrophobic lipid tails yields modular peptide amphiphiles (PAs). These PAs self-assemble in water to form micelle nanoparticles (PAMs) when at high enough concentrations. Excitingly, micelle-mediated delivery of peptide therapeutics can address many of the primary concerns associated with free peptide delivery. While promising, most work to date with PAs primarily focuses on using one or more palmitic acids. To expand the number of PAs available, this work focuses on exploring the impact that alternating lipid chain length and number has on PAM size, shape, and stability. As a test bed for this effort, novel PAs were explored for their capacity to alter the bioactivity of a therapeutic peptide that has shown broad-spectrum anti-neoplastic effects in hematological cancer. Specifically, PAM physical and biological characteristics were studied *in vitro* employing a human B cell leukemia to determine the impact lipid tail size has on PAM cancer cell cytotoxicity. Based on this work, lipids can be selectively chosen to optimize material characteristics for drug delivery applications of PAMs not only for cancer therapy but also a wide variety of other drug delivery applications.

**Ionizable Lipids**

Noah Sparks, Dr. Hu Yang, Lei Xu, Vidit Singh
University of Arkansas, Fayetteville, Arkansas

Abstract

In this project ionizable lipids were analyzed for their efficacy in delivery of mRNA in multiple metastatic lung cancer cells. Different ionizable lipids were combined using their molar ratios to make the ionizable lipid nanoparticles (LNP), which were then analyzed in order to enhance nucleic acid delivery to the cytoplasm. Phospholipids also play a role in targeting efficacy of the LNPs to the lung cells. Different combinations of ionizable lipids with multiple phospholipids were studied for physical characterization and in-vitro transcription efficiency. Transcription efficiency was then quantified using flow cytometry and optimal particles for transcription were noted.

**Didion Milling Inc. Combustible Dust Explosion**

Bram Sueppel
University of Iowa, Iowa City, Iowa

Abstract

On Wednesday May 31, 2017, around 11:00 pm in Cambria, Wisconsin at the Didion Milling Inc. dry corn milling facility, a series of combustible dust explosions occurred due to an improper temporary connection in the process. This connection was made to increase production of bran, one of the materials processed at the facility. It was determined that a fire started from smoldering particles within the system and due to the highly interconnected nature of the process systems, the fire propagated throughout the facility. A total of 19 employees were onsite at the time of the incident. None of the employees were able to evacuate in time resulting in five deaths and 14 injuries. The collapse and damage to the facility buildings caused an estimated $15.4 million in property damage. No off-site damage was reported. Numerous safety issues were identified by the CSB including inadequate process hazard recognition, lack of engineering controls, a poor emergency response plan, and more. All of these issues had a major contribution to the severity of the incident. The CSB also gave 13 total recommendations to Didion, OSHA, and the NFPA that acted to prevent future incidents that may involve the aforementioned safety hazards. These recommendations included the formation of a new comprehensive combustible dust standard by OSHA, as well as requiring Didion to update many of their systems including emergency response plans and process hazard analysis, and for the NFPA to update NFPA 61 or other successor standards.

**Comparing Automated and Manual Techniques for Heparin-Collagen Layer-by-Layer Coatings**

Ian Popp[1], Dr. Luis Pinzon Herrara[2], Dr. Jorge Almodovar[2]
[1]University of Arkansas, Fayetteville, Arkansas
[2]University of Maryland Baltimore County, Baltimore, Maryland

Abstract

Autografts are commonly used in peripheral nerve injuries. Nerve guide conduits (NGCs) require fewer surgeries than autografts[1]. NGCs are a treatment option for injuries less than 1 cm in length. This restriction is caused by the lack of resources needed by the extracellular matrix [2]. The surface of NGCs is the main site for the regeneration process [2]. The surface of the NGCs can be modified using Layer-by-Layer (LbL) coatings, and the properties of heparin-collagen (HEP/COL) bilayers has been studied extensively [3,4]. Prior work has shown that using HEP/COL bilayers with manual layer- by-layer techniques can increase the cell viability in NGCs[3]. This work aims to test the viability of automated LbL techniques in cell culture tissue plates with human Schwann Cells (hSCs) by comparing the automated (HEP/COL)6.5 LbL plates to manually coated (HEP/COL)6.5 LbL plates. Automated plates increased uniformity of HEP/COL layers across plates. Automated plates were found to decrease variance across cell culture plates in cell viability assays in comparison to manual plates. These results show promise for the practical manufacturing of LbL coatings in NGC applications.

**Protein Release Kinetics of Proinsulin Variants from HA-Collagen-Fibronectin Hydrogels**

Maryann L. Melendrez Cuadros
University of Kansas, Lawrence, Kansas

Abstract

Hydrogels, because of their adaptive properties and biocompatibility, have become promising platforms for controlled drug delivery. In this study, protein release kinetics from hyaluronic acid (HA)-based hydrogels incorporating fibronectin and collagen were examined to elucidate the influence of the hydrogel composition on the release profiles of proinsulin variants. HA- collagen-fibronectin hydrogels were synthesized according to a standardized protocol, with variations in collagen and fibronectin concentrations. Three proinsulin variants, F25D, F25D- K3, and F25D-K12, were used along with the hydrogels to conduct protein release assays over 24 hours using fluorescence endpoint measurements. Distinct release profiles were observed for each proinsulin variant. For F25D, hydrogels containing fibronectin at 0.125 mg/mL and collagen at 1.0 mg/mL exhibited the highest protein release, with a significant increase observed from 12 to 24 hours. Collagen, particularly at 1.0 mg/mL, showed the most considerable protein release across all variants, while fibronectin demonstrated comparatively lower release rates, especially at 0.25 mg/mL. The findings underscore the importance of hydrogel composition in modulating protein release kinetics. For instance, collagen emerged as a critical component in protein release, whereas fibronectin exhibited lower release rates. The results provide valuable insights for hydrogel-based drug delivery systems, emphasizing optimizing hydrogel compositions to achieve desired and realistic release profiles for real-life therapeutic applications. Further research might explore factors influencing protein release dynamics, facilitating more effective drug delivery strategies.

**Replicating Vasculature Using Coaxial 3D Printing of Gelatin-Alginate Hydrogels**

Keshawn Wallace, Berk Uysal, Sundar Madihally
Oklahoma State University, Stillwater, OK

Abstract

From skin and bone grafts to complete organ replication, 3D bioprinted cellular structures in medicine are continually advancing. Our primary focus is replicating human vasculature. Gelatin is a highly biocompatible polymer that allows cell adhesion and growth. However, printing gelatin is difficult without chemical modifications. Hence, it has been blended with other polymers such as chitosan and sodium alginate. Printed alginate is typically crosslinked using a bath and solution of calcium chloride. Furthermore, previous studies using coaxial printing have remained within a core needle size of 20-30G. Needles that are smaller than this have been shown to require a printing pressure that is high enough to denature cells involved in the process. However, it is necessary to broaden our ability to replicate these structures, as the human body includes veins and arteries as small as 10 micrometers. This project aimed to evaluate the possibility of producing 10 micrometer vascular structures by coaxially printing gelatin-alginate. First, gelatin-alginate formulations that are conducive to 3D printing were explored. Post- printing, the gelation characteristics and rheology of the solution were analyzed to determine shear-stress levels. Multiple core solutions were tested along with varying flowrates and stability of the fibers. Formed fibers were analyzed by taking microscopic images. Also, the possibility of printing these solutions with cells was tested using liver sinusoidal endothelial cells. These results show significant potential of using the formulations in the development of vascular structures.

**Fighting Freezing Rain: Surface Texturing for Improved Hydrophobicity**

Bruce Baker, Katie Kersten, Nick Wayman, Syed Ibrahim Gnani Peer Mohamed, Siamak Nejati
University of Nebraska-Lincoln, Lincoln

Abstract

Reduction of droplet-to-surface contact time has a wide variety of industrial benefits and is a primary focus of anti-icing technology. It is known that contact time may be affected to some degree by surface texture, droplet radius, variations in hydrophobic coating, and temperature variation of the droplet or surface, among other factors. The team's work is focused on quantifying the effect of these factors and comparing their impact on contact time.

This presentation is focused on the study of surface roughness as it relates to hydrophobicity. In this study, poly(1H,1H,2H,2H-perfluorodecyl acrylate) (pPFDA) is deposited via iCVD on a smooth silicon surface as well as two laser-roughened aluminum surfaces. The surfaces are imaged at the millimeter scale to compare roughness, and droplet impacts are then measured and evaluated at a high framerate to yield kinetic information. The roughened surfaces repelled the droplets more effectively and saw a much more elastic collision between the droplet and surface. The variation in roughness as well as many aspects of the contact dynamics can then be quantified for comparison with other factors such as temperature.

**In Vitro Pancreatic Tumor Microenvironments using DNA-Directed Patterning**

Lily Towery[1], Soheyl Mirzababaei[1], Molly Kozminsky[2]
[1]Iowa State University, Ames, Iowa
[2]Nanovaccine Institute, Ames, Iowa

Abstract

Pancreatic cancer stands as one of the most lethal forms of cancer globally, underscoring the urgent need for advancements in early detection methods and treatment strategies. Within this context, understanding the dynamics of the pancreatic tumor microenvironment (TME) holds pivotal importance given its significant influence on tumor progression and spread. Among the techniques employed to explore TME dynamics, DNA-directed patterning stands out as a promising avenue, leveraging photolithography-based templating and the unique properties of DNA to engineer intricate cellular arrangements at the microscale. This method compromises two main steps: initial patterning of a substrate with short single-stranded oligonucleotides; followed by cell labeling with complementary oligonucleotides and their placement onto the patterned substrate, thus generating well-defined cellular layouts. These patterns can include various components of the TME, such as cancer-associated fibroblasts (CAFs), different macrophage phenotypes, and tumor cell clusters. Subsequently, by introducing different mixtures of extracellular matrix (ECM) components, researchers can mimic the native tumor microenvironment with remarkable precision. This controlled spatial organization allows for comprehensive investigations into cellular behaviors, including migration, proliferation, differentiation, and responses to therapeutic agents. This process provides a versatile platform to study cellular behaviors in response to varying cues, allowing for a more accurate representation of in vivo conditions.

**MXene Marvel: Advancing Textile-Based Supercapacitor Fabrication**

Abaigeal Aydt, Alyssa Grube, Mona Bavarian
University of Nebraska-Lincoln, Lincoln, NE

Abstract

The research in developing wearable supercapacitors is of particular interest, given the widespread use of portable electronics in everyday activities. Current methods to create textile-based supercapacitors (TSCs) involve the synthesis of conductive materials to coat fiber such as cotton or wool. Among various materials, MXenes, a family of two-dimensional transition metal carbides or nitrides, have gained significant attention. Methods of coating and different types of yarn are of particular interest for optimization to address limiting factors in current techniques. In comparing two yarns, wool and cotton, the wool yarn in comparison to the cotton yarn has higher MXene content on the yarn's surface when examined with X-ray Photoelectron Spectroscopy (XPS). Additionally, the wool yarn exhibited more pseudocapacitive behavior when compared to the cotton yarn due to its fiber's increased aqueous electrolyte uptake. Initially, yarn coating was done by simply dipping the yarn into the MXene colloidal solution and drying under a continuous vacuum. This process has two steps, coating and drying. To further optimize the coating process, an auto-coater was developed. In the ongoing optimization, the auto-coater streamlines this into a one-step process where the yarn is simultaneously coated and dried. Although this method is still undergoing refinement, the current auto-coater employs a fan and motor system. The motor, in conjunction with a shaft, spins the newly coated and dried yarn onto a spindle. Once the yarn is coated and run through a series of tests, the yarn is knitted into a TSC. Currently, the TSC is knitted by hand, but with the help of a Kniterate knitting machine, this process can be improved. The knitting machine can be programmed to knit electronic components that can be used in this research. In order to utilize the Kniterate machine, fundamentals of operation and coding knowledge are needed. Using a knitting machine offers several advantages; TSCs can be knitted with more consistent sizing than what can be done via hand knitting, mass production is more efficient, and the knitting environment is more controlled. Using wool fibers, the auto-coater, and the new Kniterate machine, the research of developing wearable MXene TSCs is expanding to include studying the effect of yarn substrate and processing on performance.

2024 MID-AMERICA REGIONAL CONFERENCE


STUDENT TECHNICAL PRESENTATION

# Abstracts

**Poloxamer Gels in Biocompatible Ionic Liquids to Treat Middle Ear Infections**

Colin Houts[1], Charles Knisely[2], Arit Das[2], Michelle Calabrese[2]
[1] University of Iowa, Iowa City, Iowa
[2] University of Minnesota, Minneapolis, Minnesota

Abstract

The current standard of care for otitis media (OM, middle ear infection) has many limitations including contribution to bacterial antibiotic resistance and unwanted side-effects. Recent research has highlighted the potential of aqueous, drug-loaded poloxamer gels (composed of hydrophilic and hydrophobic blocks) for treating OM. These formulations can be directly administered onto the ear drum for targeted, non-invasive drug delivery. However, small-molecule chemical permeation enhancers (CPEs) must be added to the poloxamer gels to enable drug transport across the eardrum, making formulation difficult. Choline-based ionic liquids (IL) are a potential solution to this problem as they are stable, biocompatible, and can serve as both a solvent and CPE. In this work, the interactions of biocompatible poloxamers and choline-based IL are investigated to fine-tune the rheological and structural properties of the drug delivery system. Poloxamer in choline-hexenoic IL and water was shown to transition to a gel state upon heating with a corresponding gel structure of body-centered-cubic (a = 83.5 A). The anion-to-cation ratio of IL and poloxamer concentration were varied to analyze its effect on sol-to-gel transition and associated final gel structure. The results obtained from this study can be exploited to develop more effective drug delivery routes to treat OM.

**Fabrication of mechanically reinforced and physicochemically-tuned polycaprolactone and cellulose nanocrystal composite membranes for cardiovascular tissue engineering applications**

Jared Noel, Taylor Norris, Joseph Batta-Mpouma, and Jin-Woo Kim
University of Arkansas, Fayetteville, AR

Abstract

Cardiovascular disease is the leading cause of death worldwide each year. Modern medical treatments for myocardial infarctions primarily consist of stents or blood thinners and are aimed at restoring oxygen flow to the heart. However, these treatments do not address the scar tissue that forms as a result of cardiac events, thus leaving patients at a greater risk for repeat events. Cell scaffolding is a prominent technology in tissue engineering that utilizes biomimetic materials to facilitate native tissue regrowth. Polycaprolactone (PCL) is a synthetic biopolymer that has successfully been used in bone and musculoskeletal tissue engineering in the past. However, PCL is limited for cardiovascular cell scaffolds because of its low mechanical strength and poor cell affinity. Cellulose nanocrystals (CNCs), naturally occurring subunits of cellulose, have a high tensile strength and tunable surface chemistry rich in hydroxyl groups. These unique properties make CNCs ideal candidates as additive materials for PCL-based cell scaffolds. In this research, the preparation of uniformly mixed PCL and CNC composite materials at different ratios was utilized to make membranes. Mechanical properties, including tensile strength, Young's modulus, and elongation strain, were characterized. It was found that an increasing concentration of CNCs in the composites led to increasing mechanical strength values of the membranes, demonstrating the practicality of PCL/CNC composite materials for tissue engineering applications in stress-intensive environments like the cardiovascular system.

**Designing Unique Mechanical Gradient Patterns in Alginate Hydrogels**

Zoe Ostrowski, Juntao Zhang, Juan Ren, Fred Namanda, Ian Schneider
Iowa State University, Ames Iowa

Abstract

Directed cell migration is an important aspect in wound healing and cancer metastasis. Cells take in and process many signals including the mechanical signal of tissue stiffness. Durotaxis is the process in which cells migrate towards stiffer regions of the extracellular matrix. Alginate, which comes from brown algae, is commonly used in wound dressings, especially hydrogels, due to its biocompatibility and capability to retain large amounts of water. Alginate hydrogels can be crosslinked with calcium to create a stiffer hydrogel. While alginate gels have been used in wound dressings, sophisticated gels with stiffness gradients that could direct cells to particular targets within the wound bed at a faster rate have not been used. In addition, these gels can be used to engineer an environment that mimics the extracellular matrix providing insight into how cancer cells respond and migrate to mechanical signals. Using custom stencils, we can control where the calcium diffuses into the hydrogel, giving us an ability to design any unique stiffness gradient in the hydrogel. As the density of crosslinking increases, a change in opacity is observed in the hydrogel over time. We show an ability to generate gradients with different spatial features. Furthermore, the elastic modulus, a measure of stiffness, of the alginate hydrogel was quantified using atomic force microscopy (AFM). Opacity changes correlated both spatially and temporally with crosslinking and elastic modulus in the alginate hydrogel, demonstrating that opacity can be used as a proxy for local mechanical properties. Future work is geared towards examining the behavior of cells on these substrates and creating complex multi-cue environments to understand how cells migrate in response to mechanical signals.

**Investigating the Use of Biomass Derived Biochar Adsorbents for Contaminants in Water**

Sable Phillips, Donovan Daubert, Suriya Ramasubramanian, David Opiela, Dr. Hema Ramsurn
The University of Tulsa, Tulsa, Oklahoma

Abstract

Water in pipelines is contaminated with inorganic and organic ions. In industry, these ions impede fluid flow with the formation of scaling but can also pose a threat to human health. Our goal is to find a more cost-effective and environmentally friendly way to tackle this issue. This work tests various plant-based adsorbents, especially derived from plant waste streams abundant in Oklahoma, to remove contaminants, particularly calcium and chromium. The in-house prepared adsorbents tested will be cellulose biochar, lignin biochar, hemp biochar, cannabis biochar, and their activated forms. Different contaminant concentration solutions (0-500 ppm) will be prepared and tested for 24 hours for each of the adsorbents (1.5 g/L). A Flame Atomic Absorption Spectrometer will be used to detect the ions in the solutions. Our results show that at low Ca concentrations, activated cellulose and lignin are the only adsorbents that yield positive results. However, when subjected to higher Ca concentrations (100 and 500 ppm), all the activated biochars exhibited better results. The adsorbents did not work well for low concentrations or even at 100 ppm of chromium with the exception of activated cellulose. However, at 500 ppm all the activated adsorbents, except for hemp biochar, gave positive results. Based on these observations, the ash content of each adsorbent was analyzed: the adsorbents from hemp and cannabis had high amounts of inorganic compounds, believed to inhibit adsorption. For future work, the correlation between ash content and adsorption capacity will be investigated by using different ash removal methods.

**SLignin Modification for Sustainable Alternatives in Polyurethane Production**

Samantha Glidewell, David Chem, and Keisha B. Walters
University of Arkansas, Fayetteville, Arkansas

Abstract

Lignin is an abundant naturally occurring polymer that is branched, highly unsaturated, and rich in aliphatic and aromatic hydroxyl groups. Lignin has been harvested as a byproduct of the wood pulp and paper industries. However, it has yet to be widely utilized in commercial applications due to unique properties such as: non-linear structure, wide range of molecular weights, high hydrophobicity, high rigidity and brittleness. Investigations into the modification of lignin to broaden its uses have recently begun and show promising results. Polyurethanes (PU), which require polyol and isocyanate precursors, both typically petrochemically derived, exhibit poor degradability, require extreme reaction conditions, and produce toxic byproducts during synthesis that threaten human health and safety. Using lignin-based polyol and isocyanate alternatives as feedstock materials is possible with appropriate lignin modification techniques. In this study, the lignin polymer is modified to produce a polyol via phenolation and hydroxypropylation reactions that are intended to increase the number of available aromatic and aliphatic hydroxyl groups in lignin, respectively. Additionally, lignin monomers, vanillyl alcohol and guaiacol, are utilized to form a lignin-based diisocyanate following a series of reactions including amination and isocyanate termination. Then the lignin-based polyol and diisocyanate precursors are both used to produce an entirely lignin-based PU. Each reaction step was characterized by Fourier transform infrared spectroscopy, thermogravimetric analysis, and contact angle analysis to confirm chemical composition, thermal stability, and surface wettability. Additionally, the morphology of the PU products were observed with optical and scanning electron microscopy. The resultant lignin-based PUs offers a low toxicity and biodegradable alternative for the current petrochemical-based PU foams, coatings, and elastomers.

**Thermal Susceptibility of Single-Species and Polymicrobial Biofilms of Pseudomonas aeruginosa and Staphylococcus aureus**

Josiah Power, Colin Houts, Parham Parnian, and Eric Nuxoll
University of Iowa, Iowa City, Iowa

Abstract

Biofilm infections on orthopedic implants and other medical devices affect hundreds of thousands of patients and drive a multi-billion dollar annual healthcare cost. Most infected implants must be surgically removed and replaced in a painful and expensive process. Heating the implant in situ is an alternative to surgical implant removal that has been shown to reduce bacterial biofilm populations. Most thermal susceptibility studies to date have investigated single-species biofilms. The effect of a second bacterial species on the thermal susceptibility of the first was unknown. To address this, biofilms of Staphylococcus aureus and Pseudomonas aeruginosa were grown both individually and together on microscope slides. The biofilms were thermally shocked to determine the effect of heat on bacterial density. Results confirm that heat shocks substantially decrease biofilm populations and indicate that P. aeruginosa substantially weakens the thermal shock resistance of S. aureus, while S. aureus does not impact the thermal susceptibility of P. aeruginosa.

# Reducing Physical Aging of Microporous Polymer Membranes through Porous Polymer Network Blending

Aditi Gali, Lucas C. Condes[1], Matthew T. Webb[1], William J. Box,[1] Tran Le,[1] Jing Deng,[1] Alberto Striolo, Michele Galizia[1], Cara M. Doherty[2], Anita J. Hill,[2] Leoncio Garrido[3], Angel E. Lozano,[3] Cristina Alvarez,[3] Laura Matesanz-Niño[4]

[1] University of Oklahoma, Norman, Oklahoma

[2] CSIRO Manufacturing, Clayton, Australia

[3] Institute of Polymer Science and Technology, Madrid, Spain

[4] University of Valladolid, Valladolid, Spain

## Abstract

The Sixth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC) highlighted that global average temperature increase relative to pre-industrial levels will likely exceed 1.5°C by 2050. Membrane techniques for CO2 separation from gaseous streams would greatly enhance the efficiency when compared to conventional, thermal-based separations. However, several issues arise when utilizing membrane materials, one being their rapid physical aging and instability under long-term industrial operations and harsh conditions. Hence, in this study, we evaluated the effect of using relatively inexpensive, hyper-crosslinked amorphous, microporous structures, known as porous polymer networks (PPNs), composed of triptycene and isatin, to hinder the permeability decline due to physical aging. These networks were blended with a model microporous polymer, poly(1-trimethylsilyl-1-propyne) (PTMSP) to properly understand the potential of PPN to decrease the transient free volume collapse of glassy polymer membrane materials. PPN was chosen as it is compatible with organic polymers, has high surface areas, and tunable surface properties. Membranes with varying PPN composition were characterized using ATR-FTIR and SEM to verify the material morphology and compatibility between PPN and PTMSP. Positron Annihilation Lifetime Spectroscopy (PALS) measurements were additionally performed on aged samples of neat PTMSP and PTMSP-5PPN to measure the pore size distribution changes. Furthermore, physical aging was tracked by constantly permeating N2 through membrane films at 35°C.

**Sustainable Production of Wool Textile-Based Supercapacitors Using MXenes**

Kaitlin McKenzie, Alyssa Grube, Mona Bavarian
University of Nebraska-Lincoln, Lincoln, Nebraska

Abstract

Textile-based supercapacitors (TSCs) are being developed to become convenient and safe energy sources to power a variety of electronic devices. TSCs are unique in that they combine the flexibility and lightweight nature of textiles with the energy storage capabilities of traditional supercapacitors. The TSCs are prepared by coating wool yarn with V4C3TX MXenes, a 2D conductive material which is compared to wool yarn coated with Ti3C2Tx MXenes. V4C3TX MXene presents numerous benefits, such as increased interlayer spacing, enhanced structural durability, and a high specific capacity (Peng et al., 2022). In this study, an auto-coater was used to pull wool yarn through a Titanium- or Vanadium-based MXene bath then through a series of pulleys to dry the yarn. This one-step simultaneous drying and coating process was repeated to increase the mass loading of the conductive material, the conductivity, and, thus, the capacitance of the TSCs. Electrochemical characterization was performed on MXene-coated wool in a two-electrode system to determine the charge storage, capacitive, and resistive behavior of yarns. Cyclic voltammetry (CV) curves were conducted to study the charge storage and discharge behavior. Electrical Impedance Spectroscopy (EIS) was performed to characterize the impedance behavior of the yarns and build an equivalent circuit model (ECM) to determine the system parameters. The ECMs determine theoretical resistive and capacitive behavior of the coated wool yarn. Further tests were performed to model the performance of Vanadium MXenes as they oxidize using EIS and CV tests. The V4C3TX MXene TSCs have an increase in pseudocapacitive behavior due to the reduction of Vanadium flakes by acidic electrolyte during charging.

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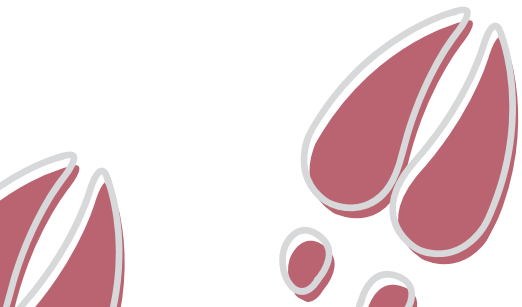


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