



AUBURN
Samuel Ginn
College of Engineering

2024

**AICHE
SOUTHERN
REGIONAL
CONFERENCE**

MARCH 15TH -16TH

Hosted by: Auburn University, Auburn, AL

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WELCOME

Auburn University's AIChE Chapter would like to welcome you to the 2024 Southern Regional Conference!

We hope that you will enjoy the events, competitions, and food that have been organized for this weekend.

Further information can also be found at our website:

<https://eng.auburn.edu/aiche/>

A MESSAGE FROM OUR KEYNOTE SPEAKER

Chemical engineering involves the translation of scientific principles from the fields of chemistry, physics, biology and engineering into tangible, real-world solutions. These diverse fields also establish a versatile foundation; on which, one can build the knowledge and skills required to succeed across a broad spectrum of careers. Whether your aim is to improve the sustainability of the energy and goods required for modern life, develop life-saving pharmaceuticals or medical devices, assume an organizational leadership role, or delve into entrepreneurship; chemical engineering will provide you the foundation required for success. Simply put, chemical engineers are innovative problem solvers, and the world has no shortage of problems in urgent need of resolution.



Biography

Jager Livingston is the North America Energy & Greenhouse Gas (GHG) Advisor for ExxonMobil's Product Solutions Company. In this role, he leads initiatives within Refining and Chemical manufacturing aimed at reducing the GHG intensity of the fuels, lubricants, and petrochemical products that make modern living possible. An Auburn University Chemical Engineering graduate, he has accumulated 14 years of diverse ExxonMobil experience spanning process engineering, research & development, business planning & optimization, capital projects, and various management roles leading technical, mechanical, and operations personnel.

This broad range of experience has provided a unique perspective on how chemical engineering skills can be applied well-outside the bounds of chemical engineering problems. In addition, Jager acts as the Team Captain for ExxonMobil's Auburn University recruiting team, and beyond his professional endeavors, he serves as a founding Board member of Mountain View Missions, a non-profit working to break the cycle of poverty in Kenya through education. Married with two sons, he is a former decathlete and Ironman triathlete who finds enjoyment in staying active outdoors, particularly through running, hiking, and climbing.

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GOLD LEVEL

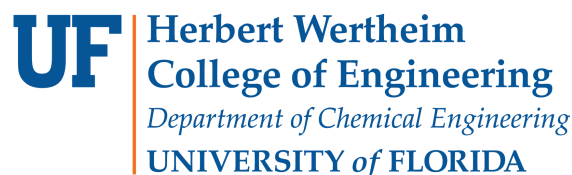


SILVER LEVEL



Fam. Ernst Pawerczik

BRONZE LEVEL



MEETING POLICIES & NOTICES

RECORDING AND GENERAL PHOTOGRAPHY POLICY

AIChE meetings are one of the primary ways the Institute fulfills its mission to advance the development and exchange of relevant knowledge. The content presented at this event is the property of the presenters. Recording sessions or taking photos of slides is strictly prohibited.

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Sessions and events at the meeting are being photographed and these will be used in the promotional avenues. By registering for this conference, you consent to your likeness being used for such purposes without compensation and release AIChE, AU AIChE, and Auburn University's Department of Chemical Engineering from any liability on account of such usage.

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CODE OF ETHICS

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AIChE is committed to promoting a fair, just, and equitable profession and society. Read the full statement at <https://www.aiche.org/equity-diversity-inclusion/statement>



FRIDAY SCHEDULE

Start Time	End Time	Event	Location
12:00 pm	7:00 pm	Registration	Brown-Kopel In Front of Grand Hall
1:00 pm	5:30 pm	Tour	Imerys & International Paper
3:00 pm	6:00 pm	Cookie Classes	Patisserie in the Tony & Libba Rane Culinary Science Center
3:00 pm	5:00 pm	Design of Coffee Classes	Ross Hall 309
3:00 pm	6:00 pm	Walk-Up Makerspace Tours	Brown-Kopel Makerspace
4:00 pm	5:00 pm	ChemE Jeopardy Preliminary Rounds	Brown-Kopel Grand Hall 1, 2, 3, 2133, & 2117
5:00 pm	6:00 pm	ChemE Jeopardy Semifinal Rounds	Brown-Kopel Grand Hall 1,2, & 3



SATURDAY SCHEDULE

Start Time	End Time	Event	Location
8:00 am	12:00 pm	Registration	Brown-Kopel In Front of Grand Hall
8:00 am	9:00 am	Breakfast	Brown-Kopel Atrium
9:00 am	12:00 pm	Poster Competition	Brown-Kopel Grand Hall 1 & 2
9:00 am	12:00 pm	ChemE Poster Competition/Safety Inspection	Brown-Kopel Grand Hall 1 & 2
9:00 am	12:00 pm	Future's Fair	Brown-Kopel Grand Hall 3
9:00 am	12:00 pm	Student Technical Presentation Competition	Brown-Kopel 2133 & 2117
12:00 pm	1:00 pm	Lunch	Brown-Kopel Atrium
12:00 pm	1:00 pm	President's Lunch	Brown-Kopel 2117
1:00 pm	2:00 pm	ChemE Jeopardy Finals	Brown-Kopel 2133
1:00 pm	2:00 pm	Conference Seminar/Bids	Brown-Kopel 2117
1:00 pm	3:00 pm	ChemE Car Competition Prep	Auburn Junior High School
3:00 pm	6:00 pm	ChemE Car Competition	Auburn Junior High School
6:00 pm	8:00 pm	Awards Banquet and Keynote Address	Auburn University Student Center



FUTURES FAIR

9:00 am - 12:00 pm
Grand Hall 3 (2157)
March 16th

COMPANIES

ExxonMobil
International Paper
Imerys
WestRock
Valero

UNIVERSITIES

Auburn University
University of Florida

POSTER COMPETITION

9:00 AM - 12:00 PM
GRAND HALL 1 (2143) & 2 (2151)

FUELS, PETROCHEMICALS, AND ENERGY

Allan Wilson
Tanishq Moondra

MATERIALS ENGINEERING AND SCIENCES

Alexandra Seesee
Cade Tharrington
Asmaa Alawbali
John Thornhill
Isabella Perez
Paul Gramelspacher

SEPARATIONS

Elliot Horn

CATALYSIS AND REACTION ENGINEERING

Valentina Milano-Benitez
Abby Mock

COMPUTING, SIMULATION, AND PROCESS CONTROL

Jarod Morris

ENVIRONMENTAL SCIENCE AND ENGINEERING

Madelyn Torrance
Sydney Buchsbaum

FOOD, PHARMACEUTICALS, BIOTECHNOLOGY

Sion Park
Gianna Fiduccia
Alison Brown
Anastasia Shaverina
Benjamin Gunasekaran

STUDENT TECHNICAL PRESENTATIONS

9:00 am - 12:00 pm
Brown-Kopel 2117 & 2133

Room 2133

9:00 - 9:30

Nathan Thornburg - University of South Carolina

Controlling metal Nanoparticle Size on Carbon Supports with Surface Tension

9:30 - 10:00

Xiang 'Jimmy' Li - Georgia Institute of Technology

Gas Transport Phenomena in PDMS/Matrimid Thin Film Composite Membrane

10:00 - 10:30

Adelyn Richgels - University of Florida

Parameters influencing the mechanical properties and solubilization of Plodia interpunctella silk fibroin for biomaterial applications

10:30 - 11:00

Imrie Ross - University of Georgia

Evaluation of a Molecular Tool to Measure the RNA Sequence-Dependent Translation

11:00 - 11:30

Emma Kim - Auburn University

Computational Analysis of Maturation in Differentiated Cardiac Cells

Room 2117

9:00 - 9:30

Katelyn Woodard - Mississippi State University

A Radical Library: Cataloging Radiation Yield of Acrylates Undergoing Electron-beam Polymerization

9:30 - 10:00

Hannah Bagnis - University of Florida

The dynamics of chemical and physical cross-linking of chemically modified silk fibroin hydrogels for 3D printing

10:00 - 10:30

Nicolas Kelhofer - Georgia Institute of Technology

Long-term delivery of contraceptive in vivo with gamma sterilized microneedle patch

10:30 - 11:00

Saim Siddiqui - Auburn University

The Effects of Sorbitol on Nanocrystal Orientation and Mechanical Properties of Sheared Cellulose Nanocrystal Films

Presentation slots will run for 30 minutes where presenters will present for 15 minutes, answer questions for 5 minutes, and the judges deliberate for 5 minutes. There will be a 5-minute break between each set of presentations.

JEOPARDY

PRELIMINARY

4:00 PM - 5:00 PM

GRAND HALL 1, 2, & 3 BROWN-KOPEL 2117 & 2133

Bracket 1: Grand Hall 1

Yellow Jackets - GT
Team CBU - CBU
South Alabama - USA

Bracket 2: Grand Hall 2

Auburn A - AU
Camel Catalysts - CU
University of Florida - UF

Bracket 3: Grand Hall 3

Hail State - MSU
Tennessee Tech Jeopardy Team -
TTU
UAH Chargers - UAH

Bracket 4: Brown-Kopel 2133

Louisiana Tech - LTU
You Just Got Beat By the
Freshmen - GT
The Aggie Elites - NCA&T

Bracket 5: Brown- Kopel 2117

Bulls - USF
ULL - ULL
Auburn B - AU

Teams will compete in preliminary rounds with first place and next four highest scores will proceed to the semi-finals after the preliminary rounds.

CHEME CAR TEAMS

1:00 PM - 5:00 PM

AUBURN JUNIOR HIGH SCHOOL

**TEG-C (Totally Epic Go Cart!) - FAMU &
FSU**

Hydrogen Horsepower - GT

Volt Pack 2.0 - NCSU

Chargertron - UAH

The InstiGator - UF

Kentucky Fried Chemicals - UK

The Good Times - ULL

Cyber UNA - UNA

Cokeep - UPRM

The Lemon - USA

Rolling Rooster - USC

Smokey - UTK

The Mocs Shot - UTC

The Lead Foot - AU

BROWN-KOPEL

GROUND FLOOR

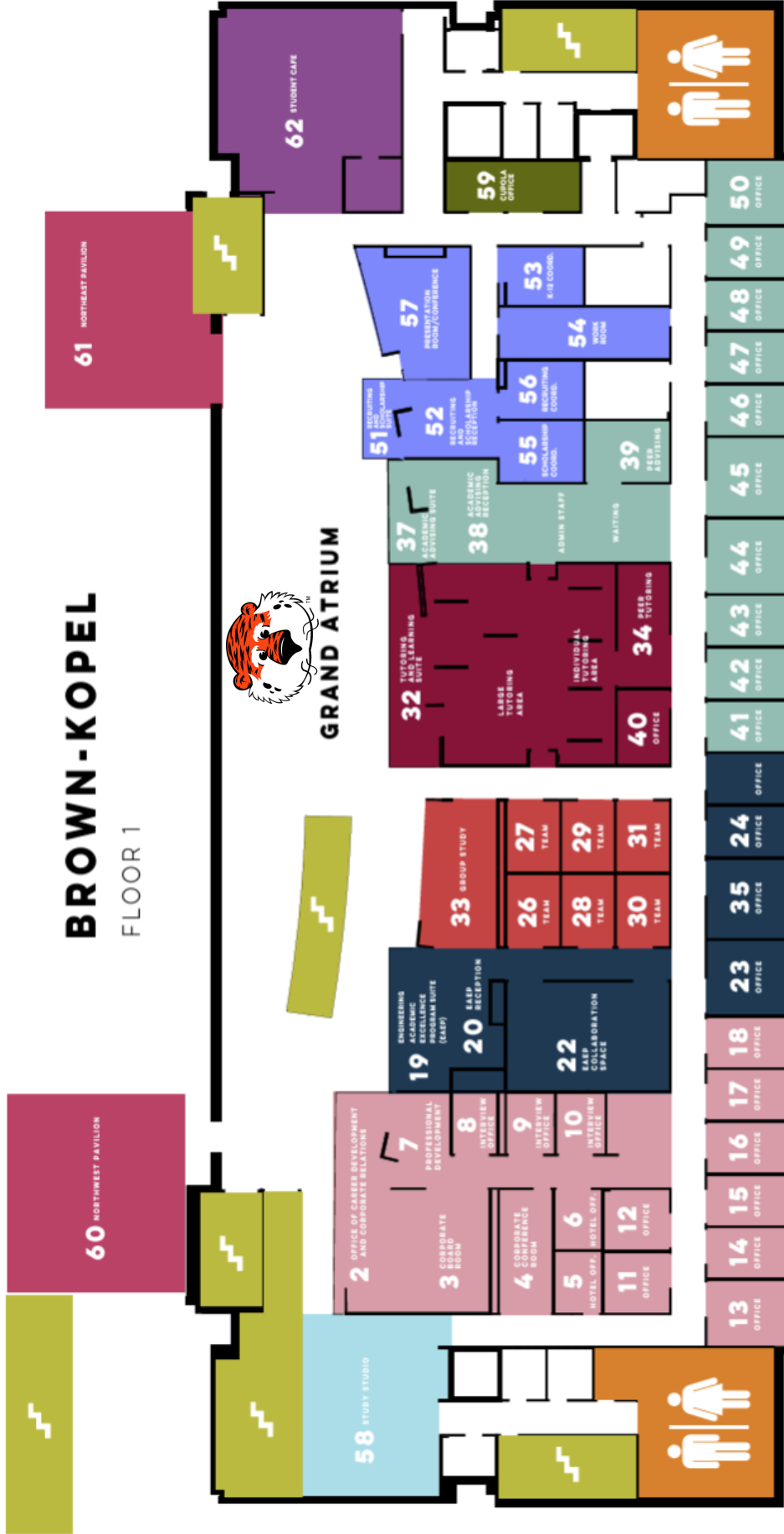


LEGEND: MAKERSPACE TOUR



BROWN-KOPEL

FLOOR 1



GRAND ATRIUM

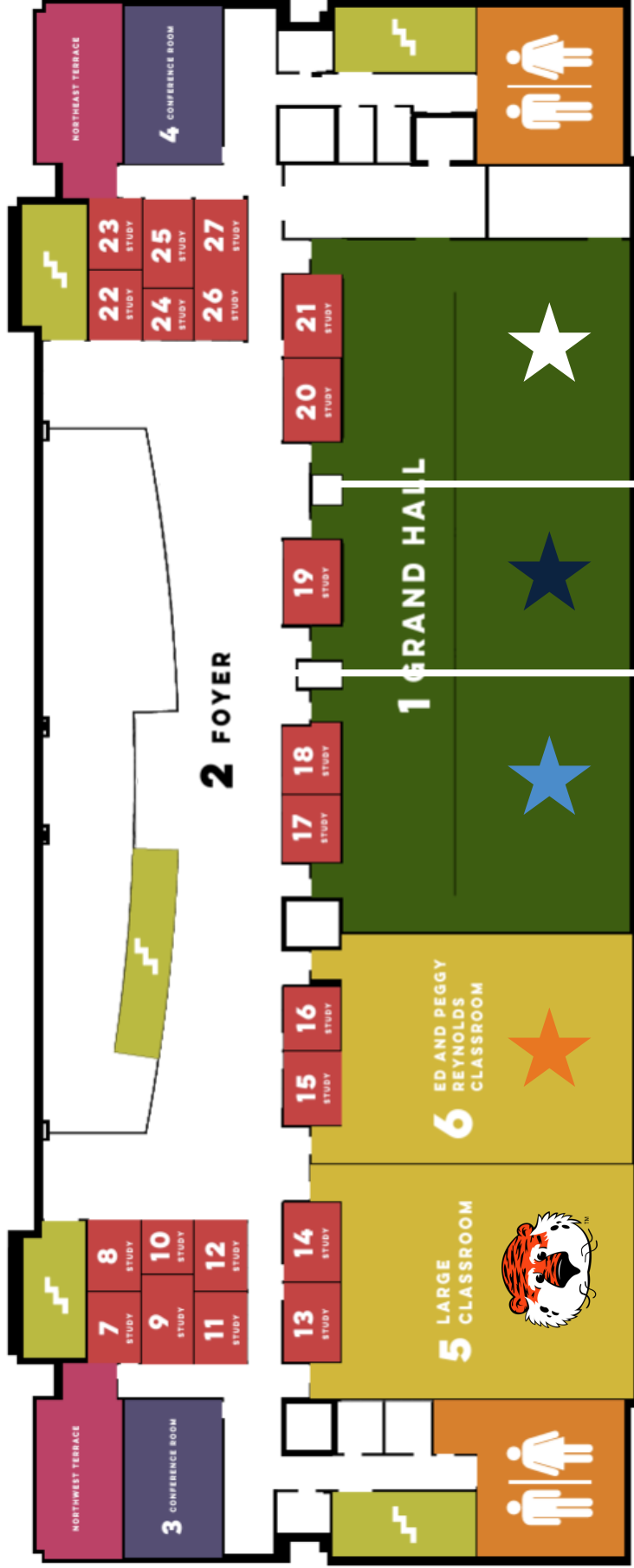
- PAVILION/COURTYARD/TERRACE
- STUDIO
- OFFICE OF CAREER DEVELOPMENT AND CORPORATE RELATIONS
- ENGINEERING ACADEMIC EXCELLENCE PROGRAM
- TUTORING AND LEARNING
- ACADEMIC ADVISING
- RECRUITING AND SCHOLARSHIP
- OFFICES
- FOOD
- STUDY ROOMS
- STAIRS
- BATHROOM



LEGEND:
ATRIUM

BROWN-KOPEL

FLOOR 2



- LEGEND:**
- GRAND HALL 1
 - GRAND HALL 2
 - GRAND HALL 3
 - ROOM 2117
 - ROOM 2133



LEVEL 3

- | | | | | | | | | | | |
|-------------------|---------------------|-----------------|------------------------|-------------------------|------------------------------|----------------------|--------------------------|--------------------------|---------------|----------------|
| | | | | | | | | | | |
| | | | | | | | | | | |
| FOOD VENUE | MEETING ROOM | OFFICE | COMPUTER KIOSKS | ATMs | BALLROOM | GAME ROOM | LOUNGE | PATIO | RETAIL | UTILITY |
| BATHROOM | STAIRS | ELEVATOR | POINTS OF ENTRY | INFORMATION DESK | WHEELCHAIR ACCESSIBLE | PRINTER KIOSK | HYDRATION STATION | LACTATION STATION | AED | AED |



**LEGEND:
BANQUET**

ABSTRACTS FOR POSTER PRESENTATION

TITLE: IONIC LIQUID PHASE BEHAVIOR: ENABLING MORE EFFICIENT SOLAR THERMAL ENERGY PRODUCTION AND STORAGE

Primary Author: Allan Wilson¹

Additional Authors: Marshall D. Manning¹, Dr. James H. Davis², Dr. Brooks D. Rabideau¹, and Dr. Kevin N. West¹

(1) University of South Alabama Department of Chemical & Biomolecular Engineering

(2) University of South Alabama Department of Chemistry

Climate change is one of the most pressing issues facing humanity in the 21st century. A major contributing factor to this problem is the continued use of fossil-fuel based sources for energy. Concentrated solar power (CST) with thermal energy storage (TES) provides a potential opportunity to support this transition away from fossil fuels but suffers from high costs and extended downtimes. Current heat transfer fluids used in these processes often consist of a mixture of alkali metal nitrates with melting points above 200°C. For CST and TES to be viable, a thermally stable, low melting fluid is needed. Ionic liquids (ILs) provide a very feasible form of TES due to their high heat capacities and low melting points. Thermally robust ILs can be synthesized by limiting the structural diversity of the species to thermally stable moieties on the cation and coupling these cations with a thermally stable anion. However, these synthetic restrictions result in salts with melting points at or above 100°C. Mixtures of these salts, with each other or with structurally similar molecular species, can yield fluids with melting temperatures low enough to be effective thermal storage fluids. In this project, the phase equilibrium of a binary mixture of tetraphenyl phosphonium bistriflimide (TPP) and benzanilide was examined to provide valuable information on eutectic behavior for organic ionic liquids with aromatic compounds. The use of digital scanning calorimetry (DSC) (Solid/Liquid Equilibrium, SLE) along with cloud-point analysis (Liquid/Liquid Equilibrium, LLE) was used to study this behavior. The phase transitions, including eutectic behavior, are expressed on a binary T-x diagram and show how the phase behavior varies with temperature and composition. Solid/liquid equilibrium behavior is compared to the ideal solution model to aid in understanding molecular-level interactions in the mixture. The study showed a minimum eutectic melting temperature of below 100 °C and liquid-liquid interactions in compositions having high amounts of TPP compared to benzanilide. Further preliminary studies were done with varying ILs containing the same tetraarylphosphonium-based cations. The findings of this study can be used to develop further ILs and their mixtures as viable thermal energy storage fluids that could dramatically reduce the cost and difficulty of operating CST at scale.

TITLE: IMPROVING EFFICACY OF ZINC OXIDE CATHODE BATTERIES USING SILVER AND CARBON NANO-SHELL COATINGS

Primary Author: Zhirao Chen

Additional Author: Tanishq Moondra

PI: Dr. Nian Liu

Department: Chemical Engineering Department

School: Georgia Institute of Technology

In recent years, the lithium-ion battery (LIB) industry has experienced remarkable growth, with a significant increase in demand. However, the high cost of raw materials in LIBs combined with their flammability, poses challenges. An alternative solution lies in zinc-ion batteries, which are made of more abundant materials, an aqueous solvent, and have high theoretical capacity. However, there are drawbacks, particularly concerning the dissolution of the zinc ion during charge and discharge, along with the accumulation of Zn(OH)₂, a byproduct oxidation of zinc, which impedes electron flow to the active ZnO in the cathode. We are working to mitigate these drawbacks and make zinc-ion batteries more feasible.

In our research, we focus on a nickel anode and a zinc oxide cathode coated with a layer of silver and a layer of carbon nano-shells. Zinc ions tend to deposit on silver, so the silver coating prevents their loss during discharge. Meanwhile, the carbon nano-shell coating has very small pore sizes, which further prevents the dissolution of zinc ions and the buildup of Zn(OH)₂ above the active zinc oxide. Experimental trials involving multiple charge-discharge cycles of coin cells with the nickel anode and zinc oxide cathode revealed that cathodes coated first with silver and then with carbon nano-shells exhibited a prolonged lifespan, lasting more charge-discharge cycles before becoming unusable.

TITLE: ASSEMBLY AND CHARACTERIZATION OF VIRUS-LIKE PARTICLE BASED FLU VACCINES

Primary Author: Alexandra Seese

Additional Authors: Kathryn Loeffler, Daniel Kim, Ravi Kane, Ph.D.

The infectivity of influenza A viruses is caused by the hemagglutinin glycoprotein spikes on their viral envelopes; hemagglutinin consists of a head domain and a stalk domain. Existing influenza vaccinations elicit a narrow, strain-specific antibody response towards the immunodominant hemagglutinin head domain, which is mutationally tolerant. In our research, we demonstrated the assembly of a flu vaccine using virus-like particle (VLP) technology. The platform studied was an engineered capsid (MS2) displaying hemagglutinin on its surface by biotin-streptavidin affinity interactions. The use of multiple hemagglutinin proteins on each VLP construct also made them polyvalent, potentially amplifying immune response. A set of constructs was assembled with the hemagglutinin proteins attached to the capsid by the stalk domain with the head domain pointing outwards, similarly to the flu virus itself. Another group of constructs was assembled with hemagglutinin in an inverted orientation to elicit a broad immune response towards the hemagglutinin stalk domain, which is highly conserved among influenza A strains. Both types of constructs were characterized by size exclusion chromatography, SOS-PAGE gel electrophoresis, and dynamic light scattering. The results supported the successful assembly of regularly oriented and inverted hemagglutinin VLP constructs, although further testing is needed to understand the breadth of protection provided by these vaccines in vivo.

TITLE: DENDRITIC ORGANIC RADICAL POLYMERS AS CATHODES FOR LITHIUM-ION BATTERIES

Primary Author: Cade Tharrington

School: North Carolina State University

With the increase in electrification to support the growth of renewable energy generation and mitigate the effects of climate change, the mining and processing of transition metals for commercial lithium-ion battery use have prompted a re-evaluation of the battery technology on both a cost and sustainability basis. Recently, organic radical polymers have received interest as an alternative cathode active material for lithium-ion batteries. In particular, poly (2,2,6,6-tetramethyl-1-piperidinyloxy-4-yl methacrylate) (PTMA) has garnered attention for its use of organic reactants, ease of synthesis, high-energy density, and faster charge-discharge kinetics compared to transition metal-based lithium-ion batteries. However, before implementation as an active cathode material, PTMA electrodes require significant conductive additives because of the electronically insulating polymeric backbone of PTMA, which lowers gravimetric charge and discharge capacity. The polymeric active material is also slightly soluble in organic electrolytes used in lithium-ion batteries, which can limit rate capability. While micro-scale polymer engineering can minimize the issues of limit rate capability and cycling stability in PTMA cathodes, the use of macro-scale processing methods to improve electrochemical function remains largely underexplored. This research aims to use macro-scale soft dendritic colloid (SDC) processing techniques to introduce novel particle morphology to rectify the solubility and electronic conductivity limitations of PTMA electrodes. SDCs are formed by precipitating PTMA into a highly turbulent flow of non-solvent, resulting in morphology containing fractal branching and nanofibrillar contact splitting. SDCs result in strong interparticle adhesion that may allow for larger contact with conductive additives and decreased solubility. Through the incorporation of novel dendritic morphology into the electrode fabrication process to produce free-standing PTMA SDC electrode films, rate capability and cycling stability improvements are expected when compared to benchmark slurry cast PTMA electrodes without unique morphologies. This hypothesis will be tested through electrochemical analysis via cyclic voltammetry and galvanostatic charge and discharge experiments of PTMA SDC.

TITLE: EVALUATING THE MECHANICAL PROPERTIES OF 3D PRINTED ORAL THIN FILMS USING A TEXTURE ANALYZER

Primary Author: Asmaa Alawbali, Senior, Chemical Engineering

Additional Authors: Farzana Rony, PhD Candidate, Applied Chemistry; Brian Rogers, MS, Bioengineering

Research Mentor: Dr. Mohammad A Azad, Chemical, Biological, and Bioengineering (CBBE)*

*Correspondence: maazad@ncat.edu

Research in 3D-printed oral thin films become more prevalent in the pharmaceutical field due to ease of development, personalization, and swallow improvement, especially for geriatric and pediatric patients. The film's mechanical properties are crucial in assessing the strength and quality of the film. The mechanical properties of a film help ensure that the film is suitable for handling, transportation, storage, and oral delivery. This research aims to evaluate the mechanical properties of 3D-printed thin films using the Texture Analyzer (model TA XT plus C, Stable Microsystems, UK). For thin-film evaluation of mechanical properties testing such as tensile strength (TS), elongation at break (E), and Young's modulus (YM) are critically important. This testing is an essential quality control parameter for film manufacturing. Sodium alginate-based and Hydroxypropyl methylcellulose (HPMC, K100M)-based 3D printed films were used to conduct the mechanical test using miniature grips. The film dimensions were 15 x10 x 0.35 mm. The test was conducted at a pre-speed of 0.5 mm/s, test speed of 1 mm/s, and post-speed of 10 mm/s. The TS (MPa), E (%), and YM (MPa) were computed, analyzed, and compared with literature studies. The results of the testing exhibited proper mechanical properties and identified the film's suitability to use.

TITLE: INDUCED DIODIC FLUID BEHAVIOR VIA APPLICATION OF A HYDROPHOBIC COATING ONTO A HYDROPHILIC SUBSTRATE

Primary Author: John Thornhill

Paper drying is one of the largest industrial uses of energy resulting in significant efforts to improve efficiency. One energy saving method currently used in industry is applying pressure to the wet paper via rollers covered in a hydrophilic felt, but this results in rewetting, the flow of water back into the paper once the pressure is relieved. A proposed solution is to engineer the felts to promote diodic fluid behavior in the felts, allowing the water to pass through easily in one direction under pressure, but not the other way. We hypothesize that applying a thin layer of hydrophobic polymers to the felt will create the desired effect. Preliminary studies suggested that when the hydrophobic side of the substrate is exposed to water, a larger pressure can be sustained before water starts flowing compared to when the hydrophilic side is exposed. We investigated the application of high-impact polystyrene (HIPS), Styrene-butadiene-styrene (SBS), and high-density polyethylene (HDPE) of varying concentrations to blotter paper using a doctor blade to apply an even coating of each polymer. Comparing the difference between the breakthrough pressures when the polymer coated side is oriented on the bottom verses on the top will allow up to determine which polymer exhibits the best diodic fluid behavior. After the best fit polymer has been determined, the polymer application process options will be characterized and compared to determine the best fit application process. With the chosen polymer, polymer thickness, and application process, the next phase of the project will involve coating a felt used in industry and running pilot scale tests to determine the amount of water saved from the polymer coating.

TITLE: AFM AND COLON CANCER TESTING

Primary Author: Isabella Perez

Cancer is typically tested via biopsy methods, and the current procedure for identifying cancerous cells through a colonoscopy is to utilize a claw-like attachment to obtain the biopsies. However, this method is unable to test for any cancerous cells that may be concealed behind healthy cells. The method being researched, inspired by Atomic Force Microscopy, is aimed at creating a small attachment with an inflatable gel membrane that allows measurement of the stiffness of cells via variations in pressure. This attachment will then be applied to colonoscopes so that the process of using this device to test for colon cancer can be achieved with a less invasive method. As cancer cells are known to have greater stiffness than healthy cells, this method would allow for in situ testing due to the difference in stiffness between different sections of tissue within the same individual. The new attachment will utilize the repeated inflation of a thin gel membrane through the injection of water or another fluid with known properties and will measure the difference in pressure caused by both the injection and the limiting of volume expansion by placing the attachment on the surface of the tissues being tested. This will then be used to calculate the difference in stiffness between sections of tissue, allowing the user to conduct a preliminary test for cancerous cells. This method is intended to be sensitive enough to test for concealed cancerous cells that may be found behind healthy tissue. This method should result in a less invasive method of conducting preliminary cancer testing and an improvement to the rate of early indication for colon cancer.

TITLE: EFFECTS OF SELENIUM DOPING ON BAZRS3 NANOPARTICLES

Primary Author: Paul Gramelspacher

As the world shifts towards renewable energy, photovoltaics are helping countries meet their energy needs. Perovskites are a class of materials that serve as potential candidates to create efficient photovoltaic devices. One such perovskite is BaZrS₃, which has a direct band gap of 1.75-1.85 eV. Literature calculations show that the band gap of BaZrS₃ can be lowered near the optimum bandgap (defined by the Shockley–Queisser model for single-junction solar cells) of 1.34 eV through selenium doping. In this project we aim to create BaZrS_xSe_{3-x} nanocrystals using trioctylphosphine selenide and selenourea precursors in a heat up reaction with oleylamine and previously established barium, zirconium, and sulfur precursors. PXRD results show a difference between BaZrS_xSe_{3-x} crystallinity and morphology compared to plain nanocrystals. Collected EDX measurements suggest that the N,N-diethyl,N'-cyclohexyl-selenourea precursors provide more stoichiometric and pure nanocrystals than trioctylphosphine selenide. With this knowledge the effects of the selenium doping on the structure and stoichiometry of the nanocrystals can be further explored.

TITLE: CAKE LAYER FORMATION ON ULTRAFILTRATION MEMBRANES WITH THE GOAL OF PURIFYING VIRAL VECTORS.

Primary Author: Elliot Horn

Additional Authors: Mara Leach, Dibakar Bhattacharyya

School: University of Kentucky

Department: Department Of Chemical and Materials Engineering

Viral vectors are a revolution in modern medicine that is used for gene therapy. This can treat many different diseases, but the current cost of viral vectors is astronomically high. Most of this cost can be attributed to the time consuming and costly separation of viral vectors from the solution they are produced in (lysate). Polymeric membranes are one way that viral vectors can be separated from their lysate. However, the lysate solution quickly fouls the membrane which decreases flux halting the separation. One method of flux decline in membranes is due to a cake layer forming on the membrane. To investigate the role of flux, decline due to cake layer formation, silica nanoparticles were filtered with an ultrafiltration membrane. The nanoparticles were much bigger than membrane pores ensuring that a cake layer would form on the membrane. The cake layer resulted in no significant flux decline suggesting that the packing of the nanoparticles formed channels of similar size to the membrane pores. These observations show that intentionally forming cake layers could aid in the separation of viral vectors.

TITLE: A NOVEL METHODOLOGY FOR THE FORMATION OF DIAZIRINE FUNCTIONALITY

Primary Author: Abby Mock

Additional Authors: Caleb Lopansri and Dr. David Forbes

School: University of South Alabama

Department: Department of Chemical and Biomolecular Engineering and Department of Chemistry

Our research focuses on a cost-effective approach which minimizes synthetic overhead when assembling compounds with diazirine functionality. This specific functionality is a three-membered ring involving two nitrogen atoms and one carbon atom. The goals are to prevent the surplus use of ammonia in the formation of the diaziridines. One way to reduce the use of ammonia is the implementation of an IKA Electrosyn 2.0 in the oxidation of diaziridine. Success with either specific aim will significantly reduce the synthetic overhead currently observed. Diazirine functionality plays a vital role in a vast number of applications. Two of interest to us include diazirine functionality as a next generation propellant and as a photoaffinity label. With the latter, this strategy plays a vital role in drug discovery and biomedical research as it allows researchers to study, understand, manipulate, and control complex biological systems. Moreover, previous research has shown that diazirine functionality has the potential to be used as propellants, so this project also aims to explore the energetic properties of this functionality and develop a deeper understanding of their physical properties. Preliminary data has shown limitations with scope and low to moderate levels of conversion. Our current approach explores three synthetic strategies that produces diazirine functionality from its precursor, diaziridine functionality.

TITLE: MELTING POINT PREDICTIONS OF THERMALLY STABLE IONIC LIQUIDS USING A MACHINE LEARNING APPROACH.

Primary Author: Jarod Morris

Additional Authors: Brooks D. Rabideau, Kevin West, James Davis

Thermally robust ionic liquids hold promise as high temperature solvents, heat transfer fluids, and high-performance lubricants. These ionic liquids, inspired by thermoplastics like PEEK and PES, incorporate peraryl functional groups that lend them high thermal stability, however they often have melting points greater than 100 °C. A broad liquid range is usually desirable in most applications, so finding thermally robust ILs with lower melting points would significantly enhance their applicability. In this study, machine learning models are developed to make predictions of melting points for these thermally stable ionic liquids using a process called quantitative structure-property relationships (QSPR). The methodology used to model these ionic liquids was adapted from a previous study [Paduszyński et al., Journal of Molecular Liquids, 344, 2021] that examined multiple different machine learning techniques in depth. Modeling was performed on the large and diverse set of 929 ionic liquids from this study, then on a set of 53 thermally stable ionic liquids, then on the combined data set. The performance of each model was evaluated using 10-fold cross validation and the calculation of Q^2 , which measures the predictive capacity of the model. This cross validation only considered the predictions of thermally stable ionic liquids since that is the overall intent of the modelling. From this cross validation, it was found that the model trained on both sets of data and had no outliers removed showed the greatest predictive capability (with a Q^2 of .6764) for thermally stable ionic liquids. This model is then used to predict ionic liquids from the thermally stable family with low melting points.

TITLE: UNDERSTANDING CALCITE PRECIPITATION KINETICS AND DLP PRINT PARAMETER OPTIMIZATION FOR REACTIVE POROUS MEDIA FABRICATION

Primary Author: Madelyn Torrance

Additional Authors: Harrish Kumar Senthil Kumar, Lauren E. Beckingham, Bryan S. Beckingham

School: Auburn University

Department: Department of Chemical Engineering

Carbon dioxide is one of the most abundant greenhouse gases that pollute our atmosphere today. Scientists are pursuing many solutions to reduce carbon emissions, one being underground carbon dioxide storage. However, it becomes important to understand geochemical reactions that take place during CO₂ sequestration, i.e. determining if this solution is feasible. The research objectives of this study are to understand the impact of calcite growth on functionalized 2D surfaces with an increase in saturation index and fabricate 3D replicas of porous medium. It was determined through previous research that functionalizing thin, high impact polystyrene (HIPS) films using sulfuric acid attributes a lower contact angle on the surface of the functionalized films compared to non-functionalized HIPS films. The higher surface energy of the functionalized films increases the precipitation rate of calcite on the functionalized 2D films. The aim of this work consists of investigating the role of saturation index of the feed solution on precipitation of calcite. To demonstrate that the precipitate from these experiments is calcite, the 2D films will be characterized using XRD analysis and compared to known XRD spectra of calcite. Additionally, this research will optimize the printing parameters of digital light projection 3D printing including layer thickness, bottom layer exposure, normal layer exposure, and offset time towards 3D printing of representative porous sandstone models for future investigations of calcite precipitation in 3D porous structures.

TITLE: EFFECTS OF SODIUM CHLORIDE ON OAK BIOMASS PRETREATMENT USING A LACTIC ACID-METHYL ISOBUTYL KETONE COSOLVENT

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Additional Authors: Seong-Min Cho², Sunkyu Park²

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Despite their negative environmental impact, the demand for petroleum-based energy and other chemicals is ever-increasing, which necessitates a search for other sources of these materials. Lignocellulosic biomass displays high potential as a green alternative to fossil fuels due to its natural abundance, renewability, and capacity for conversion to an array of value-added products. One of the primary hurdles in biomass utilization is the effective separation of lignin from cellulose. Lignin has a recalcitrant nature, limiting the ability of cellulose to be efficiently converted to fuel through enzymatic and microbial methods. For this reason, chemical pretreatment becomes necessary to cleave the interunit linkages of lignin and disrupt the recalcitrant structures to make the cellulosic sugars available for future processing steps. Organic cosolvents are one promising approach that improves delignification efficiency by extracting the fragmented lignin and preventing their condensation within the reaction process. Another viable approach is a deep eutectic solvent (DES) system, such as a mixture of lactic acid and choline chloride, where the presence of chloride ions significantly improves the effects of lactic acid on lignin fragmentation. Combining these two systems, we developed and explored a lactic acid-methyl isobutyl ketone cosolvent system for oak biomass pretreatment. To improve delignification efficiency, we introduced chloride ions through sodium chloride, which significantly affected the quality of the reaction. Through this developed process, enzymatically digestible cellulose-rich pulp can be prepared for future processing steps.

TITLE: MRNA-LOADED LIPID NANOPARTICLE DESIGN FOR MICRONEEDLE PATCH DELIVERY

Primary Author: Gianna Fiduccia¹

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mRNA is a powerful technology developed for a diverse set of uses, such as vaccination, cancer treatment, and protein therapeutics.¹ The development of lipid nanoparticles (LNPs) has aided in the delivery of mRNA into cells, but intramuscular injection of liquid LNP formulations poses a challenge, as they are not stable at low temperatures and require extensive resources for distribution and administration.² Microneedle patches (MNP) are arrays of micron-scale needles made from dissolvable polymers used to delivery therapeutics transdermally, and they offer a viable solution.³ MNPs are less painful, are easier to transport, store, and administer, and may increase thermostability compared to intramuscular injection.³ However, research pertaining to drying LNP formulations for MNP use is limited, and initial tests determined that LNPs are destabilized during MNP manufacturing. Optimizing LNP design may improve the stability and functionality of LNPs for mRNA delivery in an MNP.

Nanoluciferase encoding mRNA was formulated into LNPs using microfluidic mixing. LNP composition included ionizable lipid SM-102, cholesterol, DMG-PEG2000, and distearoylphosphatidylcholine at various molar ratios, with 50:38.5:1.5:10 used as a positive control to mimic Moderna's SpikeVax COVID vaccine LNP formulation. LNPs were then mixed into a solution of 6.25% polyvinyl alcohol and 10% sucrose, dried under a vacuum in PDMS molds, and backed with epoxy to make MNPs. The dried MNPs were reconstituted in Phosphate Buffered Saline and evaluated for size using dynamic light scattering, encapsulation efficiency (EE) using Ribogreen assay, and in-vitro cellular expression in a RAW 264.7 cell line.

A variety of lipid molar ratios were screened to determine their effect on LNP stability during the MNP fabrication process. Increasing SM-102 and DMG-PEG2000 content both had an independent stabilizing effect on MNPs, indicated by small LNP size, high EE, and high cellular expression post-drying. Increasing distearoylphosphatidylcholine content had a destabilizing effect. The mass ratio of lipid: mRNA was also modified to improve the function and biophysical characterization of dried LNPs ranging from 20:1 to 100:1. Increasing mass ratios to 50:1 and 75:1 generated high cellular expression in particles but had minimal effect on EE and size. Large mass ratios decrease the loading capacity of mRNA in MNPs, which is undesirable in a low-dose MNP.

Modifications to LNP molar and mass ratios suggest an improvement in MNP drying stability. Additional formulation optimization can improve the function of LNPs post-drying. Future directions of this work include modifying phospholipid and ionizable lipid identities, and further increasing PEG-lipid content past 2.5%.

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TITLE: ENHANCING CONTRACTILE FUNCTION OF ENGINEERED CARDIAC TISSUES THROUGH ENRICHED FATTY ACID MEDIA CULTIVATION

Primary Author: Alison Brown

Additional Authors: Mohammadjafar Hashemi, Rajesh Amin, Elizabeth Lipke

Cardiovascular disease, a global leading cause of death, demands advanced contractile tissue models for accurate disease modeling, drug studies, and pre-clinical tests. A specific focus is on diabetic cardiomyopathy (DCM), a condition causing structural and functional abnormalities in diabetic hearts. Human-induced pluripotent stem cell derived cardiomyocytes (hiPSC-CMs) present great potential for disease modeling. Previous studies on two-dimensional (2D) substrates showed immaturity issues in hiPSC-CMs. Three-dimensional (3D) tissues offer more accurate models by recapitulating native tissue complexity.

Our prior work demonstrated hiPSCs in PEG-fibrinogen (PF) hydrogels achieve cardiac differentiation and some maturation aspects. Here, we created engineered cardiac tissues (ECTs) by encapsulating hiPSCs in rectangular PF hydrogels followed by in situ cardiac differentiating. We cultured them in fully defined fatty acid-enriched metabolic maturation (MM) media, promoting the use of fatty acid oxidation as the primary energy source. To study the impact of MM media on the contractile functionality and structural maturation of hiPSC-CMs, we compared them to age-matched RPMI/B27 with insulin (RP)-cultured samples (regular media for culturing ECTs). ECTs in MM exhibited higher contraction frequency (1.4-fold), contraction and relaxation velocities (2.9 and 3.2-fold), and directionality (1.95-fold), along with significantly greater maximal fractional shortening (7.3-fold) on day 16 compared to RP (n3 individual batches with at least two tissues per batch). These data collectively suggest a significant improvement in contractile functionality in the ECTs cultured in MM. In conclusion, our study indicated that one week of ECT culture in enriched fatty acid media promoted the contractile functionality of hiPSC-CMs in ECTs. This strategy provides more appropriate mature model for studying cardiac disease, especially for metabolic diseases like DCM.

TITLE: SUSTAINABLE NANOPARTICLE SYNTHESIS USING NANOEMULSION

Primary Author: Anastasia Shaverina

Additional Authors: Emily Ingram, Dr. Malgorzata Chwatko

School: University of Kentucky

Department: Department of Chemical and Materials Engineering

In recent years, nanoparticles have gained increased attention as a method for drug delivery. The use of nanoparticles provides the capability to customize drug release time in the body, achieve greater precision in targeting specific tissues, and reduce overall toxicity. However, many current particle synthesis methods commonly use toxic, petroleum-derived organic solvents, which are harmful to the environment and human health. As such, the main objective of this study is to develop a more sustainable and non-toxic method for nanoparticle synthesis with a controlled size range, making the particles suitable for a wide range of drug delivery applications. To increase the sustainability of the emulsion-based methodology, we investigated the use of plant-derived fatty acids, mainly myristic and oleic acid as the oil phase. We further assessed the ability to recycle the reagents and synthesize varying polymeric nanoparticles such as poly(ethylene oxide) and gelatin. Dynamic light scattering (DLS) and scanning electron microscopy (SEM) were used to assess particle size. We found that poly(ethylene glycol) particle size was approximately 153.53 ± 68.49 nm and remained constant when the recycled oil layer was used in the process. Our study demonstrates remarkable waste and energy efficiency in producing nanoparticles compared to traditional synthesis methods.

TITLE: SCALABLE PRODUCTION OF MICROFLUIDIC DEVICES FOR HYDROGEL MICROSPHERE PRODUCTION

Primary Author: Benjamin Gunasekaran¹

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(1) Department of Chemical Engineering, Auburn University, Auburn, AL, 36849

Hydrogel microspheres provide microenvironments for the growth of encapsulated cells into 3D tissues. Rapid and uniform production of these cell-laden microspheres is necessary for their application in drug testing and the development of implantable biomaterials. A microfluidic device is used to achieve this scalable production through the formation of cell-laden droplets of poly(ethylene glycol)-fibrinogen precursor solution, which is subsequently photo-crosslinked into hydrogel microspheres. This research focuses on developing a technique for the efficient manufacture of the microfluidic device. The current fabrication method involves manually hand-molding and curing poly(dimethyl siloxane) (PDMS); however, this process is difficult to replicate without human error. Consequently, discrepancies between hand molded PDMS microfluidic devices result in the production of hydrogels of varying quality and adversely impact downstream experiments. Alternatively, resin-printing microfluidic devices can produce microfluidic devices of uniform quality. Using this technique, two components are separately designed and printed. One component is printed with channel grooves and inlets, while the counterpart is flat. These two components are attached together using screws to form a microfluidic device with sealed channels. The resin-printed microfluidic devices have uniform dimensions and produce uniform hydrogels for downstream experiments and applications. In the future, the components will be produced via injection molding for quicker manufacture.

ABSTRACTS FOR TECHNICAL PRESENTATION

TITLE: CONTROLLING METAL NANOPARTICLE SIZE ON CARBON SUPPORTS WITH SURFACE TENSION

Primary Author: Nathan Thornburg¹

Additional Authors: Mikayla Romero², Alaba Ojo¹, Hein Pham², John R. Regalbuto¹, Abhaya Datye²

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College/School: (1) University of South Carolina Columbia, (2) University of New Mexico Albuquerque

Abstract:

Decreasing metal particle size significantly increases catalytic efficiency which is crucial to many chemical processes. This work aims to push the limits of Strong Electrostatic Adsorption (SEA) to better understand the mechanism of nanoparticle agglomeration. SEA produces catalysts with ultrasmall nanoparticles ranging from 1-2 nm but rarely smaller. We hypothesize that the agglomeration of water nanodroplets that arise during the drying step of catalyst syntheses play a major role in determining the size of deposited metal particles. By chemically modifying the hydrophilicity of the support, the agglomeration of precursor ions can be mitigated through the decreased contact angle between the bulk aqueous solvent and the support. To better understand this phenomenon, Ketien Black 300J, a high surface area carbon support, was exposed to varied concentrations of nitric acid to increase the concentration of surface oxygen groups. This increases the hydrophilicity of the support surface reducing the support-solvent contact angle. Platinum (II) tetraamine nitrate was used as the platinum source for the syntheses involving oxidized (low PZC) supports while chloroplatinic acid was used for the unoxidized (high PZC) support. The resulting catalysts were characterized using powder X-ray diffraction and scanning transmission electron microscopy (STEM). From current studies, there is a scientifically significant effect on nanoparticle size reduction from increased support hydrophilicity; however, further studies of additional carbon supports, and transition metals are being conducted to gain a more in-depth understanding of this powerful technique.

TITLE: A RADICAL LIBRARY: CATALOGING RADIATION YIELD OF ACRYLATES UNDERGOING ELECTRON-BEAM POLYMERIZATION

Primary Author: Katelyn Woodard

Electron-beam (EB) polymerization provides a fast, environmentally friendly method to create thin films and coatings for commercial applications. Expanding EB technology to new applications requires a better understanding of how starting materials (i.e., monomers) form free radicals under the EB. Free radical formation dictates the ability for the monomer to polymerize and the properties that final polymer exhibits. One measure of this attribute is the primary radical chemical radiation yield, $G(R\bullet)$, defined as the number of primary radicals formed per 100 electron volts (eV) delivered. The monomers chosen in this study belong to the acrylate family, as this family is industrially prevalent and also exhibits a range of properties, such as number and type of labile bonds, that can be used to understand the influence of these properties on free-radical formation. The concentration of primary radicals was determined based on the absorbance of DPPH, a free-radical inhibitor, at 520 nm after EB irradiation of an acrylate monomer at a given dose (eV) and line speed (ft/s). By plotting changes in DPPH concentration over different EB exposure times through UV-Vis spectroscopic analysis, the rate of primary radical formation was calculated and used to estimate the $G(R\bullet)$ for each monomer in the study. By developing this monomer library, we can relate $G(R\bullet)$ to chemical structure and ultimately polymer properties, providing guiding principles for materials synthesis, selection, and processing, rather than trial and error, as is the current industrial practice. This monomer library can be reliably expanded using the methods developed in this study to further the potential uses for EB polymerization in the industrial field and academia.

TITLE: GAS TRANSPORT PHENOMENA IN PDMS/MATRIMID THIN FILM COMPOSITE MEMBRANE

Primary Author: Xiang 'Jimmy' Li

Additional Authors: Hammed A. Balogun, Ryan P. Lively

College/School: School of Chemical & Biomolecular Engineering, Georgia Institute of Technology

Membrane-based separation plays a vital role in various industrial sectors, facilitating the effective partitioning of mixture components at low energy and capital costs. The efficacy of this separation is largely determined by the membrane materials and their interactions with the mixture components. Polydimethylsiloxane (PDMS) membrane, a silicon-based organic polymer, is notable for its gas separation capabilities due to its high permeability and appreciable gas selectivity. Beyond its gas separation attributes, PDMS offers additional advantages including thermal stability, mechanical flexibility, and potential for hybridization with other materials, making it a versatile choice for numerous separation applications. In practical scenarios, PDMS membranes are often designed as thin-film composites (TFCs). This configuration comprises a thin PDMS selective layer cast on a porous support, which ensures membrane integrity under high feed pressures while maintaining a desirable flux. Most transport models in reverse osmosis, for membranes designed as TFCs, assume negligible resistance within the support. This study helps validate such assumptions by evaluating the pore sizes of Matrimid supports and their contributions to gas flux. PDMS was spin-coated on Matrimid supports, followed by gas permeation experiments to measure the gas permeances of N₂, He, and CO₂ through the membranes. The acquired data were utilized in a permeation resistance model, developed to evaluate the surface porosity and pore sizes of both the PDMS layer and the Matrimid support. Understanding such transport resistance within the support aids in designing support materials with optimal pore sizes for defect-free, high-flux membranes. This insight is pivotal for optimizing PDMS membranes for enhanced separation efficiency and providing a foundation for further explorations into innovative membrane designs, particularly in CO₂ capture applications.

Keywords: PDMS Membranes, CO₂ Separation, Thin Film Composite, Membrane Porosity

TITLE: THE DYNAMICS OF CHEMICAL AND PHYSICAL CROSSLINKING OF CHEMICALLY MODIFIED SILK FIBROIN HYDROGELS FOR 3D PRINTING

Primary Author: Hannah K Bagnis¹

Additional Authors: Elizabeth L Aikman¹, Marisa O Pacheco¹, Whitney L Stoppel¹

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Silk fibroin (SF) derived from *Bombyx mori* silk is a useful material in the biomedical field. Its biocompatible and tunable characteristics allow for applications in drug delivery, tissue engineering, and regenerative medicine (1). SF on its own is inert, therefore in order to enable photo reactivity for application in DLP bioprinting the polymer must be chemically modified. We explore the addition of photocrosslinkable active sites including methacrylate groups (Me-SF) and norbornene groups (Nor-SF) allowing for interactions with Lithium phenyl-2,4,6-trimethylbenzoylphosphinate (LAP), a photoinitiator. Using ultraviolet (UV) light (405 nm), Me-SF and Nor-SF can be crosslinked to form a hydrogel (2). SF hydrogels created via chemical crosslinking can be tuned to increase their load bearing capacity to mimic the mechanical properties of tendons or ligaments (3). However, a significant challenge lies in maintaining these properties for extended periods, as silk hydrogels tend to lose elasticity due to the formation of beta sheet crystals (4). This physical crosslinking is irreversible as the hydrogel has reached its thermal equilibrium. Therefore, to mitigate the formation of these physical crosslinks, which are formed by hydrogen bonding leading to beta sheet formation and a more crystalline polymer network. We investigate variables that contribute to the chemical crosslinking of SF hydrogels to hopefully interfere with beta sheet formation. Namely, we hypothesize that decreasing SF molecular weight and increasing chemical crosslinking density will slow crystalline growth. Beta sheet formation is characterized by FTIR spectra and optical transparency, while mechanical properties are assessed with shear rheology, thermal gravimetric analysis, and differential scanning calorimetry. Thus, these results explore the factors of chemical crosslinking that play a role in reducing or increasing physical crosslinking in SF hydrogels. Finding will enable future silk hydrogel based disease models and stable 3D printed structures.

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TITLE: PARAMETERS INFLUENCING THE MECHANICAL PROPERTIES AND SOLUBILIZATION OF PLODIA INTERPUNCTELLA SILK FIBROIN FOR BIOMATERIAL APPLICATIONS

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Silk, a natural biopolymer produced by silkworms, is commonly utilized in biomedical applications due to its advantageous assets – specifically, its robust mechanical properties, biocompatibility, and biodegradability. Silk is primarily composed of two classes of proteins, fibroins and sericins. However, silk fibroin (SF) is primarily used in biomedical applications because sericins can cause immune responses when biomaterials are implanted. The field of silk fibroin-based biomaterials is heavily influenced by studies of the *Bombyx mori* (Bm) silkworm as it predominates due to its regularity in the textile industry. However, due to the minimal environmental control on Bm rearing, we study an alternative silkworm, *Plodia interpunctella* (Pi), which can be safely and reliably reared in a laboratory setting. This work focuses on evaluating methods to extract SF from Pi silk, both through degumming of the solid silk fiber and through the generation of silk solution that can then be purified downstream. It is expected that degummed silk fibers will exhibit different structural and mechanical properties than non-degummed silk due to the absence of sericins, which can also impact the solubility of the SF. Ongoing work has established a protocol to solubilize Pi silk through dissolution in ionic salts, filtration, and dialysis, simultaneously paralleling and contrasting methods in that of Bm processing. Optimization of this process by modifying parameters of salt type, concentration, and dissolution temperature is essential to addressing existing challenges of silk protein stability in solution and generating SF solution that can be made into a variety of material formats. In this work, we compare structural and mechanical properties of non-degummed and degummed Pi silk fibers and evaluate parameters that aid in generating SF solution and silk-based biomaterials, demonstrating the growing potential of Pi silk biomaterials in the medical industry.

TITLE: LONG TERM DELIVERY OF CONTRACEPTIVE IN VIVO WITH GAMMA STERILIZED MICRONEEDLE PATCH

Primary Author: Nicolas Kelhofer¹

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Currently available contraceptive methods are not able to meet the needs of all users, leading to high rates of unintended pregnancy each year. Our team has been developing a novel contraceptive technology that utilizes microneedle (MN) patches¹ aimed at providing effective, long-term contraception, enhancing patient accessibility and adherence through self-administration, and ensuring cost-effectiveness for global usage. The aim of this study is to investigate the effects of gamma sterilization and storage on contraceptive release rate and demonstrate long term contraceptive release in vivo.

We evaluated the effects of gamma sterilization and storage conditions on the chemical stability and rate of drug release from poly(lactide-co-glycolide) (PLGA) MN patches loaded with levonorgestrel (LNG). MN patches were subjected to 0, 15, or 25 kiloGray (kGy) gamma irradiation followed by a stability hold at either 5°C, 25°C and 40°C. Gel permeation chromatography (GPC) was used to monitor changes in molecular weight of PLGA. LNG stability was monitored by high-performance liquid chromatography (HPLC). Drug release from microneedles was measured using an in vitro model. We determined that gamma irradiation up to 25 kGy did not lead to chemical instability of the drug or reduced capacity for long term drug delivery.

We then evaluated in vivo the pharmacokinetic profile of LNG-loaded PLGA MN patches sterilized with 25 kGy gamma irradiation. MNs were delivered to the animal model via subcutaneous implant and plasma LNG concentration was quantified using liquid chromatography-mass spectrometry (LC-MS). Following an initial burst release on day 1, the same LNG plasma levels were seen for every time point. This study is ongoing and later timepoints are currently undergoing analysis. Contraceptive drug loaded microneedles were well tolerated by the rat and no side effects have been observed. These results demonstrate that long term contraceptive could be achieved using gamma sterilized microneedles.

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TITLE: EVALUATION OF A MOLECULAR TOOL TO MEASURE THE RNA SEQUENCE-DEPENDENT TRANSLATION EFFICIENCY

Primary Author: Imrie Ross

Understanding bacterial translation initiation efficiency becomes critical when expressing heterologous genes or altering endogenous gene expression in bacteria. The untranslated region (UTR) of mRNA is the primary element in bacterial translation initiation.

An UTR sequence connecting two different reporter genes encoded in a polycistronic transcript in a plasmid can be used to investigate the role of the UTR sequence-dependent translation efficiency. In such a setting, translation of the upstream reporter gene (mNeptune2) is expected to be independent of translation of the downstream reporter gene (eGFP), which is translated using the UTR sequence of the interest. In this configuration, the upstream mNeptune serves as an intracellular internal control. Two UTR sequences of different origins, TIR-1 and TIR-2, were tested in this system to compare their translation efficiencies.

The obtained eGFP fluorescence levels were normalized to internal control mNeptune2 fluorescence levels for TIR-1 and -2. Surprisingly, the ratio of normalized eGFP fluorescence levels translated from two TIR sequences, TIR-1 / TIR-2, were quite different from what was calculated in an online program. The online program uses thermodynamics of deduced RNA sequences for calculation whereas our experimentally driven numbers may have been influenced by bacterial physiological conditions, such as available energy and free ribosomes that can participate in translation. In order to validate our plasmid tool, we are generating seven more constructs that contain TIR sequence with different mutations in and around the Shine-Dalgarno sequence.

TITLE: THE EFFECTS OF SORBITOL ON NANOCRYSTAL ORIENTATION AND MECHANICAL PROPERTIES OF SHEARED CELLULOSE NANOCRYSTAL FILMS

Primary Author: Saim Siddiqui

Cellulose nanocrystals (CNCs) are rod-like nanomaterials that can be extracted from renewable resources such as wood and cotton. CNC's liquid phase processability and exceptional mechanical properties makes them highly desirable for film applications. However, the inherent rigidity of CNCs often leads to the development of cracks and curls in aligned CNC films, negating their potential applications. To address this issue, the use of low molecular weight and eco-friendly additives, such as sorbitol, has shown positive effects in mitigating film defects when combined with drop-cast CNC films. Though there is available analysis of sorbitol on drop-cast CNC films, the effects of sorbitol on the CNC dispersion flow behavior and microstructure of shear-cast CNC films have not been thoroughly explored. The presented research is aimed to fill this knowledge gap through investigating the effects of sorbitol concentration on the microstructure and mechanical properties of shear-cast CNC films. Aqueous dispersions of sulfated CNC and sorbitol were shear cast on a polyester substrate at varying shear rates, and then dried at room temperature to produce films with varying sorbitol concentration. After drying, the alignment of CNCs within the films was quantified using optical contrast measurements obtained via cross-polarized optical microscopy. In addition, tensile testing was performed on films oriented in parallel and perpendicular to the direction of flow. These results provided new insights into how to lessen the negative effects of cracking in curling in shear cast CNC films, while maintaining the optical and mechanical properties of this eco-friendly nanomaterial.

TITLE: COMPUTATIONAL ANALYSIS OF MATURATION IN DIFFERENTIATED CARDIAC CELLS

Primary Author: Emma Kim

The human heart is largely incapable of restoring its damaged cardiomyocytes (CMs), or the human heart cells. Human induced pluripotent stem cell (hiPSCs) technology has shown promising potential in cardiac regenerative medicine due to its ability to differentiate into cardiomyocytes (hiPSC-CMs). Unfortunately, a major disadvantage of hiPSC-CMs is typical signs of structural immaturity in their cellular and intracellular morphology. Cellular structures that indicate low maturation include low cell area, elongation, eccentricity, and circularity. By examining the basic contractile units of hiPSC-CMs, called sarcomeres, one can also analyze their intracellular morphology. Intracellular features that indicate low maturation include low sarcomere orientation levels, alignment levels, and average length. While current studies assess these maturation features qualitatively, there have been increasing efforts to quantitatively measure them in an unbiased and automatic way. By extracting and enhancing the key functionalities from two MATLAB algorithms, we developed a computational platform that detects hiPSC-CMs from stained images and measures these structural maturation features. We confirmed the accuracy of our algorithm by comparing the results to manually obtained data from ImageJ. By providing a comprehensive set of morphological parameters, this approach allows researchers to efficiently and objectively compare the maturity levels of hiPSC-CMs that were created through different experimental methods.

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