28th Annual Environmental Engineering and Science Symposium

Post Pandemic Sustainable Solutions

April 14th, 2023

Civil & Environmental Engineering Buildings, Urbana, Illinois

8:15 am - 4:30 pm

Contents

Introduction

2023 marks the 28th Annual Environmental Engineering and Science (EES) Symposium at the University of Illinois at Urbana-Champaign (UIUC). This year's theme is "***Post Pandemic Sustainable Solutions."*** This theme was chosen by the Symposium organizers, who seek sustainable solutions to environmental challenges in the post-pandemic world. We hope that this Symposium will bring together researchers from a wide variety of backgrounds and specialties to present their research, ideas, and visions about Environmental Engineering and Science and its role in mitigating the impacts of human activities on the environment.

2023 Organizers

Students from CEE 595 G are major organizers of this event. CEE 595 G is a course taken by UIUC Civil and Environmental Engineering Master's students. Students in the EES program are responsible for hosting the annual EES Symposium. This is an opportunity for us to gather and invite the environmental engineering community to learn about our work. Each student presents either a poster or oral presentation which displays their research or a project they are working on.

Executive Committee: Robbie Schmidt; Neil Dcosta
Publicity Committee: Sowjanya Shankar; Kellyn Powers
Hospitality Committee and Poster Workgroup Facilitators: Sanjeet Motikhane Brahmaprakash; Malavika Pothapragada
Program Committee: Even Hou; Iris Dai; Riya Jadhav; Sudiksha Hegde
Advising Faculty: Sotiria Koloutsou-Vakakis
Administrative Support: Suzanne Giesle

Schedule

28th Annual Environmental Engineering and Science Symposium
Schedule – April 14, 2023

Time	Event	Location
8:15 am	Registration desk and breakfast buffet open	Hydro 1st floor
8:50–9:00 am	**Opening Remarks**: Prof. Rosa Espinosa-Marzal	Hydro 1017
9:00–9:55 am	**Keynote Speaker[1]**: Prof. Randall Martin (Prof. Hannah Horowitz introduces)	Hydro 1017
10:00 – 10:50 am	**E-Poster Session** (Moderator: Sanjeet Motikhane Brahmaprakash, Arthur Schmidt, Neil Dcosta)	Hydro 3017 & 3019
11:00 am – noon 11:00 am 11:20 am 11:40 am	**Podium Session 1A** (Moderators: Neil Dcosta, Sowjanya Shankar) **Sudheer Salana** (Air Quality and Climate Change) - Are health effects of ambient PM2.5 proportional to its mass? Relevance of toxicity measurements in predicting PM2.5 health effects. **Yicen Liu** (Air Quality and Climate Change) - Quantifying the impacts of aerosol mixing state on heterogeneous N2O5 uptake coefficients with the particle-resolved model PartMC-MOSAIC. **P. S. Ganesh Subramanian** (Air Quality and Climate Change) - Oxidative potential of the particulate matter emitted from common household sources.	Yeh 1311
11:00 am – noon 11:00 am 11:20 am 11:40 am	**Podium Session 1B** (Moderators: Iris Dai, Even Hou) **Xiaokai Yang** (AI) - Atmospheric chemistry surrogate modeling with sparse identification of nonlinear dynamics. **Renjing Jiang** (AI) - Machine learning based prediction of enzymatic degradation of plastics using encoded protein sequence and effective feature representation. **Hunsoo Song** (AI) - Unraveling the relationship between 3D urban landscape and urban heat island effect using deep learning.	Yeh 3310
12:00 – 1:00 pm	**Lunch**	Bridge
1:00 – 1:50 pm	**Poster Session (traditional poster)** (Moderators: Arthur Schmidt, Neil Dcosta)	Hydro 1st floor
2:00 – 3:00 pm 2:00 pm 2:20 pm 2:40 pm	**Podium Session 2A** (Moderators: Riya Jadhav, Sudiksha Hegde) **Sarang Bhagwat** (Sustainability) - Sustainable Production of Sorbic Acid viaTriacetic Acid Lactone from Lignocellulosic Biomass. **Quanhui Ye** (Sustainability) - Lanmodulin-functionalized magnetic nanoparticles as a highly selective biosorbent for recovery of rare earth elements. **Yoel Rene Cortes-Pena** (Sustainability) - Economic and Environmental Sustainability of Biodiesel Production from Microbial Oil at 1G2G Sugarcane, Energycane, and Oilcane Biorefineries.	Yeh 1311
2:00 – 3:00 pm 2:00 pm 2:20 pm 2:40 pm	**Podium Session 2B** (Moderators: Manho Park, Kellyn Powers) **Joshua Carpenter** (Sustainability) - Forest Mapping from Point Cloud Data. **Binxin Fu** (Sustainability) - A clue to the effects of temperature on nanoscale friction of calcite. **Hakyung Lee** (Water Quality) - Effects of combined chemical and biological stressors on Microcystis aeruginosa growth and microcystin production: Implications for preventing harmful algal blooms.	Yeh 3310
3:05 – 4:00 pm	**Keynote Speaker[1]:** Dr. Brian Shoener, PE (Prof. Jeremy Guest introduces)	Yeh 1310
4:10 – 4:25 pm	**Announcement of Prizes:** Symposium Student Executive Committee	Yeh 1310
4:25 – 4:30 pm	**Closing Remarks:** Dr. Sotiria Koloutsou-Vakakis	Yeh 1310

[1] Title and abstract at the Symposium website: https://publish.illinois.edu/2023-environmentalsymposium/

Poster Sessions

E-Poster Session – 10:00-11:00 am
E-Poster Presenters 1-14

Room: Hydro 3017

1. **Adam Sibal** - Modeling Biodiesel Use to Reduce Emissions and Policy Approaches in the Transport Sector.
2. **Tahsina Alam** - Application of Machine Learning in Developing Models to Estimate Oxidative Potential of Particulate Matter from its Chemical Composition across the Midwestern US.
3. **Lihui Ji** - Toward Building a Virtual Laboratory to Investigate Rainfall Microphysics at Process Scales.
4. **Ximin Piao, Manho Park, Yurui Li, Shiyuan Wang** - Is there a long-range environmental impact of the chemical spill in East Palestine, OH?
5. **Lin Guo** - Chemical surrogate modeling with uncertainty quantification using SINDy and UQSINDy.

Room: Hydro 3019

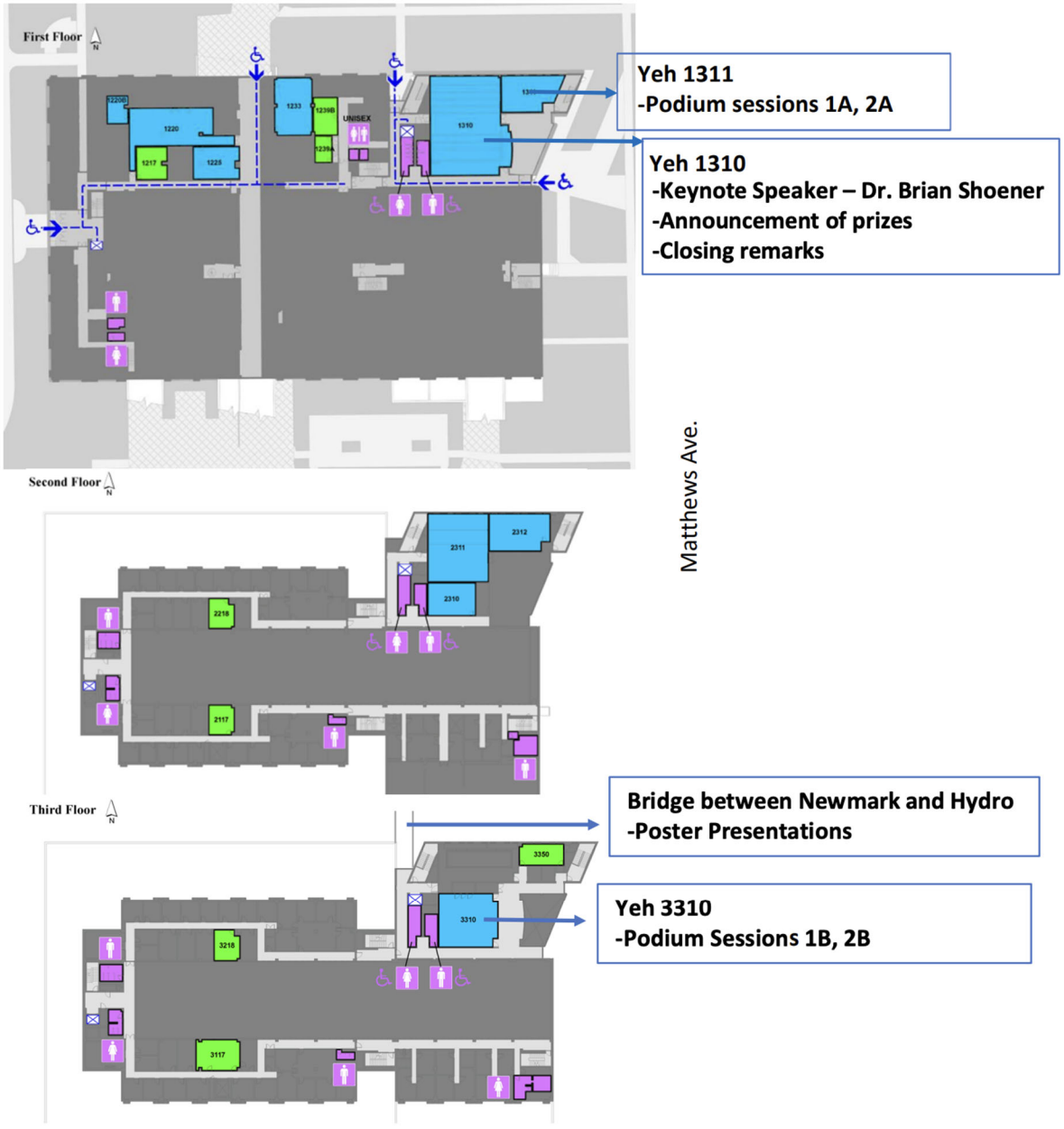
6. **Arthur Schmidt** - Post-Pandemic Viral Wastewater Epidemiology.
7. **Lane To** - Modeling the carbon sequestration potential of fecal sludge-derived biochar in a pyrolytic Omni Processor.
8. **Gang Zheng** - Moringa oleifera seed extract functionalized cotton for effective virus removal in groundwater.
9. **Jianan Feng** - Sustainable Waste Sludge Management through Hydrothermal Systems.
10. **Yongjian Ma** - Influence of hydrogel composition on calcium phosphate mineralization.
11. **Ming Jun Lee** - Tunable Lubricity and Friction Mechanisms of Biocompatible Double Network Hydrogels.
12. **Qianlu Zheng** - water in the electrical double layer of ionic liquids on graphene.
13. **Maria Florencia Bianco** - Supply chain modeling of emerging feedstocks for techno-economic analysis (TEA) and life cycle assessment (LCA) of biofuels and bioproducts.
14. **Neil Dcosta** - Analyzing Properties and Applications of Biodegradable Polymers as Replacement of Commercial Plastics.

Poster Session – 1:00-2:00 pm
Poster Presenters 1-20

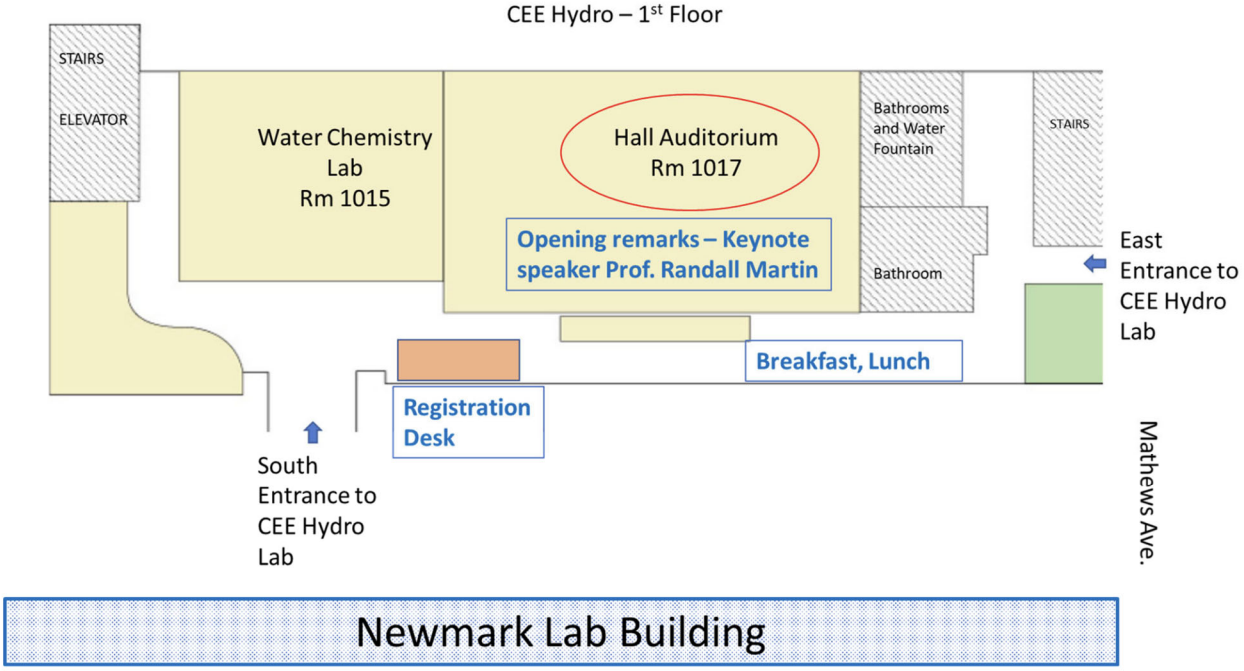
1. **Manho Park** - Computational acceleration of 2-D passive scalar advection by machine-learned discretization.
2. **Even Hou** - Control of particulate nitrate air pollution in China.
3. **Iris Dai** - A Spatio-temporal Study of Changes in Air Quality from Pre-COVID Era to Post-COVID Era in Chicago, USA.
4. **Riya Jadhav**- Effects of the Pandemic on Global Greenhouse Gas Emissions.
5. **Jack Hanley** - Irrigation Trade Flows and Water Footprints of Grains, Produce, and Animal Feed in the CONUS in 2012 and 2017.
6. **Sun Kangdi** - Structure and Potential Drug Delivery Application of Polymer/Phospholipid Hybrid Vesicle System.
7. **Saumitra Rai** - Modelling of Centralized Water Resource Recovery Facilities using QSDsan.
8. **Emily Lin** - Spatially Explicit Life Cycle Assessment and Techno-Economic Analysis of Miscanthus-Derived Biofuel and Bioproducts.
9. **Alex Deptula** - Leveraging electrostatic interactions of gel interfaces for responsive biomimetic materials.
10. **Gus Greenwood** - Measuring Surface Forces of Graphene Nanopores in Aqueous Environments Using the Surface Forces Apparatus.
11. **Jingyu Li** - Development of hydrogel-based substrates to improve coral larvae settlement and application of coral characterization methodologies.
12. **Xuhui Zhang** - The behavior of salt-in-ionic-liquid under nanoconfinement.
13. **Sammy Aguiar** - Elucidating Heterogenous Struvite Nucleation Mechanisms with AFM.
14. **Jayne Allen** - Modeling novel redox-mediated electrodialysis in the downstream processing of bio-based succinic acid.
15. **Sanjeet Motikhane Brahmaprakash** - Utilization of Plastic Waste in Pavement Construction.
16. **Lavanya Kudli** - Sustainability evaluation of azelaic acid from techno-economic analysis and environmental life cycle assessment of sustainable Azelaic acid production.
17. **Malavika Pothapragada** - Powering buildings using transparent solar panels.
18. **Guorui Zhang** - Distribution of Antibiotic Resistance in Champaign County Communities.
19. **Sudiksha Hegde** - Strategies for Wastewater Treatment During COVID-19 Pandemic.
20. **Sowjanya Shankar** - Resource Recovery from wastewater – A review of technologies, challenges and benefits.

Conference Spaces

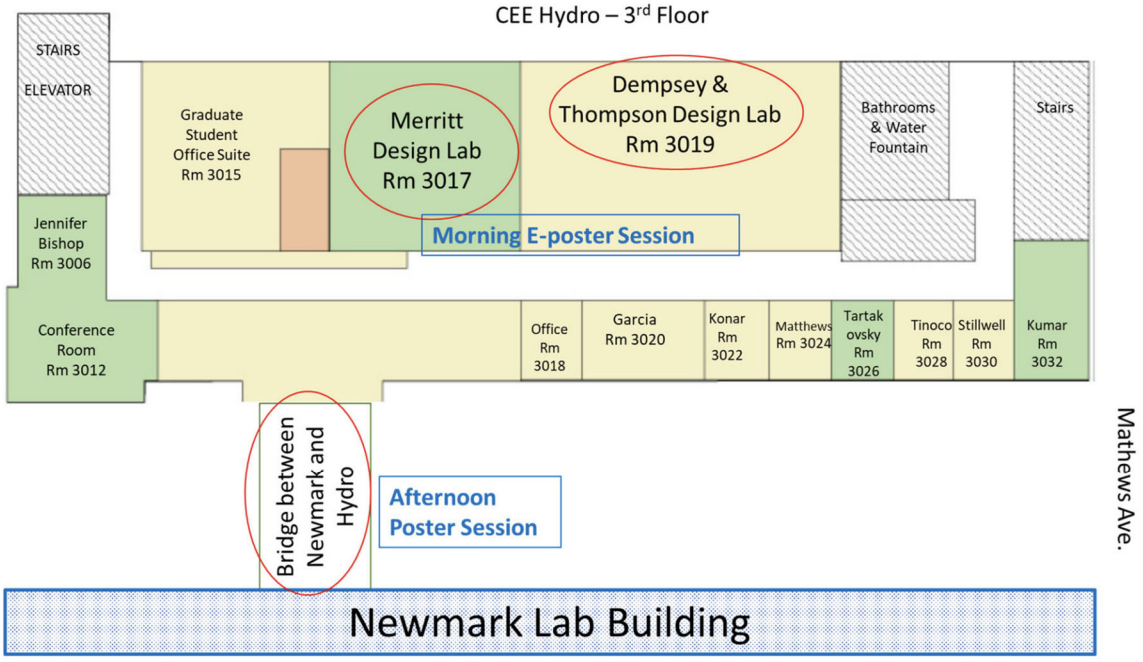
Newmark Civil Engineering Laboratory



CEE Hydro – 1st Floor



CEE Hydro – 3rd Floor



Keynote Speaker - Prof. Randall Martin

Randall Martin

Raymond R. Tucker Distinguished Professor at Washington University in St. Louis

Leading expert on advancing the understanding of atmospheric composition

April 14, 2023
9:00 am, CEE Bldg.
(Hydro) 1017

Global Air Quality: Interpreting Satellite Observations with a Chemical Transport Model to Advance Understanding for Health Applications

Ambient air pollution is the leading global environmental determinant of longevity. However, ground-level monitoring remains sparse in many regions of the world. Satellite remote sensing of aerosols and nitrogen dioxide offers global data to address this issue. Global modeling plays a critical role in relating these observations to ground-level concentrations. The resultant satellite-based estimates indicate pronounced variation around the world, with implications for global public health and insight into the association with health outcomes. Sensitivity simulations with a chemical transport model (GEOS-Chem) provide information on the sources of ambient fine particulate matter contributions that affect human health. These capabilities offer information about the effects of COVID-19 lockdowns on air quality. The Surface Particulate Matter Network (SPARTAN) is designed to evaluate and improve satellite-based PM2.5 estimates. Advanced high-performance modeling offers capabilities to connect the local to the global scale. This talk will highlight recent advances in combining satellite remote sensing, global modeling, and ground-based measurements to improve understanding of air quality from global toward urban scales.

Keynote Speaker - Dr. Brian Shoener

Brian Shoener

Ph.D., P.E., Certified Data Analyst (he/him)

Black & Veatch

AI/ML & Digital Water Applications Development Leader

Operations | Engineering & Development Services

April 14, 2023

3:00 pm, Newmark 1310

Work Smart AND Hard!

Abstract: Ideas are powerful. They can be the spark that ignites a revolution, or they can languish in obscurity. For graduate students, ideas have an even greater significance; they represent our potential to make meaningful contributions to society and create lasting change. But what do we do when our idea is met with hesitation or skepticism? How can we ensure that it reaches its full potential? The answer is simple: We work smart, and we work hard. While the adage "work smart, NOT hard" is a timeless one, combining both working smart AND working hard enables us to minimize our chances of failure with any project we undertake. Working smart requires an understanding of the task at hand and the ability to plan out how it will be accomplished in a timely manner. It also involves having the foresight to anticipate any potential issues that may arise along the way and developing strategies for dealing with those problems before they become insurmountable obstacles. Working hard, on the other hand, means putting in effort without compromising quality or accuracy; it demands dedication even when progress seems slow or nonexistent. Together these two elements form a powerful combination that can help propel you forward towards success. As part of this keynote, several case studies will be presented that serve as representative examples of working smart and hard. Ideas are powerful tools capable of creating real impact if properly utilized by those willing to put forth effort into realizing them fully. With dedication comes reward - so don't give up on yours!

E-poster Session

10:00 AM to 11:00 AM

CEE Hydro 3017 (posters 1-5) and 3019 (posters 6-14)

Poster #1 – Adam Sibal

Modeling Biodiesel Use to Reduce Emissions and Policy Approaches in the Transport Sector

This study focuses on Colorado's diesel transport fleet and its contribution to greenhouse gas and criteria pollutant emissions, leading to health and environmental issues. In this study we built a model to estimate emissions reductions and social value achieved through the use of biodiesel blended fuels in the state's transport fleet. The study analyzed biodiesel policies across the US and found that policies with mandates, incentives for biodiesel use, and biodiesel fueling infrastructure incentives correlated with higher biodiesel consumption and thereby emissions reductions. The study's methodological approach and policy analysis findings could be applied to other states and countries aiming to decrease transport sector emissions. This study emphasizes the potential for biodiesel to reduce emissions and improve public health and encourages policymakers to implement supportive policies for biodiesel use.

Poster #2 – Tahsina Alam

Application of Machine Learning in Developing Models to Estimate Oxidative Potential of Particulate Matter from its Chemical Composition across the Midwestern US

The objective of this study is to develop machine learning models to estimate oxidative potential (OP) of particulate matter (PM), particularly PM2.5, from its chemical composition. PM oxidative potential originates from the excess generation of reactive organic species (ROS) over the antioxidant capacity in cells. We are generating the training datasets by measuring OP endpoints of different solutions containing varying concentrations Ammonium Sulfate, Ammonium Nitrate, Humic-like Substances, Hydrocarbon-like and Oxygenated Organic Aerosols and metals [Cu (II), Mn (II) and Fe (II)]. The test concentrations of model species are chosen based on their typical ambient concentrations and conventional filter extraction protocol. The OP is being measured with both dithiothreitol assay (OPDTT) and consumption of reduced glutathione (OPGSH). The experimental data will be modeled using Artificial Neural Network, XGBoost, Random Forest and Multilinear Regression. The models will be validated against OP measurements of ambient PM2.5 samples collected from Midwest USA.

Poster #3 – Lihui Ji

Toward Building a Virtual Laboratory to Investigate Rainfall Microphysics at Process Scales

A 3D virtual microphysics laboratory (VML) was built upon a new raindropFoam solver to simulate explicitly rainfall microphysical processes. The VML reproduces large raindrop oscillations in shape and velocity in both horizontal and vertical planes. The simulations reveal that the magnitude of the oscillations increases with drop size from boosted turbulence at high velocity and damped pressure by surface tension. Detailed evaluation against reference experimental data sets of free-falling drops and binary collisions of drop pairs over a wide range of drop sizes shows that the simulations reproduced well different types of collision breakup including bounce; coalescence; filament, disk, and sheet breakups. The results are analyzed in the context of collision kinetic energy, diameter ratio and relative position, and outcome drop-size distributions with a view to improve the representation of aerosol-cloud-rainfall interactions in weather and climate models, and in physics-based retrieval of clouds and precipitation from satellite-based observations.

Poster #4 – Ximin Piao, Manho Park, Yurui Li, Shiyuan Wang

Is there a long-range environmental impact of the chemical spill in East Palestine, OH?

The recent train derailment at East Palestine, Ohio, released toxic chemicals into the environment. The long-range transport of those chemicals may harm human health and the ecosystem in the vast area. We quantified the air dispersion and investigated the possible water impacts of the chemical spill. We used the HYSPLIT dispersion model to estimate the horizontal distribution of the emitted chemical at near ground level. The chemical plume appeared to cover Pennsylvania and New York states with a -15 order of magnitude of the initial mass, roughly translated to the microgram range per cubic meter. The preliminary groundwater modeling assuming the worst-case scenario implies inevitable local contamination and neglectable long-distance impact. We also map the quantity of surface water supply in the Ohio River Basin to identify counties with potential water safety concerns.

Poster #5 – Lin Guo

Chemical surrogate modeling with uncertainty quantification using SINDy and UQSINDy

The sparse identification of nonlinear dynamics (SINDy) framework has shown promise in emulating dynamics of ordinary differential equations. Here we started with SINDy to create a chemical mechanism and extended the surrogate model with UQSINDy method for uncertainty quantification. We emulate a photochemical box model of atmospheric ozone formation with 10 reactions, 13 species, and external inputs of solar radiation, emission, and deposition. Trained on 3000 cases within 2-day period, the SINDy model gives test error 0.0278 (MSE) on 100 test cases within 14-day period. The SINDy model is 4.6× faster than the reference model and has a 4.3× smaller memory footprint. Trained on single parameter set, the UQSINDy model provides the posterior predictive distribution for each species using regularized horseshoe prior and No-U-Turn sampler, where the posterior mean can probabilistically capture the periodicity of the system. Future work will focus on scaling our UQSINDy workflow to larger training datasets.

Poster #6 – Arthur Schmidt

Post Pandemic Viral Wastewater Epidemiology

The COVID-19 pandemic featured lockdowns, social changes, and rapid medical advances. One of the most impactful medical advances was developed at the University of Illinois, the rapid PCR saliva test but this is just for an individual. Saliva tests only allows us to know if a certain person has Covid-19, what about a community. The way to test a community quickly is through wastewater epidemiology. This process allows for a sample to be taken and then gauge the amount of the Covid-19 virus in schools, neighborhoods, or apartments. Then this data could be used for quarantine zones or overall community infectivity. As we have progressed past the pandemic, the field of viral wastewater epidemiology has grown. Continuing research progresses our knowledge of endemic diseases and increases our ability to test for these viral diseases in wastewater, with the eventual hope of being able to limit their spread more effectively.

Poster #7 – Lane To

Modeling the carbon sequestration potential of fecal sludge-derived biochar in a pyrolytic Omni Processor

Omni Processors (OPs) are community-scale sanitation technologies that can provide decentralized wastewater treatment in areas where sewered sanitation is not feasible. Pyrolytic OPs leverage oxygen-limited thermal treatment to convert fecal sludge into biochar, a charcoal-like product that sequesters carbon and improves soil quality. Our group modeled an OP using QSDsan, an open-source quantitative sustainable design tool, to evaluate system costs and environmental impacts, as well as carbon and nutrient fates throughout the process. To reduce the model's reliance on fixed assumptions and improve its responsiveness to differences in operating conditions, we incorporated empirical relations linking pyrolysis temperature and feedstock characteristics to biochar yield and carbon sequestration potential. The resulting trends demonstrate the influence these variables have on system-wide indicators. Using this information, one can identify optimal combinations within the pyrolytic OP design decision space to calibrate biochar production and carbon sequestration potential according to context-specific needs.

Poster #8 – Gang Zheng

Moringa oleifera seed extract functionalized cotton for effective virus removal in groundwater

Waterborne viral pathogens pose a significant challenge in areas with limited access to safe drinking water. Conventional water filtration technologies widely used in such areas, including sand or ceramic filters, are ineffective in removing viruses from drinking water sources. This study aims to develop a novel water filtration technology for virus removal using locally available materials such as Moringa oleifera seeds and cotton fibers. We developed cotton fibers functionalized with Moringa oleifera seed extract as a filtration medium and determined its virus removal efficacy, kinetics, and mechanisms under practical conditions using actual groundwater spiked with two viral species in Caliciviridae and Coronaviridae families, representative of enteric viral pathogens. Our findings indicate that this novel filter can remove viral pathogens by more than 4-log10, which meets the regulations set by the US EPA and WHO. This study will contribute to improving drinking water quality, especially for individuals residing in developing countries.

Poster #9 – Jianan Feng

Sustainable Waste Sludge Management through Hydrothermal Systems

Hydrothermal systems are a promising strategy for the simultaneous treatment and valorization of waste sludge for producing high-quality biofuels (e.g., diesel) and fertilizer substitutes (e.g., struvite). In this work, we developed a modeling framework to enable the design and simulation of a hydrothermal sludge valorization system including hydrothermal liquefaction for sludge conversion, hydrotreating and hydrocracking for biocrude upgrading, hydrothermal gasification for aqueous phase upgrading, together with nutrients recovery. We leveraged QSDsan (an open-source python package) to conduct integrated techno-economic analysis and life cycle assessment. The sludge management cost and the global warming potential were estimated to be 151.0 [-2.8-287.5] USD·ton-1 and 461.7 [250.8-665.3] kg CO2-eq·ton-1 (5%-95% shown in brackets). Sensitivity analyses identified key drivers of system performance and the results were used to design new system configurations, explore contextual differences, expand feedstock scope, and set technological development goals to prioritize research, development, and deployment of the hydrothermal sludge treatment systems.

Poster #10 – Yongjian Ma

Influence of hydrogel composition on calcium phosphate mineralization

Calcium phosphate minerals, particularly hydroxyapatite, play a critical role in the skeletal and dental systems of vertebrates. Hydrogels, which mimic the extracellular matrix and offer material tunability, have shown excellent performance templates for biomineralization in vivo. Studying the formation of calcium phosphate in hydrogels can provide valuable insights and aid in the repair of human skeletal structures. In this study, we examined the mineralization pathway of hydroxyapatite in polyacrylamide hydrogels with varying monomer and crosslinker concentrations to evaluate the impact of the hydrogel polymer network on mineralization. Additionally, we investigated the role of the amorphous calcium carbonate precursor in mineralization to simulate the early stages of bone formation. We found that hydroxyapatite can be formed in the presence or absence of amorphous calcium carbonate in hydrogels but the kinetics are significantly different. Interestingly, the mineralization kinetics of calcium phosphate was not controlled by the amount of polymer in the polyacrylamide, which instead affected the diffusion of ions. Moreover, the precipitated mineral crystals enhanced the physical mechanical strength of the hydrogel. Our research contributes to the fields of biomineralization and tissue engineering by providing new knowledge and advancements.

Poster #11 – Ming Jun Lee

Tunable Lubricity and Friction Mechanisms of Biocompatible Double Network Hydrogels

Double network (DN) hydrogels are potential cartilage replacements owing to its high strength and lubricity. The microstructural similarity of these hydrogels to articular cartilage, as well as the monomers selected allow biocompatibility with the human body. Also, these hydrogels can be used in soft robotics applications where tunable friction is required to grip objects. This project explores the extrinsically tuned lubricity of agarose/poly(acrylamide-co-acrylic acid) DN hydrogels through chemical and electrical stimuli. New analytical methods in the form of friction maps are presented. These findings advance our understanding of hydrogel friction at the microstructure level and inform the development of tissue engineering and soft robotics applications.

Poster #12 – Qianlu Zheng

Water in the Electrical Double Layer of Ionic Liquids on Graphene

Supercapacitors are new-generation energy storage devices with high power density and long cycle life. Ionic liquids (ILs) are promising electrolyte candidates due to low volatility and high thermal and electrochemical stability, but they will absorb water from the environment, which might influence the performance. This work investigates the influence of water on the behavior of hydrophobic and hydrophilic ILs on graphene electrode. The results show that electrochemical stability windows of the ILs will reduce only slightly with water uptake. The hydrophilic IL exhibits the largest capacitance. And 3 hydrophilic ILs show an increase of capacitance with water. Since the energy is stored by forming an electrical double layer at the electrode-electrolyte interface, understanding the interfacial structure is important. Short-range surface forces reveal the change of the interfacial layering with potential and water uptake, reflecting the charge stored in the double layer. This knowledge will advance the design of IL-graphene-based supercapacitors.

Poster #13 – Maria Florencia Bianco

Supply chain modeling of emerging feedstocks for techno-economic analysis (TEA) and life cycle assessment (LCA) of biofuels and bioproducts

Bioenergy is a promising alternative to replace fossil fuels and achieve net zero emissions. Size and complexity of resource logistics in the biofuel supply chain are a key factor in determining the required investment and financial viability of the enterprise. Integration of feedstock logistics and biomass conversion at the biorefinery is crucial to assess the competitiveness of biofuels, especially for emerging crops that may require different management practices not yet known. This work aims to develop a discrete event simulation to model the feedstock logistics of the biomass-to-biofuels supply chain, to extend and complement the existing BioSTEAM biorefinery simulation platform and to support techno-economic analysis (TEA) and life cycle assessments (LCA) of the entire process, from biomass collection to biofuel conversion, across thousands of scenarios. This project is currently in its early stages, so this poster will focus on the planned methodology and preliminary results from the integrated modeling framework.

Poster #14 – Neil Dcosta

Analyzing Properties and Applications of Biodegradable Polymers as Replacement of Commercial Plastics

Plastics- being cheap, light, and durable- have improved almost every aspect of human life. However, plastic is resistant to biological degradation and accumulation of plastic waste causes irreversible damage to the environment. About 400 million tons of plastic is produced in the world every year, and less than 10% of it is recycled.

This literature review recognizes the use of biodegradable polymers as an alternative to plastic, and addresses the factors affecting biodegradation, properties of biodegradable polymers and its existing and potential applications in various sectors. Biodegradable polymers can naturally degrade in the soil, and switching to biodegradable polymers can exponentially reduce the quantity of plastic waste, and the volume of waste in general. This poster discusses the feasibility, advantages, and disadvantages of the use of biodegradable plastics. Research is being carried out to further improve the structure and properties of biodegradable polymers- making it a promising affordable alternative to plastic.

Podium Session 1A

11:00 AM to 12:00 PM

Yeh 1311

Sudheer Salana (Air Quality and Climate Change)

Are health effects of ambient PM2.5 proportional to its mass? Relevance of toxicity measurements in predicting PM2.5 health effects.

Globally PM mass is used as a metric to predict PM2.5 health effects. However, PM varies widely in its physicochemical characteristics and hence the notion that its health effects will solely depend on mass is incorrect. In this study, we demonstrate the advantage of using PM toxicity measurements using a large number of PM samples (n>350) collected from fourteen different sites on four different continents (Asia, North and South America and Europe). We evaluated six most widely used PM toxicity measures (4 acellular OP endpoints – OPDTT, OPAA, OPGSH, OPOH-SLF; 2 cellular endpoints- cell viability using Crystal Violet assay and cellular ROS using DCFH-DA in A549 cells) and our results show that the variation of mass within a site is much smaller than the variation in PM toxicity. There was also a significant variation in intrinsic cytotoxicity among different sites. Finally, the intercomparison of PM mass and toxicity between different sites shows that use of PM mass may often lead to overprediction of PM2.5 health effects by 2-3 times

Yicen Liu (Air Quality and Climate Change)

Quantifying the impacts of aerosol mixing state on heterogeneous N2O5 uptake coefficients with the particle-resolved model PartMC-MOSAIC.

Dinitrogen pentoxide (N2O5) is an important nighttime reservoir for NOx. The heterogeneous hydrolysis on aerosol particles is the main loss pathway for N2O5, removing NOx from the atmosphere. Current models use the bulk composition of the particle population to calculate the N2O5 reaction probability (γ_N2O5). While this is appropriate when the aerosol is internally mixed, it remains an open question of how large the error is when the aerosol has a more complex mixing state, which is common in the real atmosphere. To better understand the role of the mixing state in calculating γ_N2O5, the stochastic particle-resolved model PartMC-MOSAIC was used to generate thousands of populations with different input parameters, including primary gas and aerosol emissions, as well as meteorological parameters. We found that the internal-mixing assumption may lead to over- or underestimation of γ_N2O5, with the relative errors ranging from -83.1% to 42.4%. We will present a detailed process analysis that explains the reasons for the observed differences.

P. S. Ganesh Subramanian (Air Quality and Climate Change)

Oxidative potential of the particulate matter emitted from common household sources.

Oxidative potential (OP) is an emerging metric, which quantifies the capability of particulate matter (PM) to induce oxidative stress in human body and cause adverse health effects. Although people spend over 80% of their times indoors, OP of the PM emitted from common household sources are largely unknown. We collected PM emitted by commonly used indoor sources (candles, incense, candle-warmer, cigarettes, ultrasonic-humidifiers, and essential-oil-diffusers) in a clean-controlled environmental-chamber and measured their composition and emission rates. Three different OP assays, dithiothreitol (OPDTT), glutathione (OPGSH), and hydroxyl radical generation (OPOH) were used to quantify OP.

Preliminary results indicate following trend for PM emission rates: Incense sticks > Candles (wind-draft) > Candles (no draft). The emissions from candles increased substantially (100 times) in presence of a wind-draft (achieved by a mixing-fan). Carbonaceous materials accounted for over 60% of the total aerosols mass for tested sources. The trends for intrinsic OPDTT and OPOH-SLF were; Candles (wind-draft) > Incense > Candles (no draft). The increased intrinsic OP of candles during wind-draft could be attributed to its high elemental-carbon content. Experiments are underway for other common sources. The OP dataset obtained by these experiments will be used to develop an exposure assessment model to evaluate health risks from common household sources.

Podium Session 1B

11:00 AM to 12:00 PM

Yeh 3310

Xiaokai Yang (AI)

Atmospheric chemistry surrogate modeling with sparse identification of nonlinear dynamics.

Modeling atmospheric chemistry and physics is computationally expensive, and the computation cost arises mainly from solving high-dimensional systems of stiff differential equations. SINDy (Sparse Identification of Nonlinear Dynamics) is a data-driven approach for identifying the governing equations of a dynamical system from data, by iteratively solving a sparse regression problem to identify the most important basis functions and their corresponding coefficients. We use a box model based on a simplified photochemistry mechanism as a reference model to create a training and testing dataset and use singular value decomposition to create a compressed latent space to reduce its dimensionality. We then fine-tune the SINDy-based model using stochastic gradient descent with adjoint methods. Preliminary training results are promising; we are currently working to scale up our training workflow to realize the full potential of this approach.

Renjing Jiang (AI)

Machine learning based prediction of enzymatic degradation of plastics using encoded protein sequence and effective feature representation.

Enzyme biocatalysis for plastic treatment is of growing interest. However, it is challenging and time-consuming to identify plastic-degrading enzymes with desirable functionality given the large number of putative enzyme sequences. There is a critical need to develop an effective approach to accurately predict enzyme activity in degrading different types of plastics. In this study, we developed a machine learning-based Plastic Enzymatic Degradation (PED) framework to predict the ability of an enzyme to degrade plastics of interest. Experimental data from literature were collected, a new Context-aware Enzyme Sequence Representation mechanism was developed to learn the abundant contextual information in enzyme sequences, and feature extraction was performed for enzymes at both amino acid level and protein sequence level. Thirteen machine learning classification algorithms were compared and XGBoost was identified as the best-performing algorithm. PED achieved an overall accuracy of 93% and outperformed sequence-based protein classification models from existing literature. Furthermore, important enzyme features in plastic degradation were comprehensively interpreted. This study demonstrated a new tool for prediction and discovery of plastic-degrading enzymes.

Hunsoo Song (AI)

Unraveling the relationship between 3D urban landscape and urban heat island effect using deep learning

Effective landscape design can mitigate the intensity of urban heat islands (UHIs), thereby improving the sustainability and livability of cities. However, designing such landscapes is challenging due to the complex interplay of various factors that affect UHI intensity, including climate, geography, anthropogenic heat, and surface materials. To address this challenge, we developed a deep learning model that can estimate land surface temperature based on local 3D urban landscapes by utilizing large-scale 3D urban land cover maps. Our deep learning model has achieved an estimation accuracy of approximately 1 Kelvin mean absolute error over the metropolitan area of Dallas, TX. Using the trained model and simulated 3D urban landscapes, we investigated the impact of various factors, such as building height, tree height, water bodies, vegetation, and impervious surfaces, on UHI intensity. Our approach to unraveling the relationship between 3D urban landscapes and UHIs would offer insights into developing heat-resilient cities.

Poster Session (traditional posters)

(Posters #1-20)

1:00 PM to 2:00 PM

CEE Hydro 1st floor

Poster #1– Manho Park

Computational acceleration of 2-D passive scalar advection by machine-learned discretization

The numerical discretization of passive scalar advection is a key component in the air quality model with many environmental implications, e.g., wildfire smoke transport, or pollutants transport from chemical spill disaster. The bottleneck of this approach is the computational cost of the high-resolution simulation to approximate close to the exact solution. Our approach is to develop a coarse-grained model using machine-learning emulation of coarse representations of accurate simulations to allow more favorable tradeoffs between speed and accuracy than are possible with traditional methods. We trained 1-D neural net-based solvers with spatiotemporal coarse-graining using the numerical 1-D advection dataset. Our models showed good fidelity in emulating the 1-D numerical advection and the most coarse version of solver (16× in space and 64× in time) showed 23.2× acceleration with r^2=0.90. 2-D application of the solver in the same resolution maintained accuracy (r^2=0.49) with 337× faster computation.

Poster #2 – Even Hou

Control of particulate nitrate air pollution in China

The concentration of fine particulate matter (PM2.5) across China has decreased significantly over the period 2013–2018 due to stringent emission controls. However, the nitrate component of PM2.5, which is the principal component of winter haze pollution and an important factor of air quality degradation in China, has not responded effectively to decreasing emissions of nitrogen oxides and has increased during winter haze pollution in the North China Plain. This paper reviews the paper by Zhai's team, in which they find that winter mean nitrate increased over 2013–2018 mainly due to weaker deposition. Their results suggest that decreasing ammonia emissions from agriculture and fossil fuel combustion would decrease particulate nitrate by driving faster deposition of total inorganic nitrate. Decreasing nitrogen oxide emissions is less effective because it drives faster oxidation of nitrogen oxides by increasing the concentration of ozone and hydroxide and slower deposition of total inorganic nitrate.

Poster #3 – Iris Dai

A Spatio-temporal Study of Changes in Air Quality from Pre-COVID Era to Post-COVID Era in Chicago, USA

The COVID-19 pandemic has drastically changed human life and the world's environment. Most of major cities of the USA went under full or partial lockdown in the first half of 2020 until most public activity restrictions were gradually lifted, after the middle of year 2021. I present a novel approach of studying air quality using spatio-temporal analysis at the finer spatial level within a city in the USA. The study assessed the change in six air quality parameters from the pre-COVID era to the post-COVID era in Chicago, Illinois. The results showed that reduced human activities during COVID-19 improved air quality, especially reduced the concentrations of PM2.5, NO2, and CO. However, this improvement was transitory, and it reverted in the post-COVID era. Policies should be formulated and practiced to facing the sudden spike of air pollutants after reopening.

Poster #4 – Riya Jadhav

Effects of the Pandemic on Global Greenhouse Gas Emissions

The COVID-19 pandemic has significantly impacted the global economy, resulting in across-the-board changes in energy use, transportation, and industrial production. This study will use the recent COVID-19 pandemic as a reference to derive solutions to identified problems to make this more accurate. It will examine whether the pandemic has led to a greater focus on sustainable practices and renewable energy sources or hindered progress in these areas. The pandemic has also led to a decline in demand for fossil fuels, which may provoke governments and businesses to subsidize more heavily renewable energy sources such as wind and solar power, in contrast, the pandemic has led to considerable economic challenges, which may delay climate action and make it more challenging to invest in renewable energy. The poster aims to provide evidence-based recommendations to policymakers and practitioners to accelerate climate mitigation efforts and promote a more sustainable and resilient future.

Poster #5 – Jack Hanley

Irrigation Trade Flows and Water Footprints of Grains, Produce, and Animal Feed in the CONUS in 2012 and 2017

In the face of projected increases in water stress in the coming decades, many farmers irrigate to maintain crop production. This raises sustainability concerns as water sources are depleted across the U.S. We ask: 1. How much irrigation water is embedded in domestic transfers of agricultural commodities in the United States, and 2. Which countries produce and receive the greatest quantities of virtual irrigation water? To answer these questions, we quantify the embedded water footprint of production of domestic agricultural fluxes of SCTG commodity groups 2, 3, & 4 in 2012 and 2017 in terms of embedded surface water use, groundwater use, and groundwater depletion. We find that 4.14E14 and 3.20E14 cubic meters of water were transferred domestically in 2012 and 2017 respectively. Our results highlight the need for proactive water management and underscore the long-term risks that reliance on unsustainable groundwater use poses to the greater agricultural supply chain.

Poster #6. Sun Kangdi

Structure and Potential Drug Delivery Application of Polymer/Phospholipid Hybrid Vesicle System

Polymer-Phospholipid Hybrid vesicles (HVs) are membrane vesicles that can be self-assembled on both the micro- or nanoscale. On the nanoscale, they are potential novel smart materials for drug delivery systems that could combine the relative strengths of liposome and polymersome drug delivery systems without their respective weaknesses. For our system, the HVs were prepared via thin film method treated with Freeze-thaw method to improve the protein encapsulation efficiency. Dynamic Light Scattering were used to determine the structure of the HA-lipid vesicles in bulk solution, while a combination of Atomic Force Microscopy and Quartz Crystal Microbalance was applied to study their adsorption kinetics and assembly surface morphology on a gold surface. The indention experiment was carried out to measure the rupture force of the fused supported Hybrid bilayer on gold sensor. The results have shown that not only the prepared HVs has higher encapsulation efficiency comparing with probe sonication based thin film method, but also the higher rupture force comparing pure lipid supported bilayer. Vivo experiment proved that the HVs enable to be internalized by human Endometrial Stromal Cells and serve drug delivery function.

Poster #7. Saumitra Rai

Modeling of Centralized Water Resource Recovery Facilities using QSDsan

This study focuses on the design, simulation, and sustainability assessment of centralized water resource recovery facilities (WRRFs) as a benchmark against which to compare emerging resource recovery technologies. The use of quantitative sustainable design (QSD) of emerging technologies often requires benchmarks against which to compare, where benchmarks represent existing or conventional technologies most commonly deployed. In the prioritization of research, development, and deployment of novel decentralized wastewater treatment and resource recovery technologies, the benchmarks against systems would be compared are often centralized sanitation infrastructure. Existing studies of centralized WRRFs, however, often use proprietary software and do not make their models publicly available for benchmarking by technology developers. To overcome these shortcomings, our group has developed QSDsan [2], which is an open-source platform in python for sustainable design of sanitation and resource recovery systems. In this study, we are working to develop a benchmark WRRF using data from the Metropolitan Wastewater Treatment Plant (WWTP) in the twin cities of Minneapolis–Saint Paul. The model includes primary treatment (primary clarifier), secondary treatment (activated sludge with anaerobic, anoxic, and aerobic zones; and a secondary clarifier), and sludge management (thickeners, centrifuge, and incinerator). Multiple Python Classes have been created in QSDsan to model different treatment units in the Metropolitan WWTP. Scenario analysis will be conducted on the developed model to analyze the cost and environmental impact of treating influent with varying biochemical oxygen demand (BOD) loads.

Poster #8. Emily Lin

Spatially Explicit Life Cycle Assessment and Techno-Economic Analysis of Miscanthus-Derived Biofuel and Bioproducts

Miscanthus is a perennial grass and has attracted great research interests as a promising biofuel and bioproduct feedstock. To project the impacts of miscanthus production on an ecosystem and the sustainability of the generated biofuels and bioproducts, robust and spatially explicit evaluation of the entire field-to-biorefinery value chain is required. The overarching goal of this work is to determine the economic and environmental sustainability of biorefineries with miscanthus as the feedstock. Using ethanol and lactic acid biorefineries as examples, we leveraged the ecosystem model DayCent and the biorefinery simulation tool BioSTEAM for integrated life cycle assessment and techno-economic analysis. We quantified global warming potential and cost of the produced ethanol and lactic acid with location-specific parameters (e.g., climate and soil conditions) across the rain-fed U.S., and our preliminary results indicated that miscanthus yield and soil organic carbon change are main drivers of the sustainability of miscanthus-derived biofuels and bioproducts.

Poster #9. Alex Deptula

Leveraging electrostatic interactions of gel interfaces for responsive biomimetic materials

Active control of interfacial properties of gel systems is an important aspect for applications in biomimetic materials such as joint replacement to combat health issues in today’s society. Under specific conditions, it is possible to form lamellar near-surface forces on gel systems. Shifting the balance of these interactions results in modifications of surface forces due to the changing equilibrium. Hence, the interfacial structure and properties, such as stiffness and adhesion, can be tuned. Here, we investigate the responsive interfacial properties of a physically crosslinked poly(methacrylamide-co-methacrylic acid) gel which has been previously shown to exhibit stiff mechanical properties as well as lamellar near-surface forces. Semi-reversible responses in surface properties are measured using a variety of in-situ¬ Atomic Force Microscopy techniques and complimentary solid-state NMR. Proof of concept applications are shown using friction measurements.

Poster #10. Gus Greenwood

Measuring Surface Forces of Graphene Nanopores in Aqueous Environments Using the Surface Forces Apparatus

Solutions to emerging environmental problems require new technologies aided by the development of new materials. Graphene, a one atom thick carbon “sheet” that is strong, stable, and tunable, is one such new material. These properties suggest it is a promising candidate to improve filtration membranes, functionalize nanofluidic devices, and modify the interactions of contacting surfaces. Key to these applications are graphene surfaces with nanoscale separation, i.e. graphene nanopores. Creating graphene nanopores is traditionally an intensive fabrication process. Here we present the foundational work for reliably incorporating graphene surfaces into the surface forces apparatus (SFA), an instrument that controls surface separation with angstrom level precision while measuring piconewton forces between the surfaces. The SFA allows regulation of temperature and humidity while also enabling immersion of the surfaces in liquids. The surface forces of graphene nanopores simulated in SFA are experimentally investigated, developing foundational knowledge necessary to use graphene in engineered systems.

Poster #11. Jingyu Li

Development of hydrogel-based substrates to improve coral larvae settlement and application of coral characterization methodologies

Coral reefs can protect shoreline from storm and support commercial fisheries. They form the highest biological diverse ecosystem, providing marine habitats for more than 25% of marine life. However, recent human activities threaten their survival and coral reefs have been rapidly declining. The development of substrate to promote the settlement of coral larvae is crucial. Our hypothesis is that providing hydrogel with controlled release of oxygen that attract larvae and/or feed juvenile corals can further accelerate coral reef restauration. We have designed calcium-alginate hydrogels incorporating CaO2 particles. The CaO2 particles are coated by a layer-by-layer film made of two polyelectrolytes, which act as battier against water to slow down the reaction with water and thereby the release of oxygen. We have also used nano 3DX, scanning electron microscope (SEM), and energy-dispersive spectroscopy (EDS) to characterize corals on different substrates that were designed to promote larvae settlement and coral growth. This combined analysis demonstrates that the substrate influences the coral microstructure and elemental composition.

Poster #12. Xuhui Zhang

The behavior of salt-in-ionic-liquid under nanoconfinement

Ionic liquids (ILs) are organic salts that consist of ions solely. They are potential alternatives to conventional organic solvents in the field of energy applications due to their low volatility, low flammability, and extraordinary thermal and chemical stability. Specifically, IL-doped alkali-metal salts have been applied as electrolytes in batteries. It is intuitively expected that higher concentrations of salts in electrolytes can contribute to the better performance of batteries because the ionic conductivity is proportional to the number of charge carriers. However, this relationship has not been validated by recent studies resulting from the strong ionic interactions between salt and IL at high salt concentrations. To unveil the behavior of salt in IL, sodium trifluoromethanesulfonimide ([Na][TFSI]) and 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide ([EMIM][TFSI]) have been selected and mixed at different molar ratios. Surface forces apparatus (SFA) and atomic force microscopy (AFM) were employed to measure the interfacial structure of the electrolytes. In addition, the effects of temperature and water content of the electrolytes have also been investigated. By combining the experimental results and theoretical model, we hope to better explore the potential of utilizing concentrated salt-in-IL electrolytes for energy storage devices.

Poster #13. Sammy Aguiar

Elucidating Heterogenous Struvite Nucleation Mechanisms with AFM

"In this study we focus on elucidating the mechanism of heterogenous struvite nucleation on mica substrates using AFM to image discrete points in the nucleation process and confirm the crystal phase of observed particles using powder XRD. Our initial findings indicate struvite may follow a non-classical nucleation process in contrast to all current modelling practices. In solutions supersaturated only for struvite, we first observe the appearance of an unidentified semi-stable spherical phase. These particles grow from a few nms to ~10s of nm without significant solution pH shifts. After some time passes a fast pH drop is measured and trapezoidal prism typical of struvite crystals at equilibrium are observed distributed across the substrate. Current work is focused on imaging the transition between the two phases using liquid AFM to confirm the hypothesized nonclassical nucleation pathway."

Poster #14. Jayne Allen

Modeling novel redox-mediated electrodialysis in the downstream processing of bio-based succinic acid

Succinic acid is a widely traded platform chemical with high demand in the skincare industry. Sustainable production of succinic acid through biological conversion of sugars from renewable feedstocks has been extensively investigated to replace the barrel of oil used in fossil-based succinic acid production. The cost-intensive production of bio-based succinic acid may be improved through advancements in downstream separation processes. A novel redox-mediated electrodialysis system shows potential for commercial use in sustainable bio-based succinic acid separations with favorable long-term performance by utilization of size- and charge-exclusive membranes to separate charged species. This work aims to estimate the full-scale performance of the redox-ED system using BioSTEAM Python to perform techno-economic analysis (TEA) and life cycle assessment (LCA) of production plant scenarios under uncertainty. We aim to compare the economic competitiveness (TEA) and sustainability (LCA) of the redox-ED system to more conventional separation processes to inform the prioritization of research efforts.

Poster #15. Sanjeet Motikhane Brahmaprakash

Utilization of Plastic Waste in Pavement Construction

Plastic waste is non-biodegradable in nature. Every year 400 million tons of plastic waste is generated in the world which leads to environmental pollution. I review a study in which the author uses plastic waste in road construction. The author uses 3-4% of melted plastic instead of bitumen in the mix and this melted plastic gives a fine coat to the aggregates which increases the bonding of aggregates. After the addition of plastic melt the bitumen is added so that bitumen diffuses through the plastic layer and bonds to the aggregate forming a strong bond. This method of using plastic in pavement saves overall 8% of bitumen, increases the compressive strength, and durability of the pavement. By using plastic waste, we can save construction costs up to $12,500 per km. The study is a proof of concept for use of plastic for sustainable pavement construction.

Poster #16. Lavanya Kudli

Sustainability evaluation of azelaic acid from techno-economic analysis and environmental life cycle assessment of sustainable Azelaic acid production

Azelaic acid is a renewable bioproduct and a valuable dibasic monomer with wide ranging industrial applications including lubricants, cosmetics, and pharmaceuticals. It is derived from oxidative cleavage of oleic acid derived from vegetable oils such as high oleic sunflower oil. The conventional approach to achieving oxidative cleavage is an ozone-based process which is energy intensive and poses a combustion hazard. A more recently developed method to achieve oxidative cleavage uses hydrogen peroxide and oxygen in place of ozone, potentially representing a more sustainable alternative to conventional production. It is also known that continuous oxidative cleavage using hydrogen peroxide and oxygen has a higher azelaic acid percentage yield as compared to the batchwise oxidative cleavage. However, the financial viability and environmental significance of this emerging process remain unclear, especially given significant technological and market driven uncertainties that could undermine commercial feasibility and environmental benefits. In this study, we leverage BioSTEAM – an open-source platform for design and evaluation of biorefineries – to perform techno-economic analysis (TEA) and life cycle assessment (LCA) of a hydrogen peroxide and oxygen based continuous oxidative cleavage method for production of azelaic acid under uncertainty.

Poster #17. Malavika Pothapragada

Powering buildings using transparent solar panels

Energy consumption has increased over the years due to increasing population, new technological developments, and economic growth. Nonrenewable energy sources are depleting due to heavy consumption. The depletion of these resources is causing a world energy crisis or problems. Renewable energy sources are the best alternative. Solar energy is one of the best solutions. Solar energy is found abundant in nature. As long as the sun shines, there is solar energy. Scientists have been researching to find the best way to harness solar energy. Transparent solar panels and window blinds can harness this solar energy at higher efficiencies. This technique is relatively new. These panels are green and aesthetic. Solar panels can prevent CO_2 emissions. Approximately 70 to 300 metric tons of CO_2 can be prevented per acre a year. These solar panels can be economical as they can be used in the long run. It is a one-time investment that can save a lot. Additionally, using green roofs can contribute to the energy-saving process by helping buildings cool down. By combining these two techniques, the buildings are green and more efficient. This presentation focuses on how these transparent solar panels and blinds work.

Poster #18. Guorui Zhang

Distribution of Antibiotic Resistance in Champaign County Communities

Antibiotics have been widely used in treating human and animal diseases since they were discovered in the 1900s. Bacteria can acquire antibiotic resistance genes (ARGs) by genetic mutations under environmental pressure and directly from environments or other microorganisms and become antibiotic-resistant. Previous studies have reported the occurrence of antibiotic-resistance bacteria and ARGs in various environments, which is human society's threat and problem. In this study, we will focus on the phenotype of isolated bacteria samples by checking the minimum inhibitory concentration (MIC) of seven types of antibiotics. Isolated Escherichia coli from sewage water samples from different communities of Champaign county, are used to test their sensitivity to antibiotics. We add serial-dilution antibiotic solutions to the growth broth and cultivate them at favorable conditions for 16-20 hours before reading the MIC results. The results of this study will contribute to providing data on constructing the antibiotics resistance surveillance system in human communities and to the characterization of community-level antibiotic resistance.

Poster #19. Sudiksha Hegde

Strategies for Wastewater Treatment During COVID-19 Pandemic

With the COVID-19 pandemic that SARS-CoV2 created, the issue of disposing of biomedical wastewater is also an issue because its presence has been proven in wastewater. In the current study, the authors wanted to emphasize some SARS-CoV- 2 contaminated wastewater management strategies to reduce any potential secondary transmission to humans and the environment. This was done considering (i) the evidence that is currently available indicating the need to better understand the potential of wastewater mediated transmission and (ii) knowledge gaps in its occurrence, viability, persistence, and inactivation in wastewater. Installation of decentralized wastewater treatment units with one or more disinfection barriers in medical units seems urgent for reducing any potential risk of wastewater transmission without a regulated central treatment facility. To choose the most effective disinfection technology, it is necessary to conduct more research on coronavirus-specific disinfection data generation and routine performance monitoring considering all factors influencing virus survival.

Poster #20. Sowjanya Shankar

Resource Recovery from wastewater – A review of technologies, challenges and benefits

As global population and economic activity continue to grow, the demand for resources increases, leading to concerns regarding resource depletion and environmental degradation. In response, a growing number of scholars and policymakers shift their focus away from residue treatment and towards resource recovery. This shift represents a fundamental transformation of societal production systems, which now seek to maximize the value extracted from waste materials while minimizing waste. Advances in biological processes have made it increasingly possible to recover valuable resources from wastewater treatment. Emerging and current technologies such as anaerobic digestion generating methane, biohydrogen production, and conversion of lipid biomass to biodiesel contribute to the development of sustainable third-generation biofuels. Organic carbon and nutrient recovery technologies open new opportunities for resource recovery. This review also touches up on facility retrofitting for the use of emerging resource recovery technologies, and the challenges associated with it.

Podium Session 2A

2:00 PM to 3:00 PM

Yeh 1311

Sarang Bhagwat (Sustainability)

Sustainable Production of Sorbic Acid viaTriacetic Acid Lactone from Lignocellulosic Biomass

To address climate change by mitigating greenhouse gas emissions, there is a pressing need to replace crude oil with alternative feedstocks to manufacture fuels and products. Lignocellulosic biomass is a promising renewable feedstock for the sustainable manufacturing of biofuels and bioproducts. Triacetic acid lactone (TAL) is a bioproduct that can be upgraded to commercially significant chemicals such as sorbic acid. In this study, we designed, simulated, and evaluated under uncertainty (via techno-economic analysis, TEA, and life cycle assessment, LCA) biorefineries producing sorbic acid from renewable lignocellulosic biomass via fermentation of sugars to TAL. Novel separation processes were designed and simulated based on experimental data. Sensitivity analyses were performed to identify key drivers of costs and environmental impacts. Overall, this research highlights the ability of agile TEA-LCA to screen promising designs, navigate sustainability tradeoffs, prioritize research needs, and establish a roadmap for the continued development of bioproducts and biofuels.

Quanhui Ye (Sustainability)

Lanmodulin-functionalized magnetic nanoparticles as a highly selective biosorbent for recovery of rare earth elements.

Recovery of rare earth elements (REEs) from liquid waste represents a sustainable approach to build an REE circular economy while alleviating the environmental burden. Lanmodulin (LanM) with high REE affinity and selectivity could be harnessed for selective biosorption and recovery of REEs. Immobilization of proteins on magnetic nanoparticles (MNPs) holds great potential to enhance protein stability and enable a facile recovery and reuse of the biosorbent via a magnet. The present work constructed a novel biosorbent (MNP-LanM) by immobilizing LanM on the surface of MNPs and demonstrated its potential for effective and selective REE recovery from low-grade liquid waste. Characterization results demonstrated that the MNP-LanM had efficient REE-binding activity, improved protein stability, good reusability, and high selectivity to recover REEs from leachate of coal fly ash. Results from this study could contribute to the development of innovative technologies for recovering REEs from waste streams for sustainable REE supply.

Yoel Rene Cortes-Pena (Sustainability)

Economic and Environmental Sustainability of Biodiesel Production from Microbial Oil at 1G2G Sugarcane, Energycane, and Oilcane Biorefineries.

The wider production of biodiesel from conventional oilseed crops is limited by low productivity of oil per hectare of land. Microbial oil production and oil-accumulating feedstocks such as oilcane hold the potential to drastically improve oil production in agriculture and meet expected demands for biodiesel. Due to trade-offs oilcane biomass yields, low microbial oil yields, and challenges in oil recovery, it is difficult to determine how does the potential sustainability of vegetative cane oil compare with microbial oil, which fermentation product (oil or bioethanol) is more sustainable, and, critically, whether processing oilcane presents any advantages over processing other sugarcane lines. To address these questions, we evaluated the economic and environmental sustainability of processing oilcane, traditional sugarcane, and energycane with either microbial oil or bioethanol production. Critical research targets were established for oilcane processing and microbial oil technologies to achieve greater financial and environmental sustainability than ethanol production from traditional sugarcane.

Podium Session 2B

2:00 PM to 3:00 PM

Yeh 3310

Joshua Carpenter (Sustainability)

Forest Mapping from Point Cloud Data

Forests provide important resources for human health and prosperity, but these natural resources are faced with challenges from changing weather patterns, disease outbreaks, and growing resource demand from human populations. Ecologically responsible decision-making and forest management need spatially comprehensive and timely tree feature maps to address these challenges. To supply this data, this project develops a method for mapping individual trees. We present an unsupervised method for segmenting individual trees from point clouds. Our novel, canopy-to-root, least-cost routing method segments trees in a single routine, accomplishing stem location and tree segmentation simultaneously without needing prior knowledge of tree stem locations. Testing on benchmark terrestrial-laser-scanned datasets shows that we achieve state-of-the-art performances in individual tree segmentation and stem-mapping accuracy on boreal and temperate hardwood forests regardless of forest complexity. This is a critical step in creating the spatial data necessary for addressing threats to forests.

Binxin Fu (Sustainability)

A clue to the effects of temperature on nanoscale friction of calcite.

The comprehension of the mechanisms governing fault slip is of utmost importance in understanding fault dynamics and earthquake nucleation. The heating process is especially necessary to reproduce the nature of seismogenic zone in the earth crust. In this study, we used high-resolution AFM with in situ heating to investigate the nanoscale friction at single-asperity contacts of calcite under dry and low humidity environments, revealing three logarithmic regimes in the velocity-dependence of friction force at various temperatures. The identification of these regimes, and the associated rate parameters and transition velocities, has important implications for understanding stick-slip behavior and fault dynamics. Our findings suggest that there are multiple mechanisms underlying the influence of temperature on friction, including change of stick slip mode and the evolution of surface topography with temperature. This work provide insights into the influence of heat generated at faults and complement our understanding of RSF laws and shear-assisted thermally activated slip theory, which has important implications for seismic hazard assessment and risk reduction.

Hakyung Lee (Water Quality)

Effects of combined chemical and biological stressors on Microcystis aeruginosa growth and microcystin production: Implications for preventing harmful algal blooms

In light of climate change and anthropogenic nutrient release, harmful algal blooms frequently occur more than ever. Microcystis aeruginosa produces cyanotoxin, microcystin. This study elucidates the synergistic effects of chemical (nutrient limitation and algaecide) and biological (co-existence with no-toxin-producing bacteria) conditions on M. aeruginosa growth and microcystin production. First, phosphorus limitation in sufficient nitrogen presence may increase microcystin production up to 225 fg/cell. Second, a co-cultured system with Synechococcus elongatus (fast-growing non-toxin-generator) under nitrogen-sufficient / phosphorus-limited conditions can suppress microcystin production by 92.4 % compared to the monoculture system. Third, DCMU (3-(3,4-dichlorophenyl)-1,1-dimethylurea) inhibited 95.8 % of M. aeruginosa growth (0.1 mg/L dosage). However, S. elongatus may protect M. aeruginosa from DCMU stresses. Based on these findings, a multi-substrate and multi-species kinetic model has been built to predict microbial growth and toxin production. This study provides new scientific insights into controlling harmful algal growth and microcystin generation under complex environmental conditions.