2019

Chemical Engineering

Rising Stars Workshop

October 10-11, 2019

Massachusetts Institute of Technology

Chemical Engineering

Rising Stars 2019

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2019 Rising Stars in Chemical Engineering Workshop
cheme.mit.edu/rising-stars/

hosted by:
MIT Chemical Engineering
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Cambridge, MA 02139
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A message on behalf of the 2019 Workshop Steering Committee:

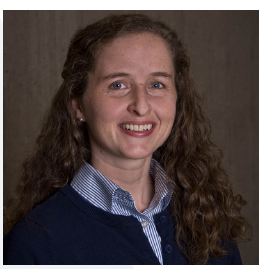
Welcome to the 2019 Rising Stars in Chemical Engineering Symposium!

We are pleased to welcome you to the MIT campus and look forward to hearing about your research and aspirations, as well as helping you to navigate the journey toward a successful and fulfilling academic career.

The goal of this event is to bring together the next generation of leaders in chemical engineering and help prepare them for careers in academia. We aim to help strengthen the academic pipeline for women in our field, and provide opportunities for you to develop your own network of peers as you decide your own next steps.

This 2019 workshop cohort represents some of the top early career women in chemical engineering today. We hope that the next two days of workshops, discussions and presentations inspire you as you find your way in your career.

We hope you find this event informative and inspiring. We look forward to meeting you!



Hadley D. Sikes
Esther and Harold E. Edgerton Career Development Professor

K. Dane Wittrup
Carbon P. Dubbs Professor of Chemical Engineering

Paula T. Hammond
David H. Koch (1962) Professor in Engineering
Department Head, MIT Chemical Engineering Department

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Agenda

Thursday, October 10

8:45am	Breakfast	
9:15am	Welcome and Introduction	Anantha Chandrakasan Dean of Engineering
9:30am	Senior Faculty Panel: Why Academia?	
10:15am	Break	
10:30am	Oral Presentations by Workshop Participants*	
12pm	Lunch in 66-201	
1pm	Panel Discussion: Getting the Job: Strategies for the Next 12 Months	
2:00pm	Faculty Applications 101	
2:45pm	Research Statement Workshop	
3:30pm	Break	
3:45pm	Chalk Talk Workshop and Interview Day Strategies	
4:45pm	Teaching Statement Workshop	
5:15pm	Break	
6:15pm	Dinner with faculty at ArtScience Culture Lab and Café	

Friday, October 11

8:30am	Breakfast	
8:45am	Junior Faculty Panel Discussion	
9:30am	AIChE Meet the Faculty Poster Session Workshop	
10:15am	Break	
10:45am	Discussions with Faculty Hosts	
11:30am	Travel to Lunch with MIT graduate students and postdocs hosts	
12pm	Farewell Lunch Thriving as a ChemE Professor	Maria Zuber Vice President for Research
1:30pm	Wrap-up	

All events are in Room 66-360 unless otherwise noted.

**A detailed schedule and map including faculty meeting and oral presentation details are included in your welcome packet.*

Chemical Engineering

Rising Stars Cohort

2019

Madelyn Ball
Georgia Institute of Technology

Burcu Beykal
Texas A&M University

Dara Bobb-Semple
Stanford University

Aditi Chakrabarti
Harvard University

Ria Corder
North Carolina State University

Elizabeth Corson
University of California, Berkeley

Gözde Demirer
University of California, Berkeley

Fatima Enam
Iowa State University

Stephanie Fernandez
McGill University

Valentina Iganegbei
University of Michigan

Paige Le Valley
University of Delaware

Yayuan Liu
Massachusetts Institute of Technology

Whitney Loo
University of California, Berkeley

Noor Momin
Massachusetts Institute of Technology

Mai Ngo
University of Illinois, Urbana-Champaign

Nisha Sosale
University of Virginia

Candice Swift
University of California, Santa Barbara

Eden Tanner
Harvard University

Lauren Taylor
Rice University

Nicole Thadani
Harvard Medical School

Madelyn Ball

Georgia Institute of Technology

Madelyn Ball was born and raised in Potsdam, NY, a small town near the Adirondacks. She obtained her B.S. in Chemical Engineering from the University of New Hampshire in 2010. During her time as an undergrad, she developed a passion for exploring the world through research, working on a range of research projects, including work on catalytic upgrading of biomass pyrolysis vapors. This work introduced Madelyn to catalysis and inspired her to continue studies in the field. She received her Ph.D. in Chemical Engineering from the University of Wisconsin – Madison under the supervision of James Dumesic in July 2019. She is currently a postdoctoral research fellow at Georgia Institute of Technology in the group of Christopher Jones. Outside of the lab, Madelyn is an enthusiastic cook and enjoys hiking and running.

Insights into active site structures for Pd-based bimetallic heterogeneous catalysts

Catalytic reactions play a vital role in the production of fuels and chemicals for our growing world. The development of new catalysts for chemical transformations is hindered, however, by a reliance on empirical knowledge due to system complexity. Without detailed structure-activity relationships for many systems, a trial and error method is often used to identify appropriate catalyst formulations. If we can elucidate the controlling factors of catalyst performance, then, a priori, we can design the best catalyst structure for a particular transformation. My research program will aim to address some of the limitations of current heterogeneous catalyst development through well controlled synthesis techniques. Novel active site structures and surrounding environments will be developed using well-controlled synthesis techniques. Furthermore, in situ characterization will be used to bridge the gap between catalyst structures as-synthesized and under reaction conditions and obtain an extensive library of structure-activity information. This systematic and detailed approach will enable the rational design of new catalytic materials for a range of reaction systems. This research will enable the development of new catalysts used to meet the energy, chemical, and food needs of a growing world population in an environmentally friendly manner.

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Burcu Beykal

Texas A&M University

Originally from Istanbul, Turkey, Burcu received her B.S. in Chemical and Biological Engineering from Koc University. During her undergraduate studies, she worked on developing MEMS sensors for measuring the density and viscosity of supercritical fluids. After graduating Koc University with honors, Burcu joined Carnegie Mellon University for her M.S. degree in Chemical Engineering. In her Master's, she investigated the interaction of biological foulants with charged electrode surfaces for the characterization of fouling dynamics in capacitive deionization electrodes. Thereafter, she joined Texas A&M in Fall 2015 where she's currently a 5th year PhD candidate working on the global optimization of data-driven systems. Throughout her academic career, she's co-authored 9 original research articles, 3 conference proceedings and gave 23 presentations in both national and international conferences. Additionally, she's serving as a journal reviewer for Computers & Chemical Engineering, Journal of Global Optimization, Computational Geosciences, and International Journal of Electrical Power & Energy Systems.

Data-Driven Modeling and Global Optimization of Constrained Grey-Box Computational Systems

The effort to mimic a chemical plant's operations or to design and operate a completely new technology in silico is a highly studied research field under process systems engineering. As the rising computation power allows us to simulate and model systems in greater detail through careful consideration of the underlying phenomena, identifying the optimal design/operating criteria of such systems becomes a formidable challenge due to the noise, complexity, the lack of analytical forms and the computational expense associated with the calculation of the derivatives. Hence, the goal of my dissertation research is to develop computational algorithms for solving large-scale complex optimization problems without the full knowledge of the underlying mathematical model (black-box) through amalgamating data-analysis, data-driven modeling and global optimization theory. Several application areas of my research in process systems engineering include nonlinear programming, multi-objective optimization, bi-level mixed-integer nonlinear programming, dynamic optimization, and problems containing stiff ODEs.

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Dara Bobb-Semple

Stanford University

Dara Bobb-Semple is a proud native of Guyana who earned her BS in Chemistry from Stony Brook University. She is currently a PhD candidate in the Chemical Engineering department at Stanford University. Her research in Prof. Stacey Bent's group focuses on investigating new methods in area selective atomic layer deposition, an emerging technique in the field of nanoscale fabrication. She seeks to do so by developing a fundamental understanding of the surface chemistries governing selective processes. The overarching goal of her work is to develop robust and generalizable chemistries that can be easily incorporated into manufacturable fabrication schemes. While at Stanford, she has built up and served as president of the Black Engineering Graduate Student Association. She is committed to mentoring, and recruiting students from traditionally underserved populations and was instrumental in founding the Stanford Exposure to Research and Graduate Education program in the School of Engineering.

Toward an Understanding of SAM-based Area Selective ALD on metal/dielectric substrates: Comparison Cu, Co, W and Ru

Device fabrication today is based on 'top-down' processes with multiple lithography and etching steps which serve as a bottleneck as well as a source of errors in device miniaturization. Area-selective atomic layer deposition (AS-ALD) shows promise in addressing some of these challenges. While there are many strategies for achieving AS-ALD, self-assembled monolayers (SAMs)-based approaches have shown significant promise. Typically, the SAMs are used as inhibitors against ALD deposition. Incorporating SAM-based processes into nanofabrication schemes require an understanding of how SAM molecules interact with different materials and how this is turn affects the selective deposition process. In this work the formation of octadecylphosphonic acid (ODPA) is studied on several metal substrates: Cu, Co, W and Ru. The ability of the layer formed on each substrate to block ALD of Al_2O_3 and ZnO is also evaluated. Near edge X-ray absorption spectroscopy, X-ray photoelectron spectroscopy and transmission electron microscopy (TEM) are used to develop a more complete understanding of ODPA formation and blocking on metals.

Aditi Chakrabarti

Harvard University

Aditi Chakrabarti is currently a postdoctoral fellow in the group of Professor L. Mahadevan in the School of Engineering and Applied Sciences at Harvard University. Her research interests are in biophysics, pattern formation and elastocapillarity in soft matter. She recently spent her summer in the Marine Biological Lab, Woods Hole attending the Physiology course to expand her knowledge of simple biological systems with which to study questions pertaining to mechanical feedback and functioning of biological "living" materials. Prior to this, Aditi received her Ph.D. in Chemical Engineering from Lehigh University in 2017, working on problems related to large deformation and elastocapillarity of soft materials, under the tutelage of Professor Manoj K. Chaudhury. Her undergraduate studies were back in India, where she obtained her Bachelor of Technology in Chemical Engineering in 2012. Aditi is enthusiastic about teaching and wants to impart her extensive experience in interdisciplinary experimental work via hands on training to young students, as she thinks that is the best way to learn and do something new!

Pattern Formation in Soft Materials

Aditi works at the interface of physics of soft materials and its implications in biology. In the past, her research involved studying various aspects of deformability in soft solids such as hydrogels and thin films of elastomers including phenomena that arise due to the interplay between surface tension, elasticity, gravity and adhesion. She has looked at how thin films of hydrogel lose adhesion from a rigid substrate by forming interfacial patterns, which has implications in understanding fracture and failure of adhesives. She found that the wavelength of such interfacial patterns formed in soft films depends on both surface tension and elasticity, whereas for stiffer elastic films, the wavelength of patterns only depends on the elastic modulus. She has worked on the elastic Rayleigh Taylor instability using thick elastic layers that undergo hexagonal buckling when they are subjected to their own weight due to gravity. In addition, she discovered a novel strategy to self-assemble particles inside or on the surface of an elastic substrate using elastic strain mediated interaction forces. The physics of elastic self-assembly of particles on gel is directly relevant to movement of macromolecules or nanoparticles on thin lipid bilayers in biological systems. Since biological materials such as cells and tissues are very similar to soft matter, she is now exploring how mechanics might affect the growth and pattern formation in developmental systems in biology. She is interested in understanding how feedback mechanisms shape patterns and in turn affects function in simple biological systems.

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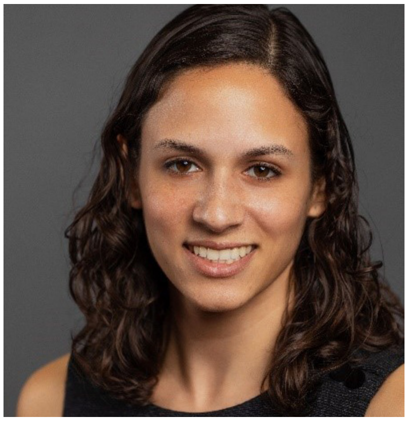

Ria Corder

North Carolina State University

Originally from Davis, California, Ria Corder is an NSF Graduate Research Fellow and Ph.D. candidate in the Department of Chemical and Biomolecular Engineering at North Carolina State University, working under the direction of Dr. Saad Khan. While at NC State, she has participated in the Preparing the Professoriate program and has served as a Mentored Teaching Fellow in the College of Engineering. Ria previously received both bachelor's and master's degrees in chemical engineering from The University of Alabama, where she was also a four-year member of their NCAA Division I gymnastics team.

Light-induced synthesis of ionic liquid-based gels

Ria's doctoral research centers around applying rheological measurement techniques to complex and dynamic soft materials. She currently works on two main projects; in the first, she uses rheology to quantify in vivo enzymatic degradation of uterine fibroids and xenograft breast cancer tumors to evaluate the effectiveness of novel injectable collagenase treatments on softening tissues and reducing metastasis. She has demonstrated that these injectable treatments can significantly reduce the modulus and increase the viscoelasticity of both benign (uterine fibroid) and metastatic (breast cancer) tumors. The mechanical response can then be related to the physiological response to gain a more complete understanding of treatment effects. Ria's second project uses photorheology to characterize in situ photopolymerization and gelation of coordinated ionic liquids (ILs) formed from mixtures of 1-vinylimidazole (the polymerizable monomer) and lithium bistriflimide salt. Her results indicate that at moderate salt levels, lithium cations can act as physical crosslinks between growing polymer chains leading to the formation of a strong gel network. Gelation is inhibited at higher salt levels due to electrostatic repulsion and lithium cation shielding by bistriflimide anions. The highest mechanical properties are thus achieved only at moderate salt levels, which had not been previously observed for coordinated IL systems. The more thorough understanding of material behavior during photopolymerization gained from this work can then be used to help engineer photocured IL-based systems with tailored mechanical properties, for applications such as battery polyelectrolytes and chemical-resistant coatings and adhesives.

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Elizabeth Corson

University of California, Berkeley

Elizabeth is a Ph.D. candidate in Chemical Engineering at UC Berkeley under the advisement of Professor Bryan McCloskey. She is at TU Delft in The Netherlands this semester as a guest researcher with Professor Ruud Kortlever through the NSF GROW program. Originally from Iowa, Elizabeth received her B.S. in Chemical Engineering from the Illinois Institute of Technology in Chicago. Before graduate school Elizabeth worked as a Research Associate at Air Liquide where she studied carbon dioxide capture from coal-fired power plants using polymeric hollow fiber membranes.

Directing Selectivity of Electrochemical Carbon Dioxide Reduction Using Plasmonics

Elizabeth researches plasmon-enhanced photoelectrochemical carbon dioxide reduction at the Joint Center for Artificial Photosynthesis at Lawrence Berkeley National Lab. Using inputs of only sunlight, electricity, carbon dioxide, and water, photoelectrochemical carbon dioxide reduction could help mitigate climate change while producing valuable fuels or chemical feedstocks. Current carbon dioxide reduction technologies suffer from high overpotentials and low selectivity, producing a mixture of carbon monoxide, methane, ethylene, formate, methanol, and other products. Elizabeth seeks to address these challenges by developing nanostructured plasmonic electrodes that, upon illumination, generate plasmonic hot-carriers and strong local electric fields that can alter product selectivity. She demonstrated that illumination of a voltage-biased plasmonic silver cathode selectively enhances carbon dioxide reduction products while simultaneously suppressing undesired hydrogen evolution.

Gözde Demirer

University of California, Berkeley

Gözde S. Demirer is a PhD candidate in the department of Chemical and Biomolecular Engineering at the University of California, Berkeley. She received her B.S. in Chemical and Biological Engineering from Koc University, Turkey, as the 2015 valedictorian, where she worked on the advancement of cancer therapeutics by targeted nanoparticles for drug delivery. Demirer's current PhD thesis research in the Landry lab pioneers the development of nanoparticle-based delivery vehicles for plant genome engineering applications for food security and advances in sustainable agriculture. She has been awarded a 5-year Schlumberger Foundation Faculty for the Future fellowship, and she is expected to graduate in May 2020. Demirer was recently selected for the ACS Merck Research Award, and Women's Initiative Committee's (WIC) Travel Award. She has also won the Carbon Nanomaterials, and Bionanotechnology Graduate Student Award Sessions at AIChE 2017 and 2018 annual meetings, respectively. She has authored over 12 peer-reviewed publications and is a co-inventor on 2 patents, including the first nanomaterial-based gene delivery platform for GMO-free agricultural biotechnologies. Demirer is interested in advancing her academic career as an independent researcher and teacher, and is eager to solve life sciences problems using nanotechnology.

Plant Genome Engineering with Nanotechnology for Agricultural Applications

Food security is threatened by decreasing crop yields and increasing food consumption in the midst of climate change and population growth. To mitigate these threats, genetic engineering of plants can be employed to create crops that have higher yields and nutritional value, and are resistant to biotic and abiotic stresses. Despite the significant progress in genome editing, most plant species remain difficult to genetically engineer. The development of a transformation tool that is (i) plant species-independent, (ii) non-pathogenic, and (iii) non-transgenic will greatly advance agricultural biotechnology. In her doctoral work, Demirer developed a nanomaterial-based gene delivery platform that efficiently delivers genes into agriculturally-relevant plants in a pathogen- and force-independent manner, without transgene integration into the plant genome. She showed delivery of plasmid DNA to mature tobacco, arugula, cotton, and wheat leaves with engineered carbon nanotubes. Importantly, she revealed that exogenous DNA does not integrate into plant genome, relevant for avoiding costly and lengthy GMO regulatory oversight (Demirer et al. Nature Nanotechnology 2019). Next, Demirer implemented this platform to deliver CRISPR plasmids, and obtained stable editing of target genes without transgene integration. In parallel, she developed a different nanoparticle surface chemistry for delivery of small interfering RNA (siRNA) for DNA-free gene knock-down. She demonstrated 95% gene silencing efficiency via direct delivery of siRNA with nanoparticles (Demirer et al. BioRxiv 2019). In a separate study, Demirer systematically investigated the effect of nanomaterial parameters on plant cell uptake and gene silencing pathways, which elucidated the underlying principles of plant nanoparticle internalization and showed that plant endogenous gene silencing mechanisms can be altered by the nanostructure shape and the siRNA attachment locus (Demirer* and Zhang* et al. PNAS 2019). Finally, Demirer implemented next-gen RNA sequencing to investigate the effect of nanomaterials on the plant transcriptome.

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Fatima Enam

Iowa State University

Fatima Enam is a fourth year PhD student in the Chemical and Biological Engineering department at Iowa State University. Lying at the intersection of synthetic biology and the gut microbiome, her research interests include engineering biological systems and expanding the repertoire of chemistry compatible with these living processes. She received her B.S. in Chemical Engineering from Bangladesh University of Engineering and Technology in 2014. Following graduation in October 2019, she will be starting as a postdoctoral fellow in the laboratory of Dr. Justin Sonnenburg at Stanford University School of Medicine.

Novel Approaches for Prebiotic Detection and Control of Microbial Communities

The gut microbiome plays a profound role in health and disease and their disruption has been linked to mortality and morbidity worldwide. My research focuses on understanding the role of prebiotic oligosaccharides in microbial communities with the intention of engineering them for improved human health outcomes. Of the many important oligosaccharides, human milk oligosaccharides (HMOs) have been linked to the bifidus factor that promotes the colonization of healthy microflora in the gut and protecting breast-fed infants against diarrhea and other infections. Synthesis of these complex sugars in microbial hosts offers a versatile, convenient alternative to the more expensive and challenging chemical and enzymatic methods. However, optimization of production is limited by the relatively low throughput of detection. I have developed a whole-cell biosensor platform for the high-throughput detection of HMOs for massively parallel optimization of their biotechnological production. My work also revealed a growth-based selection that relies on the ability of the engineered cells to utilize complex carbohydrates, closely mirroring the relationship between prebiotic HMOs and bifidobacteria in the infant gut. This will allow me to study the synergistic interplay of prebiotics and probiotics in synthetic microbial communities, and pave the path for building custom “synbiotics” for tighter control of engineered probiotics for delivery of small molecules and therapeutics.

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Stephanie Fernandez
McGill University

Stephanie Fernandez is a doctoral candidate under the supervision of Profs. Corinne Hoesli and Richard Leask at McGill University, Montréal, Canada. She earned two undergraduate majors in Biochemistry and Chemical Engineering and has performed research in the fields of cardiovascular biomechanics and diabetes cell therapy. In addition to academic research, Stephanie is passionate about community engagement and is a leader in mental health and social equity initiatives in the Montréal area. Notably, she is the founder and current Managing Director of the Graduate Engineering Equity Committee (GEEC) at McGill University, which designs spaces for the exploration of topics related to social equity, diversity, and inclusion with a focus on the culture in STEMM.

Engineering robust 3D cell culture platforms to investigate complex heterogeneous tissue constructs

Based in the Stem Cell Bioprocessing Laboratory (hoeslilab.com), Stephanie's doctoral thesis aims to develop an artificially vascularized islet macroencapsulation device as a potential therapy for type 1 diabetes. This project focuses on investigating hypoxic effects due to oxygen diffusion limitations within macro-scale tissue engineering devices and 3D cell culture systems. Hypoxia is a major barrier to developing thick tissue constructs for in vitro and in vivo applications but may be resolved by generating convective mass transport via artificial vascular networks. Using engineering principles of fluid mechanics and mass transfer, Stephanie's chief goals are to: design an in vitro system suitable for long-term perfusion cell culture; and to assess the oxygen distribution within this system with different artificial vascular geometries, ultimately proposing a model for optimizing encapsulated islet performance.

Valentina Igenegbai

University of Michigan

Valentina Omoze Igenegbai is a Ph.D. Candidate in Chemical Engineering and a Rackham Predoctoral Fellow at the University of Michigan, working under Professor Suljo Linic. Her Ph.D. research is focused on the development of catalysts and solid oxide membrane reactors for direct conversion of natural gas into value-added chemicals. She is a recipient of the AIChE Catalysis and Reaction Engineering (CRE) and Janice Lumpkin Travel Awards, and currently serves as a Graduate Student Director for the AIChE CRE division. She obtained her undergraduate degree from the University of Sheffield (UK), graduating with a first-class honors MEng in Chemical Engineering with Fuel Technology.

Developing catalytic solid oxide membrane reactors for application in natural gas conversion

Developing direct routes for converting methane (main component of natural gas) into value-added chemicals is crucial for integrating the abundant shale natural gas into the chemical industry in a more environmentally sustainable way. Current direct methane conversion routes typically give low product selectivity, thus require costly separation. An approach to solving this problem is to utilize catalytic membrane reactors that allow distributed addition or removal of reactants or products. This approach can drive the reactions towards higher product selectivity and yield. In my PhD research, I investigated the application of solid oxide membrane reactors (oxygen-ion conducting) in a promising direct methane conversion technology i.e., the oxidative coupling of methane (OCM) to C2 hydrocarbons. My results show that the membrane reactors can give significantly higher C2 selectivity and yield compared to conventional packed bed reactors. However, there are several challenges that hinder the widespread application of these membrane systems, such as limited ion transport rates and low active surface areas. My future research aims to address these challenges using a combined experimental and modeling approach with an end goal of optimizing the performance of these systems in OCM and related chemistries.

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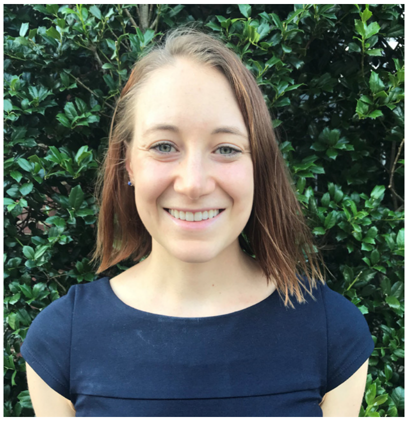

Paige Le Valley

University of Delaware

Paige is completing her thesis entitled 'Tunable and on-demand hydrogel networks for the controlled delivery of proteins toward personalized therapeutic platforms' at the University of Delaware (UD) under the guidance of Prof. April M. Kloxin. Specifically, her work focuses on the design and characterization of hydrogels containing responsive crosslinks toward the controlled delivery of antibodies for the treatment of chronic wounds or cancers. Paige completed her master's degree at the University of Wyoming under the supervision of Prof. John Oakey. Here, her studies focused on engineering a hydrogel capture and release surface for the detection of rare cells from blood samples toward the development liquid biopsies. During her tenure at UD, Paige has received several awards including a Sigma Xi Grants in Aid, the University of Delaware Dissertation Fellowship, and the Chemical and Biomolecular Engineering (CBE) Teaching Fellow. She also led the CBE graduate student outreach efforts and helped start a peer mentoring program focused on improving graduate student mental health. Outside of work, Paige enjoys traveling, baking, hiking, and running.

Addressing challenges associated with long term disease treatment in low resource settings utilizing responsive hydrogel depots

In low resource settings, the treatment and prevention of diseases, such as tuberculosis and HIV/AIDS, can be challenging due to difficulties associated with accessibility to clinics and therapeutics. In addition, many of these diseases require long-term therapeutic administration which can lead to poor patient compliance. Injectable therapeutic regimens provide an opportunity to address these problems by decreasing the burden associated with clinical visits. By providing injectable depots that deliver therapeutics over weeks to months, this approach provides a mechanism of treatment that decreases the number of required clinic visits, leading to better patient compliance and treatment outcomes. Materials that are injectable and programmed to respond to their environment are advantageous for delivering therapeutic cargos in a controlled and tunable manner through the incorporation of cleavable linkages. Hydrogels, highly water swollen polymer networks, are of interest for this application because of their hydrophilic nature, ease of modification, and biocompatibility. Therapeutics can either be directly encapsulated into the hydrogel network or linked to the network to control their incorporation and subsequent release. The rate of release can be controlled either by degradation of hydrogel crosslinks or the linkers attaching therapeutics to the network to provide therapeutic delivery over weeks or months with a sustained release profile within the required therapeutic region. Overall, injectable therapeutic regimens can be created through thoughtful material design over multiple time and length scales as a motif toward addressing challenges associated with disease treatment and prevention in low resource settings.

Yayuan Liu

Massachusetts Institute of Technology

Yayuan Liu is a post-doctoral associate in the Department of Chemical Engineering at the Massachusetts Institute of Technology (MIT), working with Professor T. Alan Hatton. She received her bachelor's degree in Materials Science and Engineering from Nanyang Technological University in 2014, and her doctorate in Materials Science and Engineering from Stanford University in 2019 under the supervision of Professor Yi Cui. Yayuan's PhD research integrated electrochemistry, nanomaterials and advanced characterization techniques to improve the design and fundamental understandings of next-generation battery chemistries and electrocatalysis. In Professor Hatton's group at MIT, Yayuan is currently working on electrochemically-mediated separation processes for the mitigation of environmental problems.

Materials Design and Electrochemical Methods for Water-Energy-Environment Nexus

During her PhD, Yayuan worked on metallic lithium anode, which is the ultimate battery chemistry for its highest theoretical capacity, yet extremely challenging due to the notoriously high reactivity of lithium metal and its infinite volume change during battery cycling. To tackle these key challenges, Yayuan pioneered a series of materials design methodologies to effectively minimize volume change; and with the aid of advanced microscopy and spectroscopy techniques, she studied novel electrolyte formulation to improve lithium metal stability and discovered a new side-reaction mechanism that had then been overlooked by the battery community. As a postdoc, she is currently exploring different redox chemistries and designing stimuli-responsive membranes for electrochemically-mediated carbon capture, which can be more energy efficient than the state-of-the-art carbon capture technologies based on thermal processes.

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Whitney Loo

University of California, Berkeley

Whitney is a 5th year Ph.D. student in Chemical and Biomolecular Engineering at UC Berkeley working in Nitash P. Balsara's research group. She received her S.B. in Chemical Engineering from MIT in 2015. Her current research focuses on synthesizing and characterizing block copolymer electrolytes for applications in next-generation batteries. When she's not in the laboratory or at the beamline, Whitney practices and teaches yoga.

Connecting Polymer Physics Fundamentals to Performance Metrics for Energy Applications

Microphase separated block copolymer/salt mixtures, in which one microphase is mechanically rigid and the other solvates and transports salt ions, are promising electrolytes for high energy density lithium metal batteries. It is well-known that the addition of salt to diblock copolymers greatly affects their thermodynamics and phase behavior, and that the ion transport abilities of the electrolyte are highly dependent on copolymer morphology and the local motion of the polymer chains. We use a variety of characterization techniques, including X-ray and neutron scattering, to determine the morphology, quantify the thermodynamics, and measure the segmental dynamics of the block copolymer electrolytes. These experiments are used in conjunction with electrochemical measurements to develop structure-property relationships between fundamental polymer thermodynamics and battery performance with the hope of designing more efficient battery electrolytes.

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Noor Momin

Massachusetts Institute of Technology

Noor Momin is a fifth-year NSF graduate research fellow in the laboratory of Prof. K. Dane Wittrup at the Koch Institute for Integrative Cancer Research. Her thesis focuses on engineering improved immunotherapies for the treatment of cancer. In the lab, she enjoys mentoring several undergraduate students and guiding their development into confident, curious, critical thinkers. Prior to MIT, Noor received her bachelors in Biomedical Engineering from the University of Texas at Austin. Her hobbies include cooking international cuisines and attempting to run.

Intratumoral collagen-anchored immunotherapies

Despite broad efforts, delivery of immune agonistic cytokines via systemic administration is plagued by poor therapeutic indices, due to extensive off-target exposure. We are examining the fundamental micropharmacokinetic issues of intratumoral administration and find that intratumorally-injected immune agonists retained on collagen can exert profound therapeutic effects while largely sparing from systemic exposure or toxicity.

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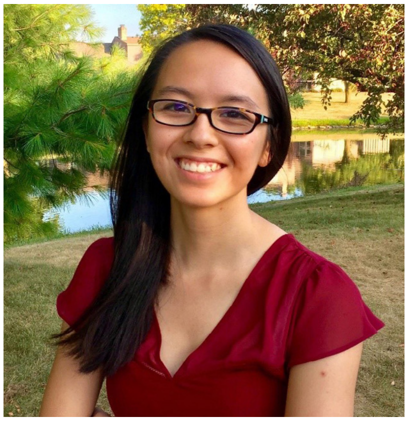

Mai Ngo

University of Illinois, Urbana-Champaign

Mai is a Ph.D candidate in Professor Brendan Harley's lab at the University of Illinois Urbana-Champaign. Prior to her graduate studies, she attended Virginia Tech and received a B.S. in chemical engineering with minors in chemistry and interdisciplinary science and engineering. She is interested in developing biomaterials as therapeutic platforms and culture models for studying various diseases. She is also interested in promoting K-12 STEM education and providing mentoring for females in STEM. She is a recipient of the NSF Graduate Research Fellowship and is a former Mavis Future Faculty Fellow at the University of Illinois. Outside of research, Mai enjoys running, rock climbing, and baking.

Biomaterials to Understand and Modulate Cell-Cell Interactions

Mai is currently developing biomaterial culture models to study glioblastoma (GBM), the most common primary malignant brain tumor. Patients with GBM have a median survival time of one year, and there is a critical need to gain new insight into the mechanisms governing GBM progression with the end goal of developing more effective therapies. Interactions between GBM tumor cells and vasculature in the tumor microenvironment have been implicated in promoting GBM invasion, cancer stem cell maintenance, and therapeutic resistance. We have established gelatin-based hydrogels that can support co-culture of tumor and vascular cells to develop artificial vascularized tumor microenvironments. We have shown that this culture platform recapitulates key aspects of tumor-vascular cell interactions, transcriptomic patterns, and drug response observed in actual tumors. We are currently using the platform to explore the effects of vascular-derived soluble factors on tumor cell behavior, as well as the mechanisms by which vasculature impacts cancer stem cell maintenance.

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Nisha Sosale

University of Virginia

Dr. Nisha G. Sosale is currently a postdoctoral fellow at the University of Virginia. She earned her bachelor of science at the Rutgers School of Engineering in 2005. After completing degree, Nisha accepted a position as an engineer at Merck's Cell Culture and Vaccine Bioprocess Development laboratories, where she participated in the development of vaccines and antibody therapeutics. She earned her PhD from the University of Pennsylvania in Chemical Engineering in 2014, working with Prof. Dennis Discher. In her thesis work she studied CD47-SIRPA mediated inhibition of macrophage phagocytosis. To support this work, Nisha was awarded the Integrative Graduate Education and Research Traineeship (IGERT) fellowship through the University of Pennsylvania's Nanobiointerface Center. After completing her thesis work, Nisha took a Transatlantic Partnership for Excellence in Engineering Fellowship at the Max Planck Institute of Colloids and Interfaces working with Prof. Reinhardt Lipowsky and Dr. Rumiana Dimova where she completed work initiated during her PhD. In 2015 Nisha accepted a postdoctoral position at the University of Pennsylvania with Prof. Matthew Lazzara. She helped move the lab to the University of Virginia in 2016, where she has been since that time. In Dr. Matt Lazzara's laboratory Nisha focuses on investigating the role of a multifunctional adaptor protein, Sprouty2, in regulating drug resistance and adhesion of GBM tumors and in regulating interactions between GBM cells and macrophages using statistical models. Nisha was awarded the Ruth L. Kirschstein National Research Service Award (NRSA) Individual Postdoctoral Fellowship (F32) to support this work.

Understanding Signaling Mechanisms with Statistical Models

Nisha's long-term goal is to conduct multi-disciplinary cancer research as a faculty member at a research university. Through the course of her PhD work, she became interested in the cell signaling underlying how biophysical properties of target cells regulate macrophage phagocytosis. She believes that these signaling processes are key to deriving novel insights into how macrophages influence the tumor microenvironment. During her postdoctoral work, she received training in several methods used to quantify cell signaling including multiplexed Luminex assays. These sorts of signaling analyses result in large datasets that require the use of systems biology approaches to fully capitalize on the information encoded within the datasets. During her postdoctoral fellowship she also received training in computational modeling methods, specifically in the use of PLSR to identify signaling molecules that most highly contribute to variability in cancer cell phenotype. In her future work, Nisha aims to conduct novel and relevant basic research that progress the development of macrophage-targeted therapeutics for cancer.

Rising Star 2019

Candice Swift

University of California, Santa Barbara

Candice Swift has a passion for protecting our planet and improving the quality of life for humankind, andshe believes these two objectives can be simultaneously achieved through scientific innovation. She was attracted to chemical engineering because as a discipline it has the power to meet society's toughest challenges across a broad spectrum of sectors. She attended UW Madison for her undergraduate education. She worked in industry for five years (UOP Honeywell, Valero, and Veolia), with roles ranging from process engineering to design, before returning to pursue a PhD at UC Santa Barbara in the O'Malley lab.

Leveraging the power of microbes to meet society's challenges: a natural solution

More than half of natural product-derived drugs approved by the FDA over the past century were sourced from bacteria and fungi (Gareiss et al., 2016). However, previous discoveries have focused disproportionately on certain phyla, such as actinobacteria and ascomycetes, leaving the potential of other biodiversity barely explored. The microbiomes of large herbivores such as cows, horses, and goats are a rich source of microbial diversity and undiscovered natural products. Anaerobic gut fungi are important members of these microbial consortia, which exist in extremely small numbers compared to other rumen microbes. The genomes of anaerobic gut fungi encode an arsenal of natural products on the order of 50 core biosynthetic enzymes per genome. The focus of my thesis is understanding how anaerobic gut fungi use natural products to compete and coexist with other consortia members. Beyond my thesis, I am interested in developing biotechnology sourced from microbial systems to meet current and future needs of society. Critical to this end is achieving a fundamental understanding of microbial interactions with each other, with their environment, and with humans.

Eden Tanner

Harvard University

Eden completed her undergraduate studies as a Chemistry major at the University of New South Wales in Sydney, Australia. She continued on to complete a DPhil at the University of Oxford as a Clarendon Scholar in Physical and Theoretical Chemistry with a thesis titled "Nanoelectrochemistry in Room Temperature Ionic Liquids". Currently, Eden is working with Samir Mitragotri at Harvard University on the application of ionic solvents to drug delivery.

Ionic Solvents for Transdermal Drug Delivery

Ionic solvents consist of anions and bulky, asymmetric organic cations that are liquid below 100°C. They have a range of favorable properties such as low volatility, recyclability, and tuneability, meaning that structural changes in the ionic components result in different observed properties. Recently, this solvent class has been employed in a biomedical context, showing great promise particularly as drug delivery agents. I seek to understand the microscopic interactions within the solvent in order to create predictive frameworks that allow the synthesis of task-specific designer solvents to overcome unsolved biomedical challenges.

Rising Star 2019

Lauren Taylor
Rice University

Lauren Taylor is a PhD Candidate in Chemical and Biomolecular Engineering at Rice University in Matteo Pasquali's laboratory. She was a 2015 National Defense Science and Engineering (NDSEG) fellow. Her research focuses on understanding the effect of solution processing parameters on the structure and properties of carbon nanotube fibers. She received her B.S. in Chemical Engineering from Cornell University in 2014 where she researched electrolyte materials for intermediate temperature solid oxide fuel cells. Her future research interests include material development for electronic textiles and woven sensors.

Multifunctional Fibers for Electronic Textiles and Sensors

Electronic textiles and wearable sensors have gained significant interest as a way to seamlessly monitor and relay information about an individual's wellbeing. The technology can be used to monitor vital signs and location of military personal, track progress for individuals undergoing physical therapy, and notify users of hazardous environments. Current wearable technology often utilizes wearable patches for biological sensing. These patches must be changed out periodically because they limit airflow to the skin, and they are one-time use. To overcome this setback, there has been a push towards integrating sensors and circuitry directly into clothing. Current electronic fibers tend to suffer for poor flex fatigue and other durability issues because they rely on small, metal fibers or electroplating. My research would aim to create multifunctional fibers through solution processing techniques. This would allow for the development of more mechanically robust fiber and better control and tuning of fiber properties. Once fabricated, the fibers would be characterized for strength, bending stiffness, flex fatigue, washability, and sensing performance. Finally, fibers would be woven to create fully integrated electronic textiles.

Rising Star 2019

Nicole Thadani

Harvard Medical School

Nicole Thadani is a post-doctoral fellow in Systems Biology at Harvard Medical School with Dr. Debora Marks. Nicole completed her undergraduate degree in Bioengineering at Caltech with a focus on synthetic biology. After graduation, Nicole worked at Acumen, LLC in San Francisco, studying vaccine efficacy in the Medicare population. Nicole completed her doctorate at Rice University with Dr. Junghae Suh, developing platforms for engineering adeno-associated virus to enhance its utility as a gene therapy vector. In her current work, Nicole focuses on applying generative models to utilize information from natural sequence diversity for the task of protein design.

Harnessing biological sequence diversity to accelerate the design of optimized proteins

Modern protein engineering has been driven by parallel approaches in the directed evolution of native proteins and the rational design of modifications to native proteins, or in recent years, the development of entirely de novo sequences. As the available breadth of natural and synthetic protein sequence data continues to grow, there is increased potential for using this information to inform the design of diverse libraries of new synthetic sequences with the desirable properties of their extant counterparts. We are interested in developing models of the functional constraints on protein families and using these models to generate new 'fit' sequences that are diverse from one another and from native proteins, with the goal of producing libraries that retain the core functionality of the family. Directed-evolution approaches may then be used to screen these variants for desired traits. This approach can probe further into the space of functional proteins than achieved by deep mutational scanning or other typical library-design strategies. Such diverse libraries are particularly appealing for design goals that benefit from extensive variation away from the known sequence space, such as the development of new antibodies or the retargeting of therapeutic vectors to novel cell populations or tissues.

Chemical Engineering

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