# Dr. Gregory Barding

The Barding Lab is interested in elucidating the complex biochemical mechanisms responsible for organism survival by monitoring changes in metabolite levels (metabolite profiling) in the presence and absence of the stressors. By incorporating a variety of analytical techniques, including liquid and gas chromatography coupled with mass spectrometry, nuclear magnetic resonance, and UV/Vis spectroscopy, a broad representation of metabolites can be quantitatively measured, including TCA cycle intermediates, glycolysis intermediates, and amino acids. Understanding how metabolism and energy flux changes during the presence or absence of stress will aid in our understanding of the stress response of the organism. The Barding Lab is currently working on several projects related to metabolomics and organism stress, including biofuel production, crop production, soil toxicity, and probiotic-containing ruffage

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# Dr. Timothy Corcoran

Our group plays with light in interesting and useful ways. We develop novel spectroscopic imaging techniques and instrumentation, mostly visible or near-infrared laser-based. Several projects are under way: 1) High-speed fluorescence spectroscopy for flowing capillary analysis of biomaterials with multiple fluorescent tags (Supercontinuum Rapid Excitation-Emission Matrix detection). 2) Raman imaging microscopy, finding the chemical fingerprints of surfaces. 3) Rapid, compact fluorescence confocal microscopy, aiming for 3D imaging of biological samples easily and cheaply. 4) Hyperspectral imaging (visible to near-infrared) for agricultural applications, helping farmers make best use their water. 5) Digital filter functions for immediate analysis of large spectroscopic data sets, such as hyperspectral or Raman imaging or in combined analytical techniques such as gas chromatography-mass spectrometry.

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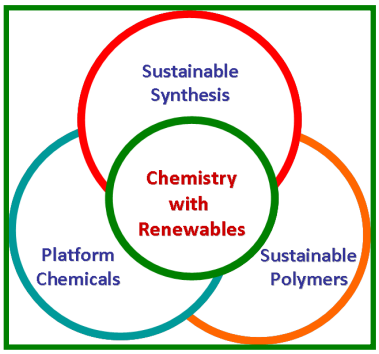
# Dr. Alex John

Fossil resources have abundantly supplied for our energy, fuel, material and consumer needs etc. over the last century. Concern over its dwindling supplies together with environmental impacts from its exorbitant use has resulted in a global hunt for alternate sustainable resources. The scientific community has thus been faced with the challenge of identifying suitable substitutes or replacements for our current petrochemical feedstock. While solar, wind, fuel cells etc. can help us meet our energy needs of the future, biomass being the source of renewable carbon atoms could supply for our chemical feedstock. However, biomass and biomass derived being structurally, compositionally and functionally different from petrochemicals demand the development of alternate methods for their efficient utilization. From a synthetic chemist's perspective this calls for a paradigm shift in how we think about our starting materials, reagents, catalysts, solvents and so on.




Keeping this in mind, my research program is directed towards efficiently incorporating biomass derived molecules in chemical processes. Research in the group scours different inter-related aspects like, (*a*) developing synthetic methods that use renewables, (*b*) converting bio-derived molecules into platform chemicals or feedstocks, and (*c*) developing sustainable plastics sourced from biomass. Our research group is developing methods for incorporating biomass-derived molecules in chemical processes. The first two projects involve developing efficient transition-metal catalyzed processes thus offering cost-minimization and waste reduction and hence, adhere to the principles of 'Green Chemistry'. Another frontier that is being explored is transforming platform chemicals obtained from biomass into value-added chemicals by engaging them in tandem reactions. I believe that research output from these projects will enhance our fundamental understanding of the reactivity of these bio-derived molecules, and thus open avenues for future research in this area.

Our research group is developing methods for incorporating biomass-derived molecules in chemical processes. Research in the group scours different inter-related aspects like, (*a*) developing synthetic methods that use renewables, (*b*) converting bio-derived molecules into platform chemicals, and (*c*) developing sustainable plastics sourced from biomass. The first two projects involve developing efficient transition-metal catalyzed processes thus offering cost-minimization and waste reduction and hence, adhere to the principles of '*Green Chemistry*'. Another frontier that is being explored is transforming platform chemicals obtained from biomass into value-added chemicals by engaging them in tandem reactions. Current projects along these lines are based on developing efficient molybdenum catalysts for effecting the deoxydehydration reaction and using vanadium catalysts for oxidative lignin cleavage.

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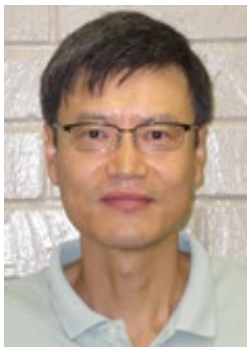

# Dr. Xiao-Chuann (Sean) Liu

Hemoglobin (Hb) is the oxygen-transport protein and hemoglobin A1 (HbA1) is the most abundant hemoglobin component in human erythrocytes. Upon glycosylation, HbA1 will form glycated hemoglobin $A1_C$ ($HbA1_C$) by a non-enzymatic glycosylation process. $HbA1_C$ level indicates the mean glycemic control during the preceding 120 days. Diabetes Control and Complications Trial (DCCT) has established the relationship between $HbA1_C$ level and the risks for development and progression of chronic complications of diabetes. One of my research interests is to investigate what other factors could affect the formation HbA1c. For example, studies have indicated a higher concentration of $HbA1_C$ in smokers as compared with nonsmokers. However, the exact substance in the cigarette smoke responsible for this higher concentration of $HbA1_C$ has not been investigated. Our study indicates that nicotine may be responsible for the elevated $HbA1_C$ level in smokers with diabetes mellitus.

Another area of my research is to study various chemistry for quantifying $HbA1_C$. Measurement of $HbA1_C$ is very important in the diagnosis and management of patients with diabetes mellitus. Clinical labs use a number of different analytical systems to determine A1c levels that include boronate affinity chromatography, ionic exchange chromatography, immunoassay, and enzymatic assay. Expensive instruments are employed in those assays. It is thus highly desirable to have a method that is fast, inexpensive and can be used at many different clinical sites as well as patient's home.

The third area of my research is related to two-dimensional stationary phases for liquid chromatographic separations. The area of high-performance liquid chromatography (HPLC) is an important field of research. One of the areas of great interest is the separation of biomolecules- proteins, nucleic acids, carbohydrates, etc. Currently, many bioseparations require several steps using different separation columns for an adequate isolation of the target biomolecules. This research was undertaken to create stationary phases that could be used in HPLC columns for separation of biomolecules. The incorporation of different functionalities into stationary phases will eliminate time-consuming steps for these isolations and improve efficiency. The stationary phases have a combination of functionalities that allow them to be used as two- dimensional material for bioseparation.

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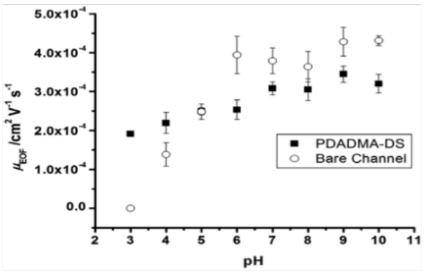
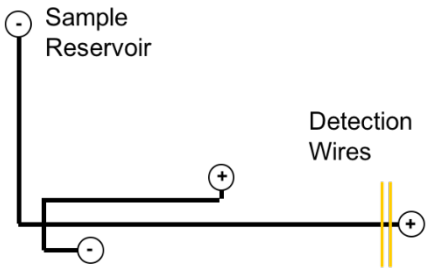
# Dr. Yan Liu

Dr. Liu's research interests include the development of a miniaturized analysis system for biological and environmental applications. This type of analyzer can integrate sample collection, injection, separation, and detection on a single microfluidic device. Current undergoing projects include:



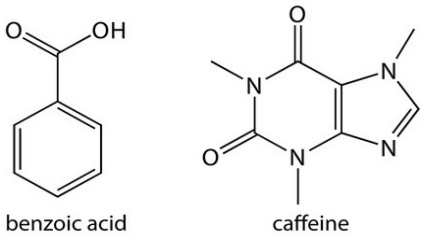

**Separations on Microfluidic Device**

Different separation methods (CE and CEC) will be adapted from conventional analysis system to the microfluidic device format. Surface chemistry of polymer-based device is being studied to facilitate more efficient separations. Currently, the surfactant and polyelectrolytes are under investigation.




**Portable Analyzer for Real-Time Monitoring of Aerosol**

The amount of component in air-borne particles is directly related to the anthropological activities. Air sample will be collected and deposited directly onto the microfluidic device, followed by the CE separation and detections. The species we are interested in, include sulfate, nitrate, ammonium, and some organic acids.




**Caffeine in Energy Drinks**

Energy drinks contain high levels of caffeine and other stimulants. High-dose consumption of energy drinks could potentially lead to the death of human beings. We are developing a new analyzer for fast determination in energy drinks and/or body fluid.

**Antioxidant Study in Orange Pomace Extract**

The orange juicing industry produces tons and tons of juice products for the market along with tons and tons of orange pomace wastes. There are, however, many nutritious components inside orange pomace wastes, such as fibers, antioxidants, and so on. We are optimizing the extraction conditions for antioxidants from orange pomace and studying the extract antioxidant behaviors.

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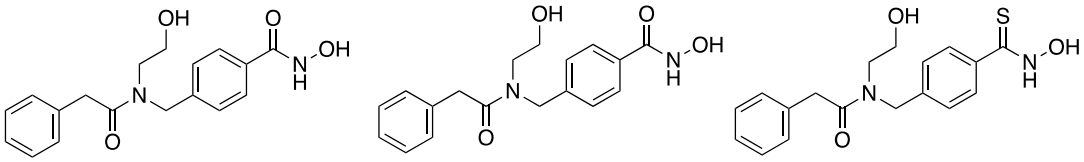
# Dr. Adaickapillai Mahendran

Our group's research interest folds into two areas:
a) Developing novel histone deacetylase 6 (HDAC6) selective enzyme inhibitors for cancer treatment and b) Understanding the chemistry, biological effects, and toxicity profile of oxidation products of phytocannabinoids.

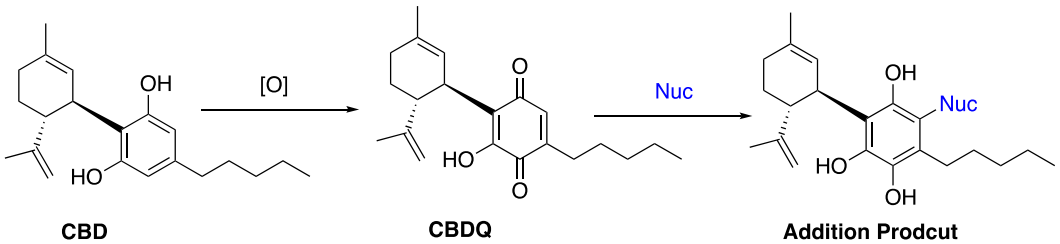
**Development of novel HDAC6 selective inhibitors:**

HDAC6 has been identified as a potential target for cancer therapy. Current FDA-approved HDAC inhibitors, including suberoylanilide hydroxamic acid (SAHA), Panobinostat, and Belinostat contain hydroxamic acid functionality to chelate co-enzyme Zn2+ ion. Strong chelation of this hydroxamate group leads these drugs to be non-selective and toxic. Thiohydroxamic acid is a compound similar to hydroxamic acid, but its chelation properties and selectivity profiles are not fully explored. In our lab, we synthesize, characterize, and study the metal binding properties of model thiohydroxamic acid molecules. Then we study its bioactivity against HDAC enzymes and its selectivity profile with collaboration. Our long-term goal is to develop novel HDAC6 selective inhibitors (eg. **thio-HPOB**) similar to known compounds **HPOP** and **HPB**.




**Oxidation of phytocannabinoids and its biological effects:**

Phytocannabinoids, including delta-9-tetrahydrocannabinol (Δ9-THC) and cannabidiol (CBD), are well known for their medicinal uses. It is also known that with prolonged exposure of these cannabinoids to sunlight, they lose their properties as they get oxidized. Cannabidiolquinone (CBDQ) is one such oxidized compound inclined to undergo further reactions with nucleophiles. It is not fully understood the biological effects of these quinone intermediates and their addition products. We are interested in the chemical oxidation process of phytocannabinoids, specifically THC and CBD. We are also interested in the mechanism of this oxidation process, supported by DFT calculations. With our biology collaborators, we study their bioactivity against different enzymes and cell-lines.

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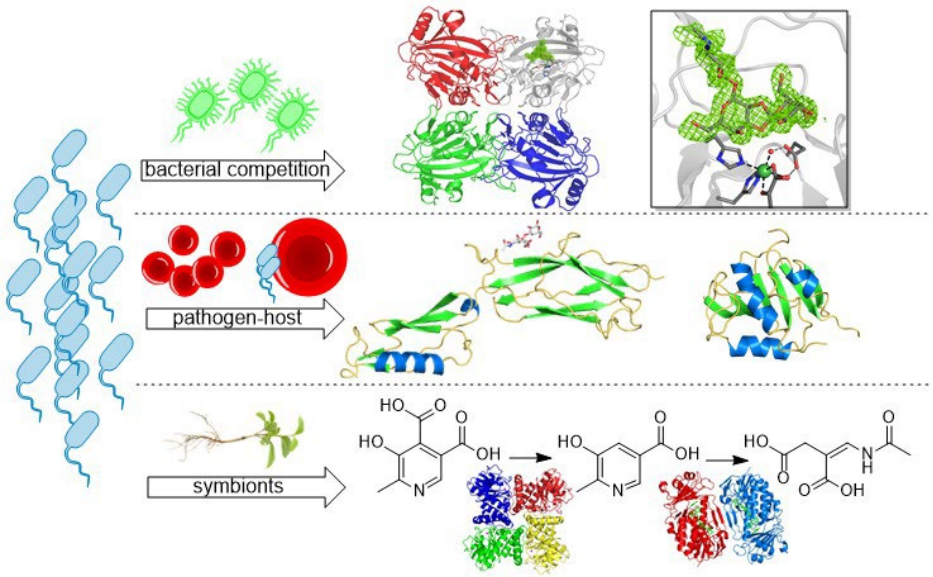
# Dr. Kathryn McCulloch

Organisms have not evolved in a vacuum – instead, they have interacted with their environment, competed for resources with other species, and collaborated with other organisms to thrive. These various forces have led to the evolution of complex pathways that produce signaling molecules, secondary metabolites, or otherwise provide the organism with an evolutionary advantage. To date, these pathways offer both the opportunity to develop new therapies, such as antibiotics, and offer potential targets for defeating pathogens or promoting human health. The McCulloch group aims to understand the chemistry of enzymes found within specific pathways. Currently, we are studying oxidoreductases (enzymes that catalyze either oxidations or reductions) encoded within the bile acid induced operon of some gut bacteria. We use a recombinant approach to overexpress each protein, and then use a combination of X-ray crystallography and *in vitro* biochemical assays to develop a molecular understanding of their structures and chemical reactivities.

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# Dr. Rakesh Mogul

My laboratory conducts research in molecular microbiology, with a focus on the biochemistry of survival in extreme conditions. Our work focuses on the microorganisms and microbial communities found in the assembly facilities for spacecraft, ancient permafrost, and desert soils. Our overall aim is to understand and characterize the enzymes and metabolic features that support survival in these extreme environments. Specifically, we are interested in learning (a) how microorganisms survive in the cleanroom facilities where spacecraft are assembled, (b) how the biochemical signatures of life change over thousands of years in ancient arctic permafrost, and (c) how the biochemistry and microbial communities change during the early development of biological soil crusts. To conduct this research, we use a multi-disciplinary approach including microbiology, proteomics, metabolomics, protein purifications, enzyme assays, chemical kinetics, lanthanide chelation chemistry, and bioinformatics. Our projects are intrinsically structured around the work of undergraduate and master's level students and integrated into the educational fabric of the University through Senior Thesis, Master's Thesis, and Internship projects.

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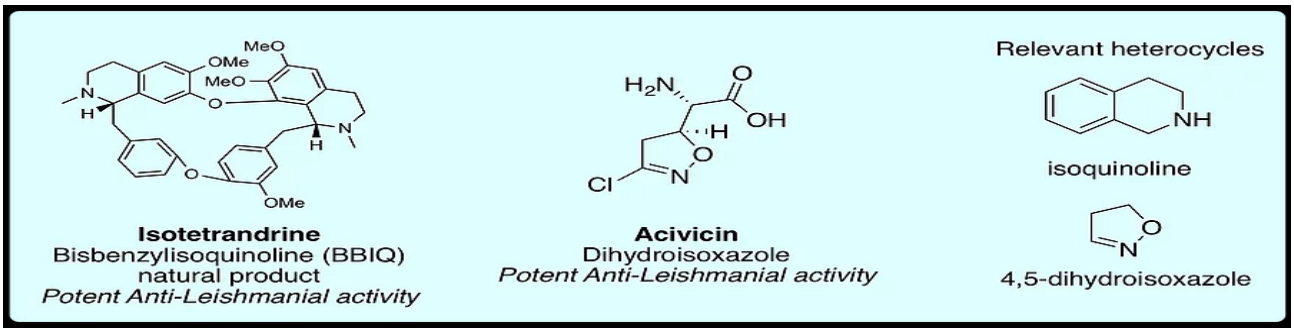
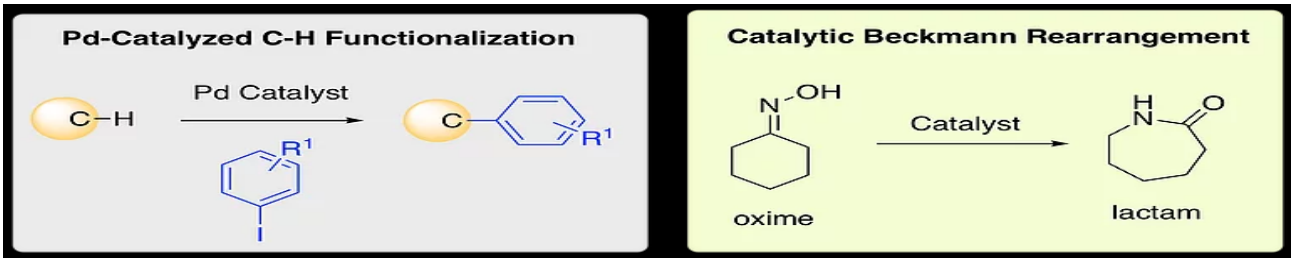
# Dr. Thomas Osberger

Synthetic organic chemistry has matured as a field considerably over the last 100 years, and it is now possible to envision applying the tools of this discipline to address the construction of any number of extremely complex targets – large molecules presenting complex architectures containing many rings, functional groups, and stereocenters, for example. However, one of the central challenges facing modern organic chemistry is the development of new strategies and techniques to rapidly build up molecular complexity. Novel and direct transformations can maximize the complexity generation of each synthetic step while minimizing waste, which increases the overall efficiency of a synthesis. The research envisioned in the Osberger Group broadly aims to address this challenge through the development and application of modern methods in organic synthesis and catalysis to achieve the construction of complex, biologically active molecules in efficient synthetic sequences, with the ultimate aim of collaboratively exploring their function.

**Novel Anti-Leishmania Compounds**. Leishmaniasis, a group of diseases caused by parasites of the genus Leishmania, represents a significant global health concern, with cases reported in at least 88 countries worldwide placing over 350 million people at risk of infection. An estimated 12 million people are currently suffering from this disease and over 2 million new cases are identified every year leading to 60,000 deaths annually. Despite this urgent threat to global health, the main chemotherapeutic agents currently deployed for treatment of leishmania have been used for over 60 years and remain essentially unchanged despite their declining efficacy, while development of new treatments has lagged. Given these factors, there is a clear and pressing need for continued investigation into sources of novel antileishmanial compounds. We are interested in synthesizing derivatives of the bisbenzylisoquinoline (BBIQ) macrocyclic natural products (like Isotetrandrine) and Acivicin, molecules containing the interesting tetrahydroisoquinoline and dihydroisoxazole heterocycles, respectively. Ultimately, our goal is to investigate the potential of these molecules as treatments against Leishmaniasis.




**Synthetic Reaction Methodology: Catalysis.** The development of new catalytic reactions is central to modern synthetic chemistry and enables the construction of entirely new chemical entities, while improving the efficiency of compound preparation overall. We are interested in exploring and developing catalysts in the field of C-H functionalization, where a C-H bond is directly converted to a C-C, C-O, C-N, or other bond by action of a transition metal catalyst. We will explore the possibility of creating C-C bonds in a stereoselective manner using Pd-based catalysts. Additionally, we are interested in exploring small molecule catalysts for the Beckmann Rearrangement, an industrially important reaction that converts an oxime to an amide. The Beckmann Rearrangement has the potential to be useful for the synthesis of lactams, which are amide-containing ring structures that are present in many natural products and pharmaceuticals.

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# Dr. Michael Page

Research Dealing with Fatty Acid Methyl Esters (FAME) has a special niche at a polytechnic university. Alternative fuel research blends hands-on education with emerging technologies. Seed oils from plants consist of triglycerides that have demonstrated utility in the synthesis of Biodiesel. Value can be added to this budding industry by using organic chemistry to repurpose FAMEs as a feedstock in the synthesis of polymeric “Green” plastics and urethanes. Through our partnership with the USDA ARS, our goal to provide addition avenues for the use of biodiesel in consumer products in place of petroleum-based compounds.

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## Dr. Bohdan Schatschneider

My group's research is broadly defined, containing complimentary experimental and computational components aimed at understanding the dynamics and energetics of organic molecular crystals and polymers under extreme conditions. My group's investigations use cutting edge techniques to elucidate how systems' structures/organizations effect the way that they treat energy. In the experimental component we have used ultra-low temperature (15K) and high pressure (up to 10GPa) within an ultra-high resolution FTIR spectrometer to investigate the vibrational relaxation/dephasing of organic molecular crystals. The computational aspect of my group's research uses many-body dispersion corrected density functional theory (DFT+vdW) and classical molecular dynamics (MD) to explore the electronic properties of organic molecular crystals and polymeric systems under ambient and extreme conditions. The coupling of the computational and experimental components provides an exhaustive explanation about how crystalline and polymer systems treat energy and react to thermodynamic as well as phase changes.

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# Dr. Jodye Selco

My research has been focused upon Chemical Education. We have been studying the effectiveness of instructional methods and curriculum on the learning success of students. I have been working with Rialto USD to develop "Common Laboratory" experiences for students at each grade. These experiments are aligned with the Next Generation Science Standards and all involve doing science to learn science. Now that these experiments are being used district-wide, we need to examine how well the students are learning from these experiences.

I have also been involved in Physical Chemistry research; as an experimentalist I have examined the spectroscopy, photochemistry, and kinetics of small organic molecules (e.g. pyridine). Most recently we investigated natural products as a source of compounds that could be used as sunblock

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# Dr. Laurie Starkey

My research interests lie in the areas of both Chemical Education and Organic Synthesis. My main focus in Chem. Ed. Research is the utilization of technology in teaching and learning, especially in the Organic teaching labs. Recent activities include the creation of online pre-lab quizzes, online lab tutorials/demonstrations, and the use of “clickers” in the classroom (student response systems). Student research projects could involve the development of new online tools or measuring the impact of such resources on student learning. My laboratory research projects involve the development and optimization of new experiments for the undergraduate Organic teaching labs. The goals of any new experiment include discovering interesting synthetic transformations and laboratory techniques, while being learning-centered, safe, time-efficient, cost-efficient, environmentally friendly (green), and inquiry-based.

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# Dr. Chantal Stieber

The Stieber Lab focuses on solving problems related to small molecule activation through complementary efforts in synthetic inorganic chemistry, spectroscopy and computational chemistry. Current directions in the group include: 1) Expanding the scope of X-ray emission spectroscopy to allow for identification of small molecules (eg. NO, $NO^{1-}$, $NO^{2-}$) bound to transition metal centers. Results of this work will be applied to understanding how biological systems reduce and capture airborne pollutants; 2) Synthesis of novel first-row transition metal complexes for benchmarking spectroscopic signatures of small molecules bound to metal centers; 3) Development of first row transition metal catalysts for transformations such as C-C bond formation and polymerizations; 4) Crystallography; 5) Multiplet calculations of f-block systems.

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# Dr. Peng Sun

My research interest is in the electrochemical characterization of chemical process or materials in mesoscopic dimension (dimension varies from 10 to 1000 nm, 1 nm= $10^{-9}$ m), such as electrochemistry of a single nanoparticle, charge transfer across a nanometer-sized liquid/liquid or liquid/solid interface. These studies can help us to develop ultrasensitive electrochemical sensors or novel sensing strategies. Here are some projects in my group:

Electrochemical study of a single nanoparticle. The understanding of the relationship between the size and shape of a nanoparticle and its electrochemical properties allows us to improve their performance, explore new applications, and design new materials. Recently, we developed a method which can be used to accomplish the direct electrochemistry of a single nanoparticle (http://pubs.acs.org/doi/abs/10.1021/jp308501j). On the base of our method, we are studying the formation mechanism, electrocatalytic activity and thermodynamics of a single nanoparticle.

Charge transfer at liquid/liquid interface. Under the influence of an electric field, hydrophilic ions can transfer from aqueous phase into an organic phase. This process can make a current flow which is proportional to ion concentration. Thus, it can be used to make a sensor. Kinetics and mechanism of ion transfer at nanometer-sized liquid/liquid interface will be studied.

Electrochemistry in very low electrolyte solutions. Normally, large amount of electrolyte is used in an electrochemical measurement to increase solution conductivity. However, the using of electrolyte can introduce contaminations and even change the kinetics and mechanism of an electrochemical reaction. The effect of electrolyte on the electrochemcial response on a nanometer-sized electrode will be studied.

Instruments. With the development of nanoelectrochemistry, one has to use a ultrasensitive potentiostat which can detect current as small as 10-15 A. However, there is no such kind of commercial instrument. We will use microprocessor and ultraprecise operational amplifier to make such a potentiostat.

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# Dr. Taylor Thane

The development of greener synthetic methods that provide access to complex molecules is of increasing importance to the fine chemical and pharmaceutical industries. Cross-coupling and cross-electrophile coupling reactions have greatly advanced the field of synthetic organic chemistry by allowing for the efficient synthesis of new carbon-carbon bonds. Additionally, dicarbofunctionalization reactions are being realized for their potential to quickly form two new carbon-carbon bonds in a single step. We aim to harness the power of carbon-carbon bond forming reactions with strained ring motifs to rapidly install new carbon-carbon bonds and transform simple starting materials into complex structures.

Oxetanes, strained four-membered oxygen-containing rings, can be accessed in a single step from aldehydes and alkenes via a Paternò-Büchi reaction. Oxetanes could serve as linchpin motifs for complexity-building reactions as they serve as stable functional groups found in natural products while functioning as reactive intermediates for synthetic manipulation. We are interested in developing nickel-catalyzed cross-coupling and dicarbofunctionalization reactions of oxetanes for the synthesis of structurally complex molecules as well developing new methods to synthesis oxetane motifs!

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