Dr. Charlisa Daniels' Research Group

Research Area(s): Analytical Chemistry - Physical Chemistry - Polymer Chemistry

Pre-requisite courses: College-level General Chemistry, Organic Chemistry (Project 2)

Proposed Start Date: The checked dates are possible start dates.

May 9th, 2016 ✔ May 23rd, 2016 ✔ May 31st, 2016

The end date for all participants will be July 29th, 2016

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Research Interests

The goal of this research is to characterize a set of methacrylate-based PPMs in efforts to understand the fundamental mechanisms that underlie the behavior and interactions of the PPMs with analytes that are recognized as common pollutants. Steric, charge, and mass are some of the properties that will be investigated as interactions are monitored via chromatography, including Capillary Electrochromatography (CE) and Ultra Performance Liquid Chromatography (UPLC). Understanding these fundamental properties is important when designing and engineering materials that could aid or support in designing materials with potential environmental, electrical, and medical uses. The results of this investigation will reveal information about how to best engineer materials to the best of current scientific knowledge.

Project 1: Initial Synthesis and Characterization of Acrylate and Methacrylate Porous Polymer Monoliths

The goal of this project was to synthesize and characterize porous polymer monoliths (PPMs) made from various acrylates and methacrylates. Attributes of the PPMs will be investigated via CE and UPLC. The relationships between the inner diameter of capillary, crosslinker, porogen, temperature, and analyte concentration will be explored. An alkyl benzene series (toluene through 1-phenyl octane) will be used to characterize the PPMs over the range of 25 °C to 60 °C in 5 °C increments, and mobile phase concentration of 75% acetonitrile: 25% Tris base.

Project 2: Spectroscopic Analysis of Tunable, Stimuli Responsive Polymeric Materials

Tunable, stimuli responsive polymeric materials are interesting due to their viability and usage in so many different fields. Engineering these materials can lead to revolutions in environmental, medical, and electrical applications, to name a few. Understanding the fundamentals of how these materials behave and interact with analytes is important. By creating polymeric monoliths that can be used as stationary phases, chromatography can reveal mechanisms by which molecules interact with them. Monoliths can be altered through reaction conditions, porogens, monomers, crosslinkers, etc. Small changes in monolith solutions may result in dramatically different structures. A variety of different acrylate and methacrylate porous polymer monoliths will be synthesized in fused silica capillary columns with some of the aforementioned modifications. Cross-sections of polymers will be coated with gold and imaged using secondary electron Scanning Electron Microscopy in order to provide morphology information. NMR and IR spectroscopy will be performed to gather more information about the structure of the PPMs. The results of these studies could provide insights for understanding the structure-function relationship tunable, stimuli responsive materials.

Dr. Kebede Gemene's Research Group

Research Areas: Potentiometric and chronopotentiometric ion-selective electrodes for clinical and biomedical applications

Pre-requisite courses: College-level General Chemistry

Proposed Start Date: The checked date(s) is(are) possible start dates.

May 9th, 2016 May 23rd, 2016 ✔ May 31st, 2016

The end date for all participants will be July 29th, 2016

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Research Interests
Among the chemical sensing technologies utilized to date, ion-selective electrodes (ISEs) arguably have the highest real world impact. These are simple and inexpensive measuring devices with a wide range of applications, especially, in biomedical and clinical areas. In fact, today, the most important physiological electrolytes such as potassium and sodium are almost exclusively measured in clinical laboratories using classical potentiometry with ISEs. However, there are certain limitations of ISEs when operated under the classical potentiometric readout. These include detection of biologically important hydrophilic anions and reversible detection of polyions such as the anticoagulant heparin and its antidote protamine. Thus, the objective of our research is to develop a new measuring method based on chronopotentiometry with ion-selective electrodes to alleviate some of the limitations of classical potentiometry. In addition, we explore chemically selective species (ionophores) that can be used in classical potentiometry and chronopotentiometry for the detection of anions.

Project 1: Reversible detection of biological polyions using chronopotentiometry
The limitation classical potentiometric polyion selective electrodes is that their response is irreversible. Therefore, they are limited to single-use applications which is not convenient for continuous monitoring purposes. Reversible polyion sensors were introduced recently and currently developing by our group as well as others. One of our research projects has focused on further developing such sensors for different biomedical and clinical applications, including detection of heparin in blood at therapeutic concentration, screening of new anticoagulants and their antidotes that can be used during surgical procedures and measuring enzyme activities for different protease enzymes.

Project 2: Selectivity enhancement of anion-selective
Unlike cations, anions are still lacking adequately selective ion carriers that can be used effectively to measure hydrophilic anions in complex samples such as blood with ion-selective electrodes. In the absence of sufficiently selective ionophores, membranes, intrinsically, respond to lipophilic ions and the measurement of important hydrophilic ions is hampered. For example, the presence of low levels of salicylate in the blood of patients under aspirin therapy and/or thiocyanate in the blood of smokers interfere with the measurement of the important hydrophilic anions such as chloride and carbonate/bicarbonate in physiological samples. Thus, it is very important to device different membrane formulations and sensing mechanism for the measurement of these ions. In our research we develop specially formulated membranes under a new technique called pulsed chronopotentiometry to enhance the selectivity of ion-selective electrodes for hydrophilic anions. In our research projects, the intern will be involved in:

- Designing and preparing ion-selective membranes
- Measurement of the analyte using pulsed chronopotentiometry and classical potentiometry
- Analysis of the data collected using some computer software
- Presenting the findings of the research

Dr. Isabelle Lagadic's Research Group

Research Areas: Materials Chemistry – Functional Organic-Inorganic Hybrid Nanomaterials

Pre-requisite courses: College-level General Chemistry

Proposed Start Date: The checked dates are possible start dates.

✔May 9th, 2016 ✔ May 23rd, 2016 ✔ May 31st, 2016

The end date for all participants will be July 29th, 2016

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Research Interests

Our research focuses on combining organic and silica-based inorganic precursors in order to create functional organic-inorganic hybrid materials. These functional materials combine properties of the silicate framework (e.g. high thermal and mechanical stability) with those of the organic components that can be tailored to the applications anticipated for the materials. We are particularly interested in organically functionalized porous silicates prepared by direct reactions between inorganic precursors and different organic precursors bearing a functional group (represented by ❨ below) such as $(CH_2)_3SH$, $CH_2)_3NH_2$, etc. The resulting hybrid materials exhibit either a layered structure similar to that of clays (Figure 1) or a porous structure (Figure 2), with the organic functionalities lining the inside of the interlayer spaces or the pore walls. The functionalized galleries or pores can then act as "nanoreactors" or "nanoreservoirs" for a variety of reactions and applications.

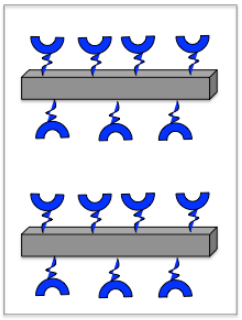


Figure 1

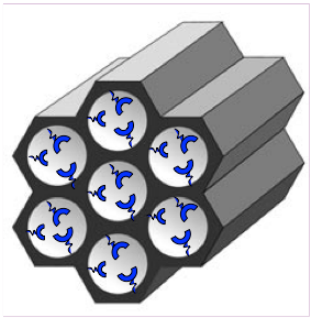
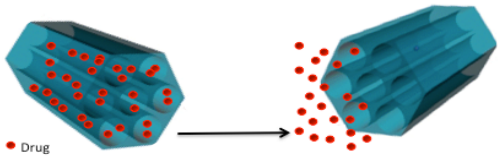


Figure 2

Organic function

Project 1: Engineering and Evaluating Porous Organosilicates for Drug Delivery. In this project, the interested candidate will be involved in the synthesis, characterization and evaluation of porous organosilicates as drug carriers for hydrophobic chemotherapeutic agents (i.e. Camptothecin) or poorly water-soluble Non-Steroidal Anti-Inflammatory Drugs (i.e Ibuprofen).



Project 2: Microwave-assisted Preparation of Organic-Inorganic Hybrid Nanomaterials: The interested candidate can be involved in either of the following sub-projects: 1) Synthesis and characterization of functional nanomaterials using microwave technology. 2) Microwave-assisted preparation of polymer-clay nanocomposites by surface-initiated polymerization using functional organoclays, for applications in aerospace, food packaging and in the biomedical sector (Figure 3).

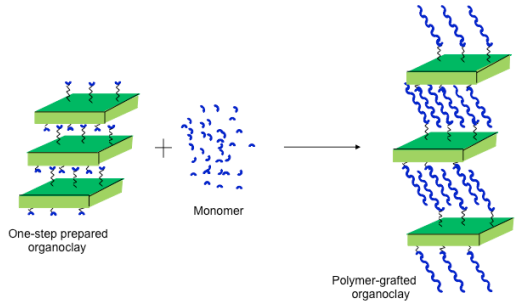


Figure 3

Regardless of the project chosen, the candidate will be exposed to various scientific fields, will use state-of-the-art instrumentation and will have the opportunity to collaborate with other students and various research groups.

Revised September 2015

Lili Ma's Research Group

Research Area(s): Organic Chemistry, Medicinal Chemistry

Pre-requisite courses: College Level General Chemistry; Organic Chemistry Preferred

Proposed Start Date: The checked dates are possible start date(s)

May 9th, 2016 May 23rd, 2016 ✔ May 31st, 2016

The end date for all participants will be July 29th, 2016

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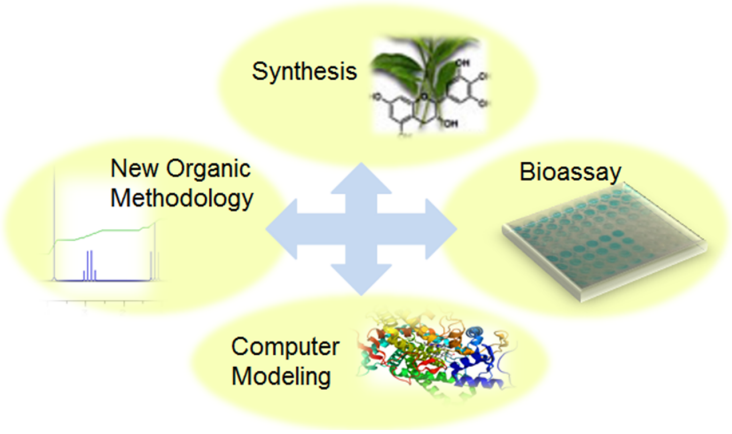
Research Interests



The Ma research group is in the area of organic chemistry, medicinal chemistry and biochemistry, with a particular interest in developing anticancer drug candidates. Breast cancer is the leading cancer for women and is the second leading cause of the deaths after lung cancer. The traditional medicine, tamoxifen, blocks the binding of estrogen to its receptor. However, tamoxifen has limited efficacy and causes serious side effects. A new promising therapy is to prevent the enzyme aromatase from producing estrogens, the main stimulant in the growth of tumors. Research in the Ma group involves the design and synthesis of bioactive natural products which exhibit anti-breast cancer activity. The biological evaluation of synthesized compounds will be determined in collaboration with Dr. Stefan Paula at Purdue University and Dr. Edward Merino at University of Cincinnati. Students involved in the research have the opportunity to gain experience in organic synthesis, computer modeling and enzyme inhibition assays for bioactive chemicals and drugs.

Project 1 Microwave-assisted Direct Heteroarylation of Ketones

Compounds bearing an α-heteroaryl functionality find their applications in many fields of organic chemistry. In this study, we will use microwave-assisted organic reactions to synthesized heteroaryl compounds and use NMR technique to investigate the reaction mechanisms. The synthesized compounds will be tested for their potential anticancer activities in follow-up study.

Project 2 Development of Heteroaryl Isoflavanone Anti-Breast Cancer Drug Candidates

Isoflavanone derivatives have been identified as a new class of aromatase inhibitors and showed anti-proliferative effects on human breast cancer cells in our previous study. In this project, we will optimize isoflavanone compounds by incorporating heteroaryl functional groups on the scaffold.

Dr. KC Russell's Research Group

Research Areas: Organic synthesis and spectroscopic characterization of molecules with materials applications.

Pre-requisite courses: College-level General Chemistry and one semester of Organic Chemistry

Proposed Start Date: The checked date(s) is(are) possible start dates.

May 9th, 2016 ✔ May 23rd, 2016 May 31st, 2016

The end date for all participants will be July 29th, 2016

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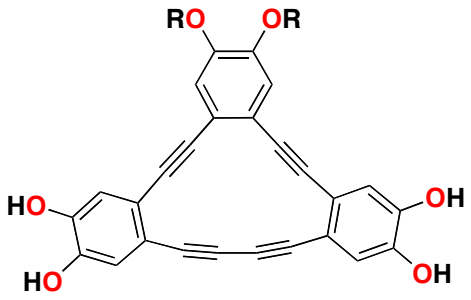
Research Interests:

The Russell Research Group is interested in compounds that are comprised of arenes linked together by triple bonds, either in a ring (annulenes) or as long chains (polyethynylphenylenes). Such compounds are of interest because of their potential materials applications. Compounds with multiple bond that connect arenes together have been shown make useful sensors and an semi-conductors. Compounds based on this structure have been used in equipment used for the detection of land mines and other hidden explosives and in the development of flexible monitors that could be used for electronic newspapers or other applications.

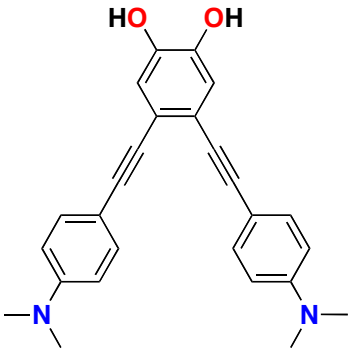
Project 1: Synthesis of catecholic annulenes for molecular recognition.

Students will work on the synthesis and characterization of an annulene (such as the compound on the right) this compound can be used in covalent organic and inorganic frameworks as well as for other molecular recognition projects. Once the compound is prepared the student study that molecule to understand its behavior in the presence of various metals. Students involved with this project will become familiar with the techniques synthetic organic chemistry, including purification by MPLC and characterization by NMR and UV-VIS spectroscopy.



Project 2: Title Synthesis of polyethynylphenylenes for oxacalixarene development.

Students will work on the synthesis and characterization of a series of catecholic polyethynylphenylenes (such as the compound on the right). These compounds all possess a catechol moiety for incorporation into oxacalixarenes. Students involved with this project will become familiar with several synthetic organic chemistry techniques, including purification by MPLC and NMR spectrocsopy. Once prepared students will study each compound UV-VIS and fluorescence spectroscopy and will have the opportunity to prepare and study oxacalixarenes.



Revised September 2015