1G

NEW CHEMISTRIES AND MATERIALS

MGH 248

12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Scalable Growth and Characterization of Monolayer WSe_2

Frank Andrew (Frank) Mc Kay, Senior, Physics: Comprehensive Physics
Undergraduate Research Conference Travel Awardee
Mentor: David Cobden, Physics

Many 2 dimensional materials, such as Tungsten Diselenide (WSe_2) have many interesting device applications such as thin and flexible photo detectors and transistors. We use a process called chemical vapor deposition, which involves depositing a vapor of WSe_2on a substrate by a specific application of heat. Specifically, we installed a secondary heating coil in our furnace which allows for a region of uniform temperature near the substrate. This modification allows for large scale growth of single crystals on the substrate. This approach to manufacturing has the advantage of allowing more samples to be studied and inevitably being more applicable to industrial applications. To determine if this method is feasible, we probe the quality of these crystals by measuring their electrical properties.

Alkane Functionalization with (Phebox)Ir^{I}II and Molecular Oxygen

Zoha Hasnain (Zoha) Syed, Senior, Chemistry, Biochemistry
Mary Gates Scholar, NASA Space Grant Scholar, UW Honors Program, Undergraduate Research Conference Travel Awardee, Washington Research Foundation Fellow
Mentor: Karen Goldberg, Chemistry

Alkanes are the major constituents of natural gas and petroleum. The development of catalysts for the efficient and cost-effective catalytic conversion of alkanes to functionalized organics is highly desirable. Previously, Nishiyama and coworkers found that the Ir^{I}II complex (^{d}mPhebox)Ir$(OAc)_2(OH_2)$ (Phebox = 3,5-dimethylphenyl-2,6-bis(oxazolinyl)) could activate the C-H bonds of n-octane at high temperatures under nitrogen. Goldberg and coworkers found upon increasing the temperature, β-H elimination could be promoted, giving isomers of n-octene. Reactions of similar Ir complexes with alcohols, ketones and other organic substrates will be presented.

Characterization of Poly(alkyl glycidyl ether) Homopolymers as a Platform for Use in Stimuli-Responsive Hydrogel Synthesis and 3D Bio-Printing

Cecilia Grace (Cece) Martin, Senior, Biochemistry, Chemistry
Mary Gates Scholar
Mentor: Alshakim Nelson, Chemistry

Stimuli-responsive hydrogels represent a promising class of inks for use in 3D-bioprinting. These materials respond to external stimuli such as heat, light, pH, and pressure, and researchers have utilized these different stimuli responses to develop inks for direct-write 3D printing. The objective of our work is to understand how the composition of poly(alkyl glycidyl ethers)–more specifically, allyl-, ethyl-, isopropyl, n-propyl-, and methyl-glycidyl ether homopolymers–affects their thermal response in aqueous solutions. UV-Vis Spectroscopy was used to determine the lower critical solution temperature (LCST) of each homopolymer, varying the molecular weight, concentration and polymer composition to demonstrate poly(alkyl glycidyl ethers) versatility as a platform for synthesis of stimuli-responsive hydrogels. We determined that the identity of the alkyl group significantly affected the temperature-response of the respective hydrogel. These studies will guide our work toward developing temperature and shear-responsive inks for 3D-bioprinting. In particular, these materials can be used to develop printed hydrogel lattices for whole-cell catalysis to produce medicinal compounds.

Structure and Properties of Novel Ceramic Membranes for Flow Batteries

Eden L. (Eden) Rivers, Fifth Year, Materials Science & Engineering
Mary Gates Scholar, Undergraduate Research Conference Travel Awardee
Mentor: Lilo Pozzo, Chemical Engineering

Renewable energy harvesting technologies such as wind and solar cannot provide on-demand sources of power unless they are paired with energy storage technologies (e.g., batteries). Flow batteries are the best candidate for grid-scale load shifting, bridging and power management due to their safety, efficiency and scalability. Flow batteries operate by pumping liquid-based electrolytes into a two-part cell where charging/discharging occurs through ion exchange across a membrane. Unfortunately, the current membrane technology (Nafion©, a Chemours fluoro-polymer) is expensive to synthesize and cannot be optimized to improve performance. This presentation will highlight the development of a new, low-cost membrane based on ceramic materials. Previous work using the sol-gel method of curing sodium silicate in acid has shown a promising membrane structure (with pore sizes of 0.5-2nm) for selective proton transport. My work investigates variations in the properties and structures that arise from using different acid solutions for the curing agent in this process. I made samples using six different acids and then characterized the pore size, shape and network structure through fitting of small angle x-ray scattering (SAXS) profiles. I studied macroscopic membrane features such as defects using scanning electron microscopy (SEM). Key membrane performance attributes such as proton conductivity and vanadium ion permeability I tested with experimental set-ups involving a Potentiostat and a UV-vis measure of ion concentration over time, respectively. I found that acid chemistry did have an effect on pore size, shape and network structure, however, this structural information could not be directly correlated to key flow battery performance attributes. SEM investigations indicate that membranes contain inherent stress fractures leading to macroscopic defects. These defects likely dominate the observed performance attributes. Future investigations will focus on developing new methods to eliminate these defects and create uniform structures.