Materials Research Science and Engineering Center

UNIVERSITY OF MINNESOTA

Driven to Discover℠

Summer Undergraduate Research Expo

August 6, 2015
McNamara Alumni Center
Memorial Hall
4:00-6:00pm

Undergraduate Poster Presentations
Listed Alphabetically by Presenting Author

Presenters should be at their posters at the following times:
4:00 - 5:00 odd numbered posters
5:00 - 6:00 even numbered posters

1. **Victor Acero**
Enhancement of High-Performance Graphene Biosensors for Cancer Detection
Advisor: Tianhong Cui
Sponsoring Program: NNIN
Home Institution: Pennsylvania State University
Abstract: Current Alpha-fetoprotein (AFP) sensing technologies such as ELISA require a lot of equipment, time, and skill. Still, it would be less sensitive then our proposed graphene biosensors, which in theory could detect a single AFP. Graphene's unique material properties and sensitivity to the surrounding environment are exploited in our sensor for the detection of AFP. A U-shaped gold electrode containing a small gap for the sensing area would then be patterned using photolithography. The gap would be closed by covering the bare substrate with our few-layer-graphene (FLG) structure. We tune the thickness, and thus the properties, of graphene through a unique layer-by-layer self-assembly process which uses graphene solution and polyelectrolytes. The graphene sensing area is further prepared with poly-l-lysine and then functionalized with anti-AFP. Lastly, due to the fact that the ability to detect AFP is heavily limited by the signal-noise ratio, we redesigned the basic interface between gold and graphene in multiple ways to achieve a better signal-noise ratio in our sensors.

2. **Angel Agrinsoni**
Surface preparation of single crystal perovskite substrates for epitaxial growth of BaSnO3
Advisor: Bharat Jalan
Sponsoring Program: MRSEC
Home Institution: University of Puerto Rico at Mayaguez
Abstract: Perovskites, having a chemical formula of ABO3, exhibit a myriad of functionalities such as superconductivity, ferroelectricity, ferromagnetism and metal-insulator transitions. Interestingly, some of these properties can be observed exclusively in epitaxial thin films grown on single crystalline substrates. Advancements in deposition techniques have facilitated growth of thin films with atomic level precision, and greatly improved our understanding of these phenomena. However, in order to obtain films with smooth morphology it is essential to start with an atomically flat substrate surface. For accomplishing this task we will prepare the surfaces of SrTiO3(001), LaAlO3(001), and KTaO3(001) substrates using a combination of chemical etching and thermal annealing. Following this, growth of epitaxial BaSnO3 films will be carried out via high pressure oxygen sputtering. Substrate and film surface topologies will be studied using atomic force microscopy.

3. **Medinat Akindele**
Synthesis of a Novel Modulator of Retinoic Acid Receptor Alpha for Male Contraception
Advisor: Rebecca Cuellar
Sponsoring Program: Project SEED
Home Institution: 2015 Graduate, Harding High School, St Paul, MN
Abstract: The goal of this research is to synthesize a novel modulator of retinoic acid receptor alpha (RARα). RARα is testis-specific protein essential for spermatogenesis, which makes it a specific and effective target for male contraception. Our novel modulator is designed to be an α-selective antagonist by tuning the molecular architecture of the linker and the hydrophobic ring system in the binding pocket. This research is part of a multi-institutional collaborative effort that includes design, synthesis, and binding & activity assessment to identify strong pre-clinical candidates for male contraception. The synthesis towards a new retinoid as well as data from an activity assay that was conducted this summer will be presented.

4. Anthony Anderson

Utilizing the Leidenfrost Effect to Direct the Motion of Cellulose Particles During Pyrolysis

Advisor: Paul Dauenhauer

Sponsoring Program: MRSEC

Home Institution: Arizona State University

Abstract: Altering the heat transfer characteristics during the thermal processing of cellulosic biomass affects the fuel products formed. Similar to volatile, low boiling point liquids, crystalline cellulose particles have been shown to exhibit liftoff when exposed to a highly heated, non-porous surface. At temperatures above 700 °C, small cellulose particles pyrolyze to short-lived liquid intermediates which are then dewetted from the surface and self-propelled by the Leidenfrost effect. Utilizing a heated, asymmetric sawtooth patterned surface, the motion of these particles caused by the vapor-liquid viscous flow can be directionally controlled. In an oxygen free environment, a high speed camera shows the directional motion of the cellulose particle exhibited by the Leidenfrost effect. Both an increase in droplet lifetime and the ability to influence the directional motion have been shown due to the Leidenfrost effect on a micro-milled surface.

5. Genesis Ayala

Synthesis of rare earth and transition metal doped BaSnO3 sputtering targets for growth of thin films via high pressure oxygen sputtering

Advisor: Chris Leighton

Sponsoring Program: MRSEC

Home Institution: University of Puerto Rico at Humacao

Abstract: Perovskite oxides (ABO3) are a subset of complex oxides that display a staggering range of functionalities such as high Tc superconductivity, multiferroicity and colossal magnetoresistance, owing to the large choice of cations for filling up the cationic sites. Furthermore, the perovskite structure is also amenable to chemical substitutions on both A and B sites, thus providing an effective pathway for modulation of electronic properties of the host material. Recently, a very high electron mobility (~300 cm2V-1s-1) at room temperature was observed in BaSnO3. This is particularly interesting from the point of view of high mobility two-dimensional electron systems and oxide transistors. The first part of this work will consist of synthesis of BaxRE1-xSn1-yTM1-y O3 (RE: rare earth, TM: transition metal) sputtering targets by high temperature solid-state reaction, followed by sintering. Wide angle X-ray diffraction (WAXRD) will be used to probe phase purity and stoichiometry of the reacted product. The next step will be growth of epitaxial thin films from the synthesized targets via high pressure reactive sputtering in oxygen. High-resolution WAXRD and atomic force microscopy will be used for structural characterization in addition to electrical transport measurements for the characterization of electronic properties.

6. Alex Ayoub

Additional Authors: Laura Hawk, Clifford Gee

A Fluorescence Polarization Assay for Quantifying Bromodomain-Small Molecule Interactions

Advisor: William Pomerantz

Sponsoring Program: UMN Chemistry- Heisig Gleysteen

Home Institution: University of Minnesota

Abstract: Proteins containing a regulatory segment called a bromodomain recognize specific patterns of acetylated lysines on N-terminal histone tails, an interaction associated with active gene transcription. Misregulation of processes that control bromodomain localization, concentration or function often lead to disease. Brd4 and BrdT, members of a class of bromodomain-containing proteins in the bromodomain and extraterminal domain (BET) family, are the subject of this research. Brd4 has been implicated in both cancer and heart disease and is a major target of BET inhibitors. BrdT, a testis-specific BET family member, is being actively pursued as a molecular target for male contraception. This research focuses on the development of a high throughput screening (HTS) method for analyzing a variety of potential ligands as Brd4 and BrdT-specific inhibitors using a fluorescence polarization (FP) assay. Variables including detergents, additives, and time are used to determine optimized conditions for bromodomain binding experiments, which are validated by protein-observed 19F NMR. Using a fluorescently-labeled small molecule binder BI6727, I conducted a large-scale competition assay of BI6727 analogs, fragments, and small molecules identified in a 6 million compound virtual screen to quantify BrdT and Brd4 inhibitors.

7. Nicholas Barberio

Zero Length Chromatography and Diffusion in Zeolites

Advisor: Paul Dauenhauer

Sponsoring Program: MRSEC

Home Institution: University of Massachusetts Amherst

Abstract: Due to its abundance and renewability, transportation fuel from domestic biomass has the potential to be a significant part of our nation's energy future. By 2050, the United States could produce the equivalent of 8 million barrels of oil per day of biofuels: an amount greater than half of current transportation fuel consumption (NRDC Growing Energy). Today however, the absence of efficient and low cost conversion technologies prevents biofuels from being produced at this scale. Zeolites are microporous aluminosilicate catalysts which could be critical for economical biofuel synthesis. Reactions in zeolites are fast, but their overall conversion rate is limited by diffusion of molecules to and from the reaction site. Therefore it is critical to develop structures with fast diffusion rates to improve catalyst functionality. To determine diffusion rates, this project measures the desorption rate of organics from novel zeolite structures using Zero Length Chromatography. Desorption data is then fit with the experimental model to determine diffusivity. Multiple experiments are performed by varying temperature and particle size to calculate activation energy of desorption and the dominance of surface barriers. The novel zeolite structures are compared to spherical zeolites to determine how these structures affect diffusion. If diffusion can be significantly increased, then the cost of biofuel synthesis can be greatly reduced.

8. Marissa Beam

Sustainable Copolymers with Tailored Thermal Properties

Advisor: Marc Hillmyer

Sponsoring Program: Center for Sustainable Polymers

Home Institution: Tulane University

Abstract: A major challenge facing modern polymer scientists is how to make affordable high-performance polymers that are environmentally benign. Poly(lactide), is both biorenewable and biodegradable, and has achieved great commercial success. However, its thermal and mechanical properties limit its potential uses. Previous work has shown poly(ε-caprolactone-co-ε-decalactone) to have tunable thermal properties, but the high cost of the ε-decalactone monomer inhibits its commercial viability. My work investigates poly(γ-methyl-δ-valerolactone) homopolymers and poly(γ-methyl-δ-valerolactone-co-ε-caprolactone) (P(γMVL-co-CL)) statistical copolymers as potential new sustainable materials. These polymers can be produced in high yield, with no byproducts and minimal waste, using bulk, room temperature polymerizations. Depending upon its composition and the sample preparation, P(γMVL-co-CL) can be either amorphous or semicrystalline with a range of possible melting temperatures. Interestingly, the thermal properties of the P(γMVL) homopolymers depend upon tacticity. Atactic P(γMVL) is amorphous whereas isotactic P(γMVL) is semicrystalline with improved thermal stability relative to caprolactone. The ability to tailor the thermal profiles of these sustainable polymers makes them extremely attractive for a wide variety of potential commercial applications.

9. Emilie Benson

Electrostatic Gating of the MBE-Grown NdTiO3 thin films

Advisor: Bharat Jalan

Sponsoring Program: NNIN

Home Institution: Gustavus Adolphus

Abstract: With the emergence of ionic gel gating in an electric double-layer transistor (EDLT), materials that could not be easily chemically doped, or had significant structural changes upon being doped, can now be examined. NdTiO3 (NTO) is a Mott-Hubbard antiferromagnetic insulator, with the insulating state being sensitive to doping and chemical distortions. This experiment explores the use of ionic gel gating in order to investigate the insulator-to-metal transition in NTO thin films using electrostatic doping. Single crystalline, epitaxial NTO films were grown onto an insulating substrate using a hybrid molecular beam epitaxy technique. The device was patterned using two shadow masks, one for etching with ion milling and the other to deposit metal contacts with sputtering. The ion gel, 1-ethyl-3-methylimidazolium-bis (trifluoromethylsulfonyl) imide (EMI-TFSI), was placed on top of the patterned NTO films and electronic measurements were taken in a Physical Property Measurement System (PPMS). The influence of ionic gel on the electronic transport of NTO films was determined by performing measurements before and after the placement of ionic gel. Voltage-dependent leakage current through the ionic gel was established, which allowed for calculation of injected charge. Temperature-dependent resistivity measurements were performed for each gate bias.

10. Vamsi Bhadriraju

Genetic Engineering of Alcohol Acyltransferases to Improve Isoamyl Isovalerate Production with Escherichia coli

Advisor: Kechun Zhang

Sponsoring Program: UROP

Home Institution: University of Minnesota, Twin-Cities

Abstract: Biofuels research has grown more interesting as scientists have looked for new feedstocks and means to produce them efficiently. This project discusses the production of two esters, isoamyl isovalerate (IAIV) and isobutyl isobutyrate (IBIB), by metabolically engineering Escherichia coli. Esterification processes for commercial products generally use of organic solvents and are not entirely efficient. Previous work in the field of metabolic engineering showed that alcohols and acyl-coAs could be esterified in the presence of an enzyme called an alcohol acyl transferase (AAT). Previous tests done with wild-type enzymes showed promising increases in production titers with a LuxE gene sequence for IAIV production. Another AAT, the strawberry alcohol acyl transferase (SAAT) was tested to see if it could further improve production of IBIB. Following a transformation with wild-type E. coli, colonies that were tested were then carried on to a shakeflask fermentation. IBIB production was not shown to improve at all with LuxE mutations and mutations of SAAT that were tested did not exceed this wild-type production titer for SAAT. Overall, IBIB production could not be improved from wild-type production titers but IAIV was successfully improved with a mutation of the LuxE gene sequence.

11. Joseph Blatner

Investigation of Synthetic Route to 2,4-Di(methyl pyridine)-1,2,4-triazole bromide

Advisor: Marites Guino-o

Sponsoring Program: University of St Thomas- Chemistry

Home Institution: University of St. Thomas

Abstract: Applications of lanthanide(III) pincer ligand complexes include medical diagnostics and probing tags. However, the optical properties of lanthanide(III) ions require energy transfer from antenna ligands. Thus, it is imperative to determine the sensitizing effect of antenna ligands on the metal center. By doing so the luminescent properties of the lanthanide(III) ions may be improved. My project involves studying the sensitization of 2,4-di(methylpyridine)-1,2,4-triazole bromide on a lanthanide(III) center. My first goal is to optimize the synthetic route to 2,4-di(methylpyridine)-1,2,4-triazole bromide. Herein my attempts at synthesizing my desired ligand are outlined.

12. Ernesto Borrego

Block Copolymer Modified Thermosets

Advisor: Frank Bates

Sponsoring Program: MRSEC

Home Institution: The University of Texas Rio Grande Valley

Abstract: As a result of the remarkable chemical and thermal stability that thermosetting polymers display, they have the potential to be used for a variety of industrial applications. Unfortunately, due to the fact that the thermoset resin is a highly cross-linked material, it is especially brittle. Traditionally, researchers have been successful in resolving this problem by adding liquid rubber as a second phase modifier to the system, though this has unfortunately required the forfeiture of other properties (Ex: Modulus, Transition glass temperature, etc.). Recent advances have proved the ability of block copolymers to serve as toughening agents in thermosetting resins—not only showing an increase in the toughening effects, but demonstrating the ability to be well controlled and retaining key properties as well. For our purposes, we have employed poly(ethylene-alt-propylene)-b-poly(ethylene oxide) (PEP–PEO) as our block copolymer. This study aims to obtain a detailed account on how different parameters will affect the curing extent in these systems—primarily by changing the curing procedures for the formulation of the thermosets and changing modifier loading in the polymer matrix. Dynamic Scanning Calorimetry (DSC) and Fourier Transform Infrared Spectroscopy (FTIR) are used to measure the curing extent. Mechanical property tests followed to evaluate the resin's performance: compact tension test for fracture toughness and nanoindentation techniques for modulus, hardness, and toughness.

13. Stephanie Breunig

Synthesis of APOBEC3 Inhibitors Based on High-Throughput Screening Hits

Advisor: Daniel Harki

Sponsoring Program: UMN Chemistry- Heisig Gleysteen

Home Institution: University of Minnesota, Twin Cities

Abstract: APOBEC3 (A3) is a family of single stranded DNA cytosine-to-uracil deaminases that function within the innate immune response, such that when a deaminated DNA template strand is replicated, an adenine nucleobase is base-paired with the newly-formed uracil. Therefore, the activity of A3 results in an overall guanine to adenine mutation. The accumulation of A3-catalyzed mutations within a pathogen's genetic material ultimately results in a loss of pathogen viability and therefore provides protection to the host cell. However, when misregulated, A3 activity can instead contribute to the initiation and propagation of certain diseases; sub-lethal A3G activity can contribute to the growing problem of HIV-1 resistance and immune system avoidance by aiding in the virus's evolution, while the overexpression of A3 in cancer cells can similarly contribute to chemotherapeutic resistance. The Harki and Harris Laboratories have hypothesized that a potent A3 inhibitor might serve as a potential drug that could be used in combination with antiretroviral anticancer therapies to minimize the development of drug resistance due to A3-catalyzed genome mutation. A fluorescence-based high-throughput screen identified structurally unique chemical motifs that might serve as potential drug scaffolds, such as a 4-amino-1,2,4-triazole-3-thiol moiety. As the presence of a thiol functional group within a small molecule drug would be highly cross-reactive within an organism, it has been hypothesized that the instillation of a nitrile at this 3-position would afford an equally as potent drug, with increased selectivity due to reversible targeting of A3 thiols. This poster presents efforts to synthesize such a molecule, as well as the observation of the formation of the interesting [1,2,4]triazolo[3,4,b][1,3,4]-oxadiazole ring system when such attempts were carried out using microwave radiation.

14. Clayton Brown

Hydraulic Oil Maintenance and Awareness

Advisor: Kim Stelson, Brad Bohlmann

Sponsoring Program: CCEFP

Home Institution: Montana State University - Bozeman

Abstract: Oil, the driving force behind any hydraulic system, is the root cause behind 80% of all component or machine failures. The necessity for well-maintained oil is overlooked for the vast majority of research labs here at the University of Minnesota. A misconception that often said is that new oil is clean oil. However, the particulate count in a new drum of oil is extremely high which leads to high corrosion and wear if not filtered correctly. The focus of this research is to establish a practice for maintaining and accessing hydraulic oils throughout the life of a hydraulic system. By designing an effective and cost efficient portable hydraulic filtration cart to pre-clean oils, the accessibility to take the first steps to maintaining oil can be done. The second part of this research is to educate labs in analyzing oil by putting in to place the best methods to collect and understand the results of an oil analysis. By investigating and discovering the problems within a particular system, a methodical process can be developed to fit a specific lab or test bed. This will allow the labs here on campus to better understand the operation of their equipment, along with reducing downtime by controlling the particulate count in their oil. The goal is to grow the understanding for the importance of oil maintenance by showing the ramifications that simple steps can have on the longevity of a hydraulic system.

15. Meaghan Bruening

Progress Toward the Synthesis of New Alkyne-Containing Geranylgeranyl Diphosphate Analogues

Advisor: Mark Distefano

Sponsoring Program: UMN Chemistry- Lando

Home Institution: St. Catherine University

Abstract: Prenylation is critical for facilitating interactions between proteins and cell membranes. Most notably, prenylated proteins are involved in the cell division and replication cascade, making it a useful target for designing anti-cancer compounds. This process is catalyzed by the enzymes PFTase, PGGTase-I and PGGTase-II which transfer either a 15 carbon or 20 carbon isoprenoid-containing group to the end of a protein with a specific CAAX box sequence. By synthesizing non-natural analogs with bioorthagonal moieties, the process of prenylation can be investigated. Reporter groups can be incorporated for post-prenylation modifications via site-specific click reactions allowing different functionalities to be installed. Here, progress is reported towards the synthesis of two alkyne containing analogs: a farnesyl-diphosphate analogue with a homopropargyl moiety and a geranylgeranyl-diphosphate analogue with a propargyl moiety. These analogues will help to investigate the role which isoprenoid length plays on the enzymatic activity of PFTase and PGGTase.

16. Michelle Bundy

Induced Surface States in n-GaAs

Advisor: Paul Crowell

Sponsoring Program: MRSEC

Home Institution: Saint Augustine's University

Abstract: Electronics categorizes materials into three main types: metals, insulators, and semiconductors. We designed an experiment in which we gate an ionic liquid to investigate if this induces a metallic surface state on insulating n-GaAs. We measured the resistivity from 2-300 K using the Physical Property Measurement System (PPMS) and a Van der Pauw method. Ohmic contacts to the GaAs substrate were created by annealing Ge/Au/Ni. In an experiment with 1x1016 cm-3 n-GaAs, applying a positive gate voltage increased the resistivity, but this increase in resistivity could not be reversed by applying a negative voltage. In experiments with 3x1015 cm-3 n-GaAs, the temperature-dependence of the resistivity showed no evidence of a change from insulating to metallic behavior.

17. Brian Bustrom

Optimizing the synthesis of luminescent lanthanide(III) complexes using the microwave technique

Advisor: Marites Guino-o

Sponsoring Program: University of St Thomas- Chemistry

Home Institution: University of St. Thomas

Abstract: Trivalent lanthanides are naturally occurring, rare-earth metals that possess unique photoluminescent properties with line-like emission. Because of this, these complexes are of interest in bioimaging, anti-counterfeiting, and telecommunicating applications. Their unique properties arise from 4f electronic transitions that are shielded by 5s2 and 5p6 subshells. However, according to Laporte's rule, these transitions are parity forbidden so excitation of these electrons to the emissive state is difficult. Emission can be achieved through the use of "antennae ligands" which are organic chromophores that sensitize the metal by binding to it and transferring energy. The synthesis of these complexes can be complicated and time consuming with the use of large quantities of volatile organic solvents. Outlined herein is our investigation of the use of microwave technique to optimize the synthesis of lanthanum(III) bistriphenylphosphineoxidetrithenoyltrifluoroacetonato and other lanthanide analogs of this complex. We also report the photophysical properties and crystal structures of all lanthanide(III) complexes synthesized.

18. Kenson Cai

Monitoring Water Dynamics using Remote Sensing Data

Advisor: Vipin Kumar

Sponsoring Program: Big Data REU

Home Institution: University of Minnesota- Twin Cities

Abstract: Freshwater, though vital to all life forms on Earth, is becoming increasingly scarce due to droughts, decreasing amounts of groundwater, and more. As a result, we want to create a global water monitoring system that can display information of inland water bodies over a regular period of time. This project looks at classification algorithms to classify every pixel (a rectangular area of 0.25 sq. km.) on the Earth as land or water given the remote sensing data obtained from satellites. In this way, changes in water body formations can be seen over time. We trained predictive learning tools such as support vector machines over training data before using them to analyze the rest of the data. Several problems arose in the forms of heterogeneity, lack of training instances, and noisy/missing values. Heterogeneity problems occur when land features look similar to water features in different parts of the Earth while cloud cover caused the missing values. We addressed these problems by designing algorithms specific to certain land/water features and that could generate accurate results from looking at already classified surrounding areas. The results were then stored, through a multi-step process, into a database that can be displayed on a publically accessible web interface created for increasing public awareness.

19. Jonathan Castellanos-Gomez

Peer-to-Peer Framework Based on Location-aware Mobile Distributed Engine

Advisor: Jon Weissman, Abhishek Chandra

Sponsoring Program: BIg Data REU

Home Institution: Normandale Community College

Abstract: Smartphones have become pervasive in modern day, and while the technological specifications improve yearly, they continue to experience notable resource constraints and limited battery capacity. Recent wearable smart technology such as Google Glass, though less ubiquitous, share equivalent drawbacks in their resources limitations. This project addresses the issue by creating a peer-to-peer framework that allows users to request pre-cached geo-locations from nearby mobile devices to provide quick, efficient, and fault-tolerant sharing of route information to nearby locations of interest. This framework is built upon an existing three-tiered architecture and middleware that encompasses Amazon EC2 Cloud, Android mobile device, and Google Glass. The Android device and Google Glass relay their geo-coordinates to the cloud, which will create a geo-spacial model containing directions to locations that the user may be interested in. By offloading heavy computations from the end-devices to the cloud power dissipation can be significantly reduced, as well achieving a reduction in latency by pre-fetching and pre-caching results from the cloud onto the mobile device. We enhance this architecture by implementing a peer-to-peer framework that allows sharing of pre-cached data through Wi-Fi Direct. Rather than making a request to the cloud, the user can query whether the desired resource can be obtained from a nearby peer. With the abundance of smart devices presents in public areas, reliable communication and data transfer can be achieved even in the absence of network connectivity. Our evaluation demonstrates the effectiveness of the architecture and middleware in reducing delay in resource retrieval and improving battery longevity on both Android device and Google Glass.

20. Emily Cliff

Using Microfluidic Platforms to Develop a Cell-Cell Co-culture Model

Advisor: Christy Haynes

Sponsoring Program: UMN Chemistry- Lando

Home Institution: Ripon College

Abstract: The goal of this project was to mimic the in vivo setting of cancer migrating into a blood vessel, and provide better understandings about how the interactions between cancer cells and endothelial cells. Herein, microfluidic platforms were used to create a cell-cell nteraction model to study three separate aspects of the in vivo tumor microenvironment, including the effects of chemoattractant gradients (interleukin 8 (IL-8) and tumor necrosis factor (TNF-α)), flow rate and sheer stress, and hypoxic environments. First, we found that cancer cells are able to naturally induce endothelial cell migration by secreting vascular endothelial growth factor (VEGF). Then, the introduction of positive chemical gradients was shown to significantly enhance the endothelial cell responses in migration, while negative gradients may downregulate cellular migratory behaviors. However, cancer cell migration was not affected. Additionally, the addition of sheer stress significantly decreases the migration of endothelial cells toward cancer cells. Currently, research continues to examine the effects of hypoxic environments on the endothelial cell-cancer cell interaction model. In a conclusion, this work enables the recapitulation of in vivo-like cancer microenvironments and reveals novel insights on the mechanisms of cellular interactions.

21. Ryan Cornelius

Additional Authors: Dr. Kenneth Leopold, Dr. Chris Dewberry, Rebecca Mackenzie, CJ Smith, Dr. Michael Dvorak

Microwave Spectroscopy and the Carbon Dioxide---3,5-Difluoropyridine Complex

Advisor: Kenneth Leopold

Sponsoring Program: UMN Chemistry- Lando

Home Institution: St. Cloud State University

Abstract: In this study, microwave spectroscopy is used to examine the CO2---3,5-difluoropyridine (DFP) complex. We use two approaches to collecting the microwave spectrum. The first approach is the Fourier transform Fabry-Perot cavity technique (cavity FTMW), and the second approach is the chirped pulse Fourier transform technique (chirp pulse FTMW). Cavity FTMW offers high sensitivity and high resolution, while the chirped pulse approach allows spectra over a large frequency range to be collected in a matter of minutes. Obtaining the rotational spectrum of CO2---3,5-difluoropyridine allows for the determination of experimental A,B, and C rotational constants leading to precise structural parameters. The goal of this research is to attain a better understanding of the secondary interactions, specifically between the CO2 oxygens and pyridine hydrogens, within the CO2---pyridine complex, for which previous research has been conducted. In this previous research, it is was found that there was an unusually short C···N distance. The CO2···3,5-difluoropyridine system is found to have a planar structure in which the nitrogen of the difluoropyridine is directed toward the carbon of the CO2, with a C···N weak bond distance of 2.8133(21) A., only marginally longer than in CO2---pyridine. Via comparison of this length with the original C---N length of CO2---pyridine as well as a previous length determined for CO2···2,6-difluoropyridine , it may be concluded that the o-hydrogens are greatly responsible for the short C---N length, as CO2···2,6-difluoropyridine showed an increase in bond length. As the bond remains short with 3,5-difluoropyridine, this means the o-hydrogens are responsible for the short length found in CO2---pyridine.

22. McKenzie Coughlin

Sustainable Pressure Sensitive Adhesives

Advisor: Frank Bates

Sponsoring Program: Center for Sustainable Polymers

Home Institution: University of Florida

Abstract: Pressure-sensitive adhesives (PSAs) are materials that quickly form bonds of measureable strength under light pressure. Triblock copolymers of an ABA architecture are commonly used for PSAs where "A" is typically a glassy block while "B" is a rubbery block at room temperature. Unfavorable enthalpic interactions leads to incompatibility of the blocks, causing them to microphase separate into distinct glassy and rubbery domains. This results in a soft yet elastic material since the glassy blocks act as physically crosslinks for the rubbery midblock.

Our objective was to create a sustainable and cost-effective PSA composed of poly(lactide) (PLA) and poly(β-methyl-δ-valerolactone) (PMVL) blocks. We used a resin tackifier with a low glass-transition temperature to lower the elastic modulus of the triblock copolymer, and tested the miscibility of the tackifier in the PMVL using differential scanning calorimetry (DSC). Rheology was used to probe the linear viscoelastic behavior of five samples with tackifier of varying weight percents, and DSC was used to characterize the glass-transition temperatures. We tested the adhesive properties of three samples using a probe-tack test. Future work will entail characterizing adhesiveness with additional experiments including peel and shear tests.

23. Rachel Daley

Using Graphene Nanoribbons to Increase the Sensitivity of Fourier Transform Infrared Spectroscopy

Advisor: James Johns

Sponsoring Program: MRSEC

Home Institution: St. Olaf

Abstract: Fourier Transform Infrared Spectroscopy (FTIR) is a vital technique for understanding the structure of organic and biological compounds. However, it is limited in its ability to accurately detect thin layers or low concentrations of a substance. Plasmons, collective oscillations of free electrons, have shown a potential use in increasing the sensitivity of FTIR. It is proposed that the FTIR signal will be greatly enhanced when the plasmonic frequency is the same as the frequency of molecular vibrations. Graphene nanoribbons are particularly suited to improving FTIR because they are able to support plasmons in the necessary wavelength range and have a weak IR absorption. We explore this effect by using thin films of PTCDI-C8, a carbonyl-containing compound, on graphene and a transmissive Si/SiO2 substrate. This research could expand the limits of FTIR and increase our ability to assess molecular interactions.

24. Phillip Dang

Magnetotransport Properties of Co2MnSi and Co2FeSi Heusler Alloy Thin Films

Advisor: Paul Crowell

Sponsoring Program: Physics REU

Home Institution: University of Maryland, Baltimore County

Abstract: Heusler alloys have been studied for decades but are of renewed interest due to their potential as half-metallic ferromagnets. Such materials have close to 100% spin polarization and are promising in applications to spin transport devices. Co2FeSi and Co2MnSi are of particular interest due to their high Curie temperature (much greater than room temperature). We report on the magnetotransport properties of Co2FeSi and Co2MnSi thin films prepared by molecular beam epitaxy onto intrinsic GaAs in order to correlate the characteristics of the materials with their potential half-metallic behavior. At high temperatures, the high-field magnetoresistance (MR) for the films are negative, linear, and isotropic, which we suggest is due to reduction of spin-disorder scattering. The temperature dependence of resistivity shows an upturn at low temperatures which can be attributed to weak localization. Ferromagnetic resonance (FMR) measurements were also taken to probe the damping of magnetic excitations in the materials.

25. Luc Desroches

Technique for Developing Air-Free Exfoliate Phosphorene

Advisor: Stephen Campbell

Sponsoring Program: MRSEC

Home Institution: University of Minnesota - Duluth

Abstract: Phosphorene is a one-atom thick layer of black phosphorus. It has large implications in the field of electronics due to its natural band gap, and its high mobility. This makes phosphorene a suitable alternative to graphene for transistor design. Mechanical exfoliation from a bulk material using Scotch tape is typically used to produce useable samples of two-dimensional materials, such as graphene. Unlike graphene, the structure of phosphorene makes it reactive when exposed to air, making the "Scotch Tape" method unusable. The aim of this research is to explore an alternative to the "Scotch Tape" method in order to produce useable samples of phosphorene without air exposure. This new method includes the use of polyethylene terephthalate (PET) tape in place of Scotch tape. The PET tape can also be used to exfoliate phosphorene, but then becomes part of the device without air exposure. To do this, the tape is first used for exfoliation, then it is put onto a Si-wafer, the sample is coated with AL2O3, and then a layer of photoresist is added. Using photolithography, a pattern can be created that allows the bottom of tape to be accessed after several rounds of chemical etching. Once the material in the holes is fully removed, the underlying layer of phosphorene can be electrically contacted without air exposure in the device area.

26. Jaya Dhami

Crystal Structures of Reactive Nitrile Oxides: 3-Bromobenzonitrile Oxide

Advisor: William Ojala

Sponsoring Program: University of St Thomas- Chemistry

Home Institution: Chemistry Department, University of St. Thomas

Abstract: Nitrile oxides dimerize in solution to form three different products: a furoxan, a dioxadiazine, or an oxadiazole-N-oxide. We are using single-crystal X-ray diffraction to determine whether the identity of the product formed by solid-state dimerization can be correlated with the molecular packing arrangement of the parent nitrile oxide. We report here the crystal structure of 3-bromobenzonitrile oxide, which crystallizes in space group C2/c with eight molecules occupying general positions in the unit cell. The fulminate group is slightly bent at the carbon atom with a C-C-N angle of 177.1(6) degrees, a bend larger than that shown by our 4-chlorobenzonitrile oxide structure (C-C-N angle 179.5(2) degrees) but smaller than that shown by our 2,6-dichlorobenzonitrile oxide structure (C-C-N angle 172.3(2) degrees). A close intermolecular oxygen…halogen contact in 4-chlorobenzonitrile oxide suggested that similar contacts in other halogenated benzonitrile oxides might define their molecular packing arrangements; however, no close oxygen…bromine contacts are observed in 3-bromobenzonitrile oxide. Instead, a close bromine…bromine contact is found. Close intermolecular oxygen…hydrogen approaches define N…N intermolecular separations of 3.971 angstroms and 3.221 angstroms. These approaches, in addition to the b-axis repeat distance of 3.903(2) angstroms, are within solid-state dimerization range but do not unambiguously determine which dimer is preferred.

27. Aditya Dhumuntarao

ADS/CFT on a Pure SU(3) Gauge Theory

Advisor: Joseph Kapusta, Dr. Sean Bartz, Micheal Albright

Sponsoring Program: Physics REU

Home Institution: Arizona State University

Abstract: The Anti-de Sitter Space/Conformal Field Theory (AdS/CFT) correspondence proffers novel insights into the non-perturbative regime of strongly coupled gauge theories such as Quantum Chromodynamics (QCD). We present a 5-dimensional effective gravity dual to the 4-dimensional non-Abelian gauge theory of QCD. In addition, we constrain the model to a pure SU(3) gauge theory by suppressing chiral and axial fields, while introducing a Glueball field. The conformal symmetry is broken by a background Dilaton field. The Glueball and Dilaton background fields are derived from a potential, which is constructed from the gravity/gauge duality. The potential is described in detail and undergoes numerical treatment to model the Glueball spectra.

28. Samsam Dirie

Additional Author: Nu Wang

Effects of injection solvent on retention times and peak shape in Reverse Phase Liquid Chromatography

Advisor: Paul Boswell

Sponsoring Program: Project SEED

Home Institution: Class of 2016, Harding High School, St Paul, MN

Abstract: Liquid chromatographs and mass spectrometers are a dynamic duo of technology in the field of analytical chemistry. Together, they can identify and illustrate the retention times of specific chemical compounds. The precision and accuracy produced by these machines can be compromised by the interaction between solvents used in samples and the mobile phase used in the LC. This study will discuss the relationship between solvent polarity and peak distortion of RPLC-MS data by using 9 injection solvents varying in polarity.

29. Erin Duffy

Single Enzyme Molecule Detection using Capillary Electrophoresis

Advisor: Michael Bowser

Sponsoring Program: UMN Chemistry- Heisig Gleysteen

Home Institution: University of Minnesota, Twin Cities

Abstract: Single molecule enzyme assays have been performed in order to better understand the activity, electrophoretic mobility, and heterogeneity of each individual enzyme. The goal of this research is to determine reproducibility of this detection method in order to quantify the abundance and distribution of catalysts in more complex materials such as naturally occurring and non-natural biopolymers. This method of detection relies on the ability of a single enzyme molecule to catalyze a substrate reaction in a capillary such that when the product reaches the detector, a broad peak will be observed. Calculations performed on the peak's width can then quantify the activity of that individual enzyme molecule. Furthermore, using a low concentration of enzyme and continuous detection allows for multiple, separate reactions to be observed over time, within the same capillary.

30. Shannon Dulz

Monte Carlo Simulations and Polymerization of Neutron Veto Plastics for SuperCDMS Experiment

Advisor: Priscilla Cushman

Sponsoring Program: Physics REU

Home Institution: Missouri State University

Abstract: The SuperCDMS experiment is an attempt to detect WIMPs (Weakly Interacting Massive Particles) to explain the nature of dark matter in our universe. Dark matter is thought to make up a quarter of the mass of our universe but its properties have yet to be experimentally established. After several years running at Soudan Mine in Minnesota the experiment is moving to SNOLAB in Sudbury, Canada; to further decrease cosmogenic radiation. One possible upgrade for SNOLAB includes an active neutron veto to detect neutron events near the detector. For this project, we have been developing a process for polymerizing gadolinium loaded polystyrene scintillators in the lab to test optical properties for developing a large scale neutron veto system. Also using Geant4 Monte Carlo simulations, we have been simulating a simplified version of possible configurations to better understand gamma multiplicity and energy deposition in the polystyrene as well as to build on existing code for use in future simulations. These simulations could be applied to other classes of dark matter detectors in the future as well.

31. Robert Enright

Surfactant Effects on Organic Electrolyte Gated Transistors

Advisor: Dan Frisbie

Sponsoring Program: MRSEC

Home Institution: Ripon College

Abstract: Organic Semiconductors have shown promise for their use in flexible and wide area electronics and biosensing devices. Studies of organic single crystals as semiconductors in Electrolyte Gated Transistors (EGTs) give insight into charge transport properties of organic semiconductors. Electrolyte gating creates an electrical double layer with high charge density at the electrolyte-semiconductor interface. As charge density increases in organic EGTs, carrier mobility decreases dramatically, resulting in a peak in conductivity. The use of surfactants in the electrolyte layer may diminish this mobility loss by increasing the distance between charges in the electrolyte and charge carriers in the semiconductor. The addition of Brij-58 surfactant to [P14]+[FAP]- ionic liquid in a rubrene EGT has shifted the conductivity peak and threshold voltage (the gate voltage at which the device turns on) significantly, with minimal changes to peak conductivity, suggesting potential tunability of these important voltage levels.

32. William Flotte, Caleb Larson

Additional Authors: Caleb Larson, Duc Tran, Lana Yarosh, Daniel Keefe

Creating a multisensory presence in the virtual world: Toward virtual reality (VR) applications for the management of anxiety and pain.

Advisor: Daniel Keefe, Lana Yarosh

Sponsoring Program: CS&E REU

Home Institution: Brown University

Abstract: We present an exploration of new possibilities for creating more effective, realistic VR applications for the management of anxiety and pain utilizing Bluetooth, haptic feedback, hand tracking and sound. It is now possible to create VR experiences using low cost and therefore widely accessible smart-phone based systems. Early versions of these low cost systems have focused on the visual component of the virtual world. In contrast, our goal is to create virtual worlds that engage several senses including visual, auditory, and tactile senses. The rationale is that the resulting widely accessible, multi-sensory experiences will increase realism, engagement, and presence within the virtual environments and thereby serve as a more effective distraction from persistent and chronic pain or anxiety. To accomplish this, we utilize the Bluetooth communication protocol to create cordless connections between a smart phone and a variety of custom-built haptic devices. The smartphone acts as a VR viewfinder and is programmed to display a stereoscopic 3D view of the virtual world, and the devices provide haptic feedback to the user. To date, we have built two-such haptic device prototypes and coupled them with virtual environments that we believe can eventually be utilized as part of pain and anxiety treatment protocols. The first environment is a soothing, sitting meditation in an ocean cove complete with sounds and visuals of waves gently rolling in. The custom haptic device vibrates under the participant's feet in time with the visuals to create the feeling of the waves. The immersive environment helps the user focus on something other than their pain. The second environment is a digital animal companion that sits on the participant's lap, designed to help reduce anxiety. The custom haptic device responds to the users' petting gestures in real world by vibrating and in the virtual world by changing color and audibly purring. The key results of this work in progress include identifying the most appropriate technical mechanisms (hardware and software) to build the two prototypes and early demonstrations of the potential for these enriched, low-cost, mobile virtual experiences to assist in managing anxiety, stress or pain.

33. Alex Foley

Avatar Embodiment and Animation in a Multi-User Virtual Reality Environment

Advisor: Dr. Victoria Interrante

Sponsoring Program: MRSEC

Home Institution: Lawrence University

Abstract: Creating and animating realistic avatars based on head tracking data is important for immersion in a MuVR (multi user virtual reality) environment using HMDs (head mounted displays). When multiple users participate in the same virtual environment, they must know the location of other users in both the real and virtual spaces and they must be able to interact. While a 3D cylinder can give a users' position, a realistic avatar provides for more accurate representation of nonverbal behaviors such as nodding and seeing where a user looks. This presents two major technical challenges: creating accurate avatars from real people, and animating those avatars based solely on head tracking data. By utilizing Body{SNAP}, we are able to create a virtual avatar from Kinect scans of a person. Texture data is not preserved, but this method is able to quickly and accurately capture body shape and facial features while still providing an avatar that is robust and fully capable of animation. Once the avatar is created and imported it needs to be animated from the head-tracking data. While full body tracking is theoretically possible, it is cumbersome for the user and requires the use of additional tracking hardware which may not be readily available. Our technique seeks to infer reasonable full body tracking data solely from the head data and determine if the person is rotating, walking, or even stationary and only moving their head. This allows the avatar to walk, rotate, and freely move their head as the user does. During our initial lab tests, the results have been very positive, but more refinement is needed to better match the animation speed with the actual distance moved and increase the motions available to the avatar.

34. Michelle Galarneau

A Microfluidic Mimic of the Human Microvasculature

Advisor: David Wood

Sponsoring Program: NNIN

Home Institution: University of Notre Dame

Abstract: The major cause of morbidity and mortality in sickle cell disease, a genetic disorder caused by a DNA mutation, is the vaso-occlusive crisis (VOC). In a VOC, the flow of blood becomes obstructed in the microvasculature under hypoxic conditions. Currently, hydroxyurea (HU) is the sole FDA-approved drug treatment option available to patients, and yet HU is ineffective in one-third of those treated. Moreover, there is a clear need for more effective drug treatments, as well as a screening platform to evaluate drug efficacy. Because drug efficacy is intimately linked with the occurrence of VOCs, we sought to create an in vitro disease model that accurately replicates the physiological parameters found in VOCs. To accomplish this, we built a microfluidic device that mimics the physiological vessel architecture and oxygen concentration gradient between blood and the surrounding tissue. We used AutoCAD to design the device layers and soft photolithography to fabricate the masters. We then cast the masters with polydimethylsiloxane (PDMS) to create a dual-layer device that diffusively couples the oxygen gradient to the microvasculature layer. Ultimately, this device will act as a drug-screening platform with the goal of expanding and enhancing treatment options for patients suffering from sickle cell disease.

35. Michael Gunther

Synthesis and Catalytic Exploration of Charged BINOL Derivatives

Advisor: Steven Kass

Sponsoring Program: UMN Chemistry- Lando

Home Institution: Iowa State University

Abstract: Hydrogen bonds play a critical role in many important natural processes: the formation of ice, the double helix structure of DNA, and catalytic activity of enzymes. In addition to these natural applications, hydrogen bonds are being exploited in catalysts in synthetic laboratories. Various derivatives of 1,1'-bi-2-naphthol (BINOL) have been studied as a catalyst for many reactions, such as the hetero-Diels-Alder and Mannich reactions, and the allylboration of ketones. Recently, it has been shown that positively charged hydrogen bond donors have increased acidities in non-polar media. This led to the preparation of a double charged BINOL this summer. The presence of the two positive charges is hypothesized to increase catalytic activity and lead to greater enantioselectivities by employing lower reaction temperatures. This was tested by examining the allylation of acetophenone with diisopropyl allylboronate.

36. Alek Gust

Fluid Density and Compressibility Sensor Design

Advisor: James Van de Ven

Sponsoring Program: CCEFP

Home Institution: St John's University

Abstract: In most fluid power applications, the fluid used is often considered incompressible at relatively low pressures. However, in high pressure hydraulic systems the fluid is compressible, and this becomes more apparent when gasses enter the system. There are many energy losses contributed to compressible fluids, including: energy/time spent to compress fluid to operating pressure, thermodynamic heat losses, and the mistiming of valves within the system due to the time delay. To characterize the reasons for these losses, a Bulk Modulus sensor is required to define the compressibility of different oil/gas mixtures entering a system to determine what effect the compressibility of the hydraulic fluid has on the efficiency of the system. A full design process was conducted this summer to construct a Bulk Modulus sensor that will meet the resolution necessary to accurately determine the compressibility of a given oil/gas mixture.

37. Jeremy Hamning

Evolution of the Influenza Virus

Advisor: Daniel Boley

Sponsoring Program: Big Data REU

Home Institution: Normandale Community College

Abstract: In our research we expanded on previous work by exploring the evolution of the H1N1, H3N2, and type B influenza virus strains. Taking sequences from the online NCBI flu database and converting the sequences to binary using the technique described in [Lam et al., 2015] we were able to run a principal component analysis on the sequences. Graphing the first two principal components of the results we were able to see the path of the virus evolution. In addition, we also performed a pairwise Hamming distance calculation on the PB1, HA1, HA2, and NA proteins in each H3N2 strain. We used this to measure the rate at which these proteins evolve in relation to each other in order to see how much the outer proteins (HA1, HA2, NA) change as a response to influenza vaccines.

38. Melissa Hardy

Additional Author: Nicholas Serratore

A Novel Synthesis of Hydroxyphenstatin: Applications of Tandem C-O, C-H Bond Activation

Advisor: Christopher Douglas

Sponsoring Program: UMN Chemistry- Lando

Home Institution: Grinnell College

Abstract: Hydroxyphenstatin, a derivative of the natural product family combretastatin, has been found to display potent inhibition of tubulin polymerization and cytotoxic activity against a broad range of cancer cell lines, rendering the compound an important drug candidate as an anticancer agent. To enable further testing, a concise synthesis is herein reported, yielding hydroxyphenstatin in three steps from a commercially available benzoic acid. The final, key step utilizes an iridium catalyzed tandem C-O, C-H bond activation to convert a substituted salicylic ester to a corresponding benzophenone.

39. Alexa Harnagel

Isolation and Identification of Biologically Active Secondary Metabolites from a Fungal Endophyte of Alfalfa

Advisor: Annalisa Jordan

Sponsoring Program: St. Catherine University Chemistry

Home Institution: St. Catherine University

Abstract: Fungal endophytes are known to produce an array of antimicrobial and cytotoxic compounds making them a viable source for new pharmaceuticals. Characterization of their metabolic profiles also aims to monitor their mycotoxin production in food crops such as alfalfa, wheat and corn. The following studies describe antimicrobial compounds produced by an isolate of Alternaria gaisen (S6-3 DNA 6) collected from alfalfa in St. Paul, MN. This is the first report of A. gaisen colonizing crops in the U.S. as well as its production of 5-(1-hydroxyethyl)dihydrofuan-2(3H)one. Fungal isolate S6-3 DNA 6 was identified as an isolate of A. gaisen based on DNA analysis. It was fermented on a jasmine rice culture for 30 days and extracted using ethyl acetate resulting in a crude extract of 712.08 mg. This extract showed antifungal effects against Phoma medicaginis pARL, therefore warranting chemical investigation. The crude extract was subjected to a bioassay-guided fractionation process in order to identify metabolites responsible for antimicrobial effects. The second fraction from silica VLC (B; 168.4 mg) was active against Strepococcus pyogenes and for this reason was further purified. Fractions B.13 (3.0 mg) and B.14 (1.1 mg) from gravity column chromatography displayed similar 1H and 13C NMR profiles. Their data were consistent with that of the known compound 5-(1-hydroxyethyl)dihydrofuan-2(3H)one. Bsi.14 was tested in bioassays and was active against S. pyogenes. Several other fractions from A. gaisen extracts displaying biological activity are currently being investigated and their data will be discussed.

40. Joshua Hatton

Additional Author: Benjamin Caplins

Controlled Aggregation and Impact on the Photophysics of an Organic Light Harvester

Advisor: David Blank

Sponsoring Program: UMN Chemistry- Lando

Home Institution: Bemidji State University

Abstract: Phthalocyanines, first discovered in 1907, are commonly used as a dye in many products. Currently we are looking into its use as a thin film for use in solar cells. In a solution it has favorable properties for use in a solar cell but it loses them as a solid. Using UV/VIS and Transient Absorption spectroscopy we hope to see how it aggregates and how that changes the photophysics of the molecule.

41. Kyle Hemmingsen

Using Polymers to Clean Water: Flocculation and Fluid Flow of Clay Suspensions

Advisor: Cari Dutcher

Sponsoring Program: UROP

Home Institution: University of Minnesota - Twin Cities

Abstract: Flocculation is a process used in water treatment that helps in the separation of solids and liquid with water-soluble polymers. However, the flocculation process is complex which leads to incorrect dosing levels of polymer used during the water treatment. Ultimately, un-optimized polymer dosing leads to larger costs. The purpose of this research is to reduce cost through the optimization of polymer-driven flocculation water treatment. The efficiency of flocculation is conducted using jar tests in the laboratory. In these tests, polyacrylamide is mixed and stirred with a solution of sodium bentonite. For all experiments, 30mg of bentonite is added into 1L of water in 2L Pyrex jars. These solutions are rapidly mixed to disperse the bentonite for 30 minutes at 300 RPM in a VELP Sceintifica JTL4 Flocculator. For macroscopic characterization, the degree of impurity removal is quantified by measuring turbidity using a LaMotte Turbidity meter. The pH and conductivity of the solution are also measured using a Mettler Toledo SevenExcellence pH/Conductivity meter. This research will result in a better understanding of flocculation and will directly impact the use of flocculation as a water treatment in industry; as costs for the treatment plants will decrease as the efficiency of flocculation increases.

42. Jacob Heppner

High-Throughput Fabrication of Nanofluidic Biosensors

Advisor: Sang-Hyun Oh

Sponsoring Program: NNIN

Home Institution: Bethel University

Abstract: Surface Plasmon Polaritons (SPPs) are propagation of electromagnetic fields across a metal-dielectric interface and are commonly excited through the coupling of light to a metallic surface. Plasmonic waveguides, such as a nanogap between two metals, grooves in a metal surface, or a thin metallic film surrounded by dielectric material, can be used to guide SPP's beyond the conventional diffraction limit of light, allowing for optical measurements that would not be possible with standard techniques. Linear and annular nanogaps will be fabricated to utilize plasmonic phenomenon such as surface enhanced infra-red absorption, surface plasmon resonance, and extraordinary optical transmission. These techniques allow us to sense small changes in the absorption or reflection spectra of the device or refractive index of the surrounding medium and spectroscopically detect compounds within close proximity to our structures. Increased device sensitivity will hopefully be shown through the reduction of critical dimensions.

43. Kristine Her

Synthesis of Cyclopropene containing Isoprenoid Non-natural Substrate for Protein Farnesyltransferase (PFTase)

Advisor: James Wollack

Sponsoring Program: Other

Home Institution: St. Catherine University

Abstract: Protein Farnesyltransferase (PFTase) is an enzyme that attaches isoprenoids on a cysteine near the C-terminus of Ras proteins. It is known that PFTase can also transfer non-natural isoprenoids onto Ras proteins that are capable of doing copper catalyzed click chemistry. This allows Ras proteins to be targeted using an alkyne and azide pair. Due to copper's cytotoxicity, this limits the use of this method to non-living systems. Presented here are two biorthogonal PFTase substrates that can undergo Diels Alder cycloaddition and do not require the use of a copper catalyst. The non-natural substrates include either cyclopropene or allyoxy functionality. Cyclopropene and allyogy groups can react with tetrazine-BODIPY containing fluorophores through Diels Alder cycloaddition without a copper catalyst. The non-natural isoprenoid is designed to be prenylated onto a Ras protein utilizing PFTase and subsequently tagged with a fluorescent probe in a living system.

44. Kylie Hess

Fabrication of a Cosmic Ray Detector and Creation of Accompanying Data-Processing Code

Advisor: Roger Rusack

Sponsoring Program: Physics REU

Home Institution: Rose-Hulman Institute of Technology

Abstract: We worked on the construction of a cosmic ray detector that will be able to read out the position of a particle that passes through it. When a cosmic ray passes through the detector, it will interact with scintillator tiles, which will produce photons that will travel through an optical fiber and recorded by electronics. Scintillator tiles work using Cherenkov radiation, a phenomenon in which a particle traverses a medium more quickly than light travels through the medium, resulting in the release of photons. Two rows of tiles are placed perpendicularly to each other and overlapping to form a grid at each end of the detector so that recording which tiles produced photons will yield a lateral and vertical coordinate for the position of the incident particle as it enters and leaves the detector. We also wrote accompanying code that will read in and process the data recorded by the electronics. Each row of tiles connects to one circuit board that records input from the optical fibers. For each input channel on each board, the program will calculate and record the pedestal value and the analog-to-digital conversion value, which are the background caused by noise in electronics and the signal produced by an incident particle, respectively.

45. Kieu Ho

MODIFICATION OF POLYMERIC BEADS FOR COLORIMETRIC ANION ANALYSIS

Advisor: Phillippe Buhlmann

Sponsoring Program: Project SEED

Home Institution: 2015 Graduate, Como Park High School, St Paul, MN

Abstract: Colorimetric sensing can provide a simple readout about the analyte of interest and can be a powerful sensing tool. We have been developing a colorimetric test for anions using modified rink amide beads. The amino groups were modified to thiourea groups by a solid state reaction with synthesized 1-(N-Boc-aminomethyl)-4-(isothiocyanato ethyl)benzene. Several repeated reactions allows for the synthesis of mono-, di-, tri-, and tetrakis (thiourea) substituted groups. Beads were then plasticized and a dye was added. The beads should change color depending exposure to various anion (AcO- , H2PO4- ,NO3- ,Cl-). The color reaction was optimized by varying the dye concentration and degree of substitution of thiourea groups so that a difference between various anions can be more clearly observed.

46. Levi Hogan

Olefins from Biomass: Catalytic Ester Decarbonylation

Advisor: William Tolman

Sponsoring Program: UMN Chemistry- Heisig Gleysteen

Home Institution: University of Minnesota-Twin Cities

Abstract: With an increasing demand for polymer feedstocks, a dwindling supply of petroleum, and rising concern about environmental impacts of the current polymer industry all occurring in tandem, finding a sustainable route to polymer feedstocks is necessary. An answer lies in the massive resource potential of renewable biomass, particularly in the ability to convert bio-derived carboxylic acids into olefin monomers. Our recently developed methodology for achieving these conversions negates the previous use of sacrificial anhydride additives, instead utilizing a catalytic decarbonylation of p-nitrophenol esters of aliphatic carboxylic acids to their corresponding olefins. These conditions employ palladium complexes, no added ligands, and the addition of alalki/alkaline-earth metal halide promoters. This methodology holds promise for additional advancements in catalytic activation and conversion of bio-derived acids and related biomolecules into polymer feedstocks.

47. Kiersten Idzorek

Crystal Structures of Reactive Nitrile Oxides: 2,6-Dichlorobenzonitrile Oxide

Advisor: William Ojala

Sponsoring Program: University of St Thomas- Chemistry

Home Institution: Chemistry Department, University of St. Thomas

Abstract: Benzonitrile oxides are useful synthetic intermediates in 1,3-dipolar cycloaddition reactions. They also dimerize in solution, forming three possible products: a furoxan, a dioxadiazine, or an oxadiazole-*N*-oxide. We are using single-crystal X-ray diffraction to examine whether the molecular packing arrangement in a crystalline benzonitrile oxide might determine which of the three dimers is formed in a solid-state dimerization. To determine the role of potential halogen bonding in establishing the nitrile oxide molecular packing arrangement, we have now determined the X-ray crystal structure of 2,6-dichlorobenzonitrile oxide, which has a reported stability of approximately 30 days at room temperature. We have found 2,6-dichlorobenzonitrile oxide to crystallize in space group $P2_1/c$ with four molecules in general positions within the monoclinic unit cell. The fulminate group is bent slightly at the carbon atom, with a C-C-N bond angle of 173(2) degrees. Our prior determination of the crystal structure of 4-chlorobenzonitrile oxide had revealed a close intermolecular oxygen···chlorine contact but no close chlorine···chlorine contacts, but we find 2,6-dichlorobenzonitrile oxide to exhibit close intermolecular chlorine···chlorine contacts but no close oxygen···chlorine contacts. The closest N···N separation is between molecules translated along the a-axis, consistent with formation of the furoxan upon solid-state dimerization.

48. Andrey Joaqui Joaqui

Design of a synthetic Siderophore functionalized analogue of Bacillibactin.

Advisor: Valerie Pierre

Sponsoring Program: UMN Chemistry- Lando

Home Institution: Universidad del Valle

Abstract: Iron is an essential metal associated with many biological processes including photosynthesis, respiration, and amino acid and DNA synthesis. Despite the fact that iron is one of the most abundant element in the Earth's crust, it also has very low solubility. As a result of the low concentration of free Fe(III) in aerobic neutral pH environments, obtaining iron is challenging for the organisms that rely on it. For this reason, bacteria have developed a way to confront this nutritional limitation through the use of organic compounds called siderophores, low molecular weight ferric ion specific chelating agents. The design and study of synthetic siderophores have attracted wide attention due to the potential application of microbial iron(III)-uptake phenomena to biomedical applications, particularly with regard to improving the delivery of antibiotics to antibiotic resistant bacteria. Herein we report on novel strategies to obtain a functionalizable synthetic siderophore analogues and to use this analogue as a potential selective molecular probe to bacteria strains.

49. Hillis Johnson

Decarbonylation of Fatty Acid Esters for the Selective Production of Linear Alpha Olefins

Advisor: William Tolman

Sponsoring Program: Center for Sustainable Polymers

Home Institution: California Lutheran University

Abstract: Linear alpha olefins are a class of valuable and widely used compounds that are traditionally derived from petroleum sources. Recent efforts towards sustainability have targeted biomass as a renewable source for these olefins. Recently, a catalytic method for the decarbonylation of p-nitrophenylesters of aliphatic carboxylic acids to olefins was developed. Current efforts are directed towards achieving selectivity for the production of alpha olefins. Optimization of the ligand-to-catalyst ratio afforded high selectivity for the alpha olefin product over the less valuable internal olefin isomers.

50. Ryan Johnson

Solid-State Nitrile Oxide Dimerization: Crystal Structure of bis(2,3-Dichlorophenyl)furoxan

Advisor: William Ojala

Sponsoring Program: University of St Thomas- Chemistry

Home Institution: Chemistry Department, University of St. Thomas

Abstract: Nitrile oxides dimerize in solution to form three possible products: a furoxan, a dioxadiazine, or an oxadiazole-N-oxide. We are using single-crystal X-ray diffraction to determine whether the molecular packing arrangement of the parent nitrile oxide determines which product is formed upon solid-state dimerization. We report here the crystal structure of bis(2,3-dichlorophenyl)furoxan, formed from 2,3-dichlorobenzonitrile oxide by refluxing in ethanol. This dimer crystallizes in the monoclinic space group P21/c with four molecules in general positions in the unit cell. A residual electron density peak near the uncharged nitrogen atom suggests crystallographic disorder in which two sites are partially occupied by the exocyclic oxygen atom, although the solid-state conformation of this furoxan lacks the approximate twofold symmetry possessed by those of previously examined furoxans that are definitely disordered. Unlike our 4-chlorobenzonitrile oxide crystal structure, which involves close oxygen…chlorine contacts but no close chlorine…chlorine contacts, the crystal structure of bis(2,3-dichlorophenyl)furoxan involves both close oxygen…oxygen contacts and close chlorine…chlorine contacts; no close oxygen…chlorine contacts are observed. We are pursuing the X-ray crystal structure determination of 2,3-dichlorobenzonitrile oxide to determine whether its intermolecular contacts are preserved in the dimer described here and might favor the formation of this dimer over the other two possible dimers.

51. **Adam Juelfs,** Amani Lee, Clifford Gee, Bradley Weegman, Samuel Einstein, Samuel Egger, Christy Haynes, William Pomerantz, Michael Garwood.
Fluorine-loaded Ultraporous Mesoporous Nanoparticles as Sensitive Oximetry Agents
Advisor: Christy Haynes
Sponsoring Program: UROP
Home Institution: University of Minnesota Twin Cities
Abstract: : Oximetry is a valuable diagnostic tool to examine the physiological state of cells and tissues as oxygen is critical to many biological processes. Oxygen concentration, indicated by pO_2, can be measured non-invasively by fluorine nuclear magnetic resonance (19F NMR) and fluorine magnetic resonance imaging (19F MRI) of a local fluorine contrast agent. In biomedical applications the agent is commonly a perfluorocarbon (PFC), a compound with fluorine atoms in place of hydrogen atoms, chosen for their high oxygen solubility, chemical inertness, and biocompatibility. However, PFCs are lipophobic and hydrophobic, not soluble in lipids or water respectively, which poses a significant challenge for biomedical use. This challenge may be overcome by loading the PFC into a hydrophilic platform for delivery to the area of interest. In this research the platform is a mesoporous silica nanoparticle with a hydrophilic functionalized surface. These nanoparticles are sub-100 nanometers in diameter with 8-10 nanometer diameter pores, or mesopores, on the particle surface but, most importantly, contain an internal cavity for PFC loading. Mesopores promote the diffusion of hydrophobic PFC, and oxygen, into the nanoparticle while the hydrophilic nanoparticle surface provides stability for the loaded contrast agent in aqueous solution. Presented here is the characterization and oxygen sensitivity of PFC-loaded silica nanoparticles.

52. **Eric Kalkman**
Synthesis of Organometallic Ni Complexes for Use in Ethylene/CO2 Polymerization
Advisor: Ian Tonks
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota-Twin Cities
Abstract: The copolymerization of ethylene and carbon dioxide provides a cheap and renewable route to polyesters. One strategy to achieve this is the use of a Ni/X (X=Ni, Zn, Mg, Al) heterobimetallic catalyst system, N-bipyridyl salicylaldimine (SAbpy), in which each metal is responsible for the incorporation of one of the monomers into the polymer chain. Existing catalysts have experienced problems with bis-chelation and β-hydride elimination, so similar ligand backbones were designed with a bulky tert-butyl group close to the offending coordination site (tBuSAbpy and its nitrated counterpart tBuNO2SAbpy) in an effort to discourage these processes. The proposed syntheses of both ligands were successful, though tBuSAbpy proved difficult to isolate for further chemistry. The syntheses of various monometallic Ni complexes with tBuNO2SAbpy were also accomplished. Further research will be conducted on the optimization of these syntheses and the effectiveness of these complexes for polymerization.

53. **Kara Kassekert**
Toward Isomorphous Bridge-Flipped Isomers: Crystal Structure of a Hydrated Phenylhydrazone
Advisor: William Ojala
Sponsoring Program: University of St Thomas- Chemistry
Home Institution: Chemistry Department, University of St. Thomas
Abstract: We designate as "bridge-flipped isomers" pairs of organic molecules differing only in the orientation of a bridge of atoms connecting two major molecular moieties, as among benzylideneanilines, Ar1-CH=N-Ar2 vs. Ar1-N=CH-Ar2, and phenylhydrazones, Ar1-CH=N-NH-Ar2 vs. Ar1-NH-N=CH-Ar2 (Ar = aryl). Isomorphous bridge-flipped isomers might be co-crystallized to form solid solutions with properties tailored by adjusting component concentrations; non-isomorphous bridge-flipped isomers may serve as seed crystals for obtaining new polymorphs of each other. To determine whether intermolecular interactions such as H-bonding and Lewis acid-base contacts possessed by both isomers might facilitate their isomorphism, we have determined the X-ray crystal structure of the 4-cyanophenylhydrazone of 5-bromo-2-pyridinecarboxaldehyde looking for a possible cyano…bromo interaction. The compound crystallized from ethanol as a monohydrate in space group P(-1). Cyano…bromo contacts are absent; instead, the water molecule acts as an H-bond donor to the cyano group and to the ring nitrogen atom of two different molecules while acting as an H-bond acceptor from the bridge N-H moiety of a third molecule. The bromine atom participates in an R22(8) motif with a pyridine ring hydrogen atom. The participation of the bridge N-H group in this extensively H-bonded network suggests that bridge reversal in the isomer will be disruptive and structure-differentiating.

54. Nathan Klein

Incorporating Zirconia Catalysts into Mesoporous Silica Nanoparticles

Advisor: Christy Haynes

Sponsoring Program: UMN Chemistry- Heisig Gleysteen

Home Institution: University of Minnesota

Abstract: Zirconia nanomaterials have many potential catalytic uses. To increase the efficacy of these catalysts, it is important to provide the maximum possible surface area to interact with the active sites. Metal organic frameworks have previously been used in the literature to provide a high-porosity scaffold for these materials, however, metal organic frameworks can be subject to thermal degradation at temperatures needed for catalysis due to their organic linkers. The goal of this project was to incorporate Zr6O6 clusters into high-surface area mesoporous silica nanoparticles to provide stability and ready access to catalytic sites. This was done by adding zirconia clusters at varying times during the particle synthesis and analyzing the resultant particles. The particles were characterized using dynamic light scattering, x-ray diffraction, nitrogen physisorption, and transmission electron microscopy with energy dispersive x-ray spectroscopy.

55. Diane Kuai

Synthesis and characterization of methylcellulose-containing diblock copolymers for potential gene therapy applications

Advisor: Theresa Reineke

Sponsoring Program: MRSEC

Home Institution: University of Illinois at Urbana-Champaign

Abstract: Polymers derived from sustainable resources are of growing interest for a large variety of applications ranging from packaging, adhesives, and coatings to water purification, personal care, and pharmaceuticals. The goal of this project is to synthesize block copolymers using methylcellulose as the sustainable block and poly(2-aminoethylmethyacrylamide) as the second block to create methylcellulose-block-poly(2-aminoethylmethacrylamide) (MC-b-PAEMAm), a diblock copolymer with potential uses for water purification, composites, and nucleic acid complexation and delivery. PAEMAm was synthesized using a modified chain-transfer agent (CTA) containing an alkyne by Reversible Addition-Fragmentation chain Transfer (RAFT) polymerization. The reducing end hydroxyl group of methylcellulose was functionalized with an azide. Synthesis of MC-b-PAEMAm by clicking the azide-functionalized methylcellulose with the alkyne-functionalized PAEMAm via copper-catalyzed [2+3] Huisgen cycloaddition is in progress. We are interested in using PAEMAm as the synthetic block because it can form pH-responsive complexes with polyanions such as DNA through electrostatic interactions. Similarly, the use of methylcellulose as the naturally-derived block may be a novel alternative to poly(ethylene glycol), serving as a hydrophilic polymer "coating" which enables the drug carrier to exhibit stealth behavior.

56. Matthew Libersky

Ionic liquid gating of strontium iridate

Advisor: Allen Goldman

Sponsoring Program: Physics REU

Home Institution: Valparaiso University

Abstract: Strontium iridate (Sr2IrO4) has a layered perovskite structure similar to that of La2CuO4, a parent compound of high-Tc cuprate superconductors. In cuprates, on-site Coulumb repulsion dominates the electronic structure and forms an anti-ferromagnetic Mott insulator, but strontium iridate's electronic states are also modified considerably by spin-orbit coupling at the Fermi level. Strontium iridate is theoretically expected to have an insulator-metal transition and perhaps even become a superconductor with doping of charged carriers, making it interesting to explore how its electronic properties evolve with changes in doping level. In order to achieve a high carrier concentration in this material without introducing much disorder, a field effect transistor-like structure using an ionic liquid as a gate dielectric (known as an electric double layer transistor) to induce carriers in the nearby sample by applying a gate voltage was fabricated. This process and future prospects will be presented.

57. Aaron Lindsay

Effects of Cross-Linking on Solid Polymer Electrolytes Prepared via Polymerization-Induced Microphase Separation

Advisor: Timothy Lodge

Sponsoring Program: MRSEC

Home Institution: New Mexico State University

Abstract: Solid polymer electrolytes (SPE) have been proposed as a means of suppressing lithium dendrite formation in high energy density, rechargeable lithium metal anode batteries. Upon repeated battery cycling, dendrites grow and span the battery, resulting in premature and, often, catastrophic battery failure. It has been proposed that a SPE with high modulus and ionic conductivity could prevent this dendrite growth, but previous efforts have had limited success. Recently, our group reported on a novel polymerization induced microphase separation (PIMS) method for the production of an unprecedented high modulus, high conductivity cross-linked polystyrene and poly(ethylene oxide)/ionic liquid SPE with a bicontinuous morphology and excellent temperature stability. Through electrochemical impedance spectroscopy as well as mechanical and small angle X-ray scattering measurements the effects of crosslinking were quantified. Although little variation was seen in the elastic modulus with varying divinylbenzene, the domain size, ionic conductivity, and sample quality were all found to be dependent on crosslinker concentration.

58. Bryan Linehan

Measuring the Sun and Moon Cosmic Ray Shadow on the NOvA Far Detector

Advisor: Marvin Marshak

Sponsoring Program: Physics REU

Home Institution: Saint John's University

Abstract: By blocking cosmic rays, both the moon and sun produce their own directional shadow of cosmic muons. This project aims to analyze the significance of the shadow caused by the moon and sun on the NOvA (NuMI Off-Axis Electron Neutrino Appearance) experiment's far detector located in Northern Minnesota. This analysis uses NOvA cosmic ray data beginning in 2014.

59. Wilson Lough

Signal Processing and Detection of the Gravitational Wave Background

Advisor: Vuk Manic

Sponsoring Program: Physics REU

Home Institution: Northern Arizona University

Abstract: While there is strong indirect evidence for their existence, the gravitational waves predicted by Einstein's theory of relativity have yet to be directly observed. If detected, these waves could provide unique cosmological and astrophysical information inaccessible through electromagnetic observations. A possible candidate for direct observation with LIGO and Virgo detectors is the stochastic gravitational-wave background. The weak interaction of gravitational waves with detectors along with the relatively high levels of "noise" intrinsic to the detectors presents a major obstacle to directly detecting the stochastic background. Various signal processing techniques have been developed to help sift for a signal within the noise, but these techniques have proven to be insufficient. The standard approach involves analyzing cross-correlations of data from pairs of detectors. We improve upon existing techniques by analyzing auto-correlations of data from individual detectors in addition to the cross-correlations. Preliminary results suggest an increase in detector sensitivity over the standard approach of 29% for a pair of detectors and an increase in sensitivity of 18% for a group of three detectors.

60. Jinci Lu

Enzymatic Synthesis of 4-Cl-Tryptophan

Advisor: Jerry Cohen

Sponsoring Program: Project SEED

Home Institution: Class of 2016, Washington Technology Magnet High School, St Paul, MN

Abstract: This research is to synthesize 13C labelled 4-Cl-Tryptophan, so it is available for metabolite analysis. Tryptophan has been made previously with the enzyme tryptophanase, indole, and either L-serine or pyruvate, and ammonia. In place of indole, 4-Cl-Indole was used to create the desire chlorinated tryptophan. The reaction occurred in a buffer solution at pH 8.6, and it was incubated at 37oC and shaken at 100 rpm for 4 days. The reaction progress was monitored by TLC. The product was purified with preparative HPLC, and the identity was confirmed by GC-MS.

61. Eowyn Lucas

Fabrication of Zinc Oxide Nanocrystal Thin Films for Solar Cells

Advisor: Lorraine Francis

Sponsoring Program: MRSEC

Home Institution: North Carolina State University

Abstract: Semiconducting thin films have many applications, such as flexible electronics, transistors, and solar cells. Much research is being done to find more efficient, sustainable, and cost effective semiconductors. This specific research was designed to find an efficient method of producing zinc oxide (ZnO) nanocrystal thin films for solar cells. ZnO is an n-type semiconductor and in solar cells, is most commonly used as an electron transport later. For this project, there were three steps for fabrication of films. First, films were printed using an aerosol jet printer. The printer creates an aerosol from a suspension of ZnO in methanol and then uses nitrogen gas to spray the aerosol onto a substrate. Second, the coatings are compacted in order to decrease porosity. Finally, the films were sintered using either thermal annealing or intense pulse light (IPL) annealing. Tests were done in which coatings were annealed before compaction to prevent delamination during compaction. Tests were also performed in which coatings were compacted and then annealed for a range of times and energy levels. From these tests, crystal size was determined using x-ray diffraction and conductivity was calculated using an electrical probe instrument. As expected, grain size increase with increased annealing time and energy. All other results are still being recorded and analyzed.

62. Tyler Matijevich

Control Methods of Miniature Hydraulic Systems for Powered Ankle Foot Orthosis

Advisor: William Durfee

Sponsoring Program: CCEFP

Home Institution: University of Illinois, Urbana-Champaign

Abstract: In recent years, the CCEFP has proven that fluid power is a viable solution for powering human assist devices. Its particular advantages are utilized in lower limb orthotics for individuals with muscular system impairments. Hydraulic and Pneumatic systems have been implemented into Ankle Foot Orthosis braces to assist the movement of the ankle foot joint. The fluid power generates torque and angular velocity at the joint through rotary actuators. The limitations of these systems include the power that needs to be supplied, the addition of weight to the segment of the body, and the range of time for and untethered energy supply. My research begins with testing different control methods and command loops to maximize the precision and performance of these miniature hydraulic circuits to actuate the ankle-foot joint. A customized test rig as well as comprehensive simulations have been developed in order to acquire necessary data for future designs of hydraulic systems to be used in the described medical applications.

63. Alan Medina-Gonzalez

The Exploration of Azasilatranes with Ozone

Advisor: Wayne Gladfelter

Sponsoring Program: UMN Chemistry- Lando

Home Institution: Augsburg College

Abstract: Little is know about the reaction of organometallic compounds with ozone, which is important in processes such as the atomic layer deposition of metal oxide films. Among those reports the reaction of silicon hydrides and alkyls with ozone were reported to lead to insertion of the O3 into the Si-H or Si-C bond. To study this in more details we report the reaction of ozone with azasilatranes bearing Si-H and Si-Me groups. Silatranes are extensively studied hypervalent molecules. Hypercoordination branches from bonding to donor accepting bonds such as silicon and nitrogen, otherwise known as azasilatranes. This results in a delocalization of the bridgehead nitrogen lone par into a three-center system with an extra lone pair beneath the silicon bond. Using known procedures, azasilatranes were synthesized from tris(dimethylamine)silane and tris(2-aminoethyl)amine by a condensation reaction to produce the corresponding organometallic compound. The compounds were characterized by spectroscopic methods and reacted with ozone using a specially designed reactor. The results of these reactions will be reported.

64. Monika Molenda
Developing a sugar-based carboxylic acid hardener for thermoset epoxy resins
Advisor: Teresa Reineke
Sponsoring Program: Center for Sustainable Polymers
Home Institution: Oakland University
Abstract: Epoxy resins are the most important thermosetting resins and usually display excellent mechanical strength, good thermal and chemical resistance, and fine adhesion to many substrates after cure. However, conventional hardeners are both unsustainable and frequently harmful to humans. To create sustainable epoxy resins, we synthesized a new trehalose-based carboxylic acid hardener for epoxy resins and examined the thermal, mechanical, and chemical properties of the resulting epoxy. Trehalose was modified with succinic anhydride, achieving an average of 7.5 succinyl groups attached per trehalose as indicated by 1H NMR. The hardener formed homogenous mixtures with trimethylolpropane triglycidyl ether (TTE) in three different carboxyl-epoxide ratios (40-60, 50-50, and 60-40), and the thermal properties and curing processes of the resulting thermosets were analyzed by thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). The cure temperature was found to be about 180 °C and the resin had good thermal stability up to 320 °C. We also tested the tensile strength of the cured resins and the hydrolytic degradation behavior. The resins showed Young's moduli of about 1342 MPa, which are comparable to some resins already on the market. They were rapidly degraded in basic solutions, being completely water-soluble within 5 hours, but were resistant to degradation in both acidic and neutral environments.

65. Glendimar Molero
Characterization Device for Spin-coated and Spray-deposited Silicon Nanoparticles Films
Advisor: Uwe Kortshagen
Sponsoring Program: MRSEC
Home Institution: University of Texas-Pan American
Abstract: Luminescent solar concentrators (LSCs) are cost-effective complements to semiconductor photovoltaics and they are able to increase the output of solar cells allowing for the integration of photovoltaic materials in large-area samples such as windows. Applications of LSCs rely on enhancing other photovoltaic materials properties, for example, extending the spectral range of absorbed solar radiation, downshifting through luminescence, collecting radiation over large area, directing generated radiation into a small output target, and improving solar cell performance. The design, construction, and testing of characterization devices was developed in order to measure quantum yield and attenuation losses of thin films embedded with silicon nano-crystals produced by non-thermal plasma deposition and hydrosilylation process. An integrating sphere was implemented to characterize spin-coated homogenous transparent films because of its ability of redistributing light due to its inner diffusive reflecting coating. Once the laser with an appropriate wavelength, power supply, design and construction of the film holders were obtained, the integrating sphere allowed the study of the oxidation, agglomeration, and ensemble quantum yield without being limited by the directionality of emission. Simultaneously, an attenuation characterization device was developed in order to study films produced via spray-deposition in order to study reabsorption, roughness losses, and reduction in the intensity of light as it propagates through the film due to absorption and scattering of light.

66. Corrie Moore, Helen Dougherty
Haptic Perception and Visual Dominance
Advisor: Victoria Interrante
Sponsoring Program: Big Data REU
Home Institution: Rhodes College, Grinnell College
Abstract: Haptic perception and visual dominance are key factors in making virtual environments more immersive and useful, especially in professional and architectural settings. In order for virtual environments to be effective, the perceived scale of objects in the virtual world needs to be identical to the scale of objects in reality. We are conducting a user study to examine these questions. Participants will be immersed in a virtual environment in which they can see and feel a rectangular block. The study will involve three trials: one in which the user has no visual indication of hand position; one in which the user's hand position will be relayed visually via avatar hands; and one in which the user will see a live see-through feed of their own hands. During each trial, the physical block will be of various lengths, and the virtual block will be larger, smaller, or true-to-size in relation to the physical block. The user will be asked to report information about the block and their haptic and visual experience during each of the three trials. By representing the user's own hands in a more realistic manner through the video input, we are thinking that we will be able to get them to believe more strongly that what they are seeing is what is what they are feeling than if the hands were embodied as a generic avatar or not embodied at all. Other work that can stem from this experiment could involve studies focusing on the extent to which visual dominance could be exploited to alter the user's perception of a physical object.

67. Neyala Motlagh

Identification of Specific Binding Interactions between a Survival Protein and a Metabolic Enzyme, in Cancers

Advisor: Ameeta Kelekar

Sponsoring Program: UROP

Home Institution: University of Minnesota-Twin Cities

Abstract: Myeloid cell leukemia-1 protein (Mcl-1), an anti-apoptotic Bcl-2 family member, is over-expressed in hematological malignancies. Glyceraldehyde 3-phosphate Dehydrogenase (GAPDH), a multifunctional cellular protein, catalyzes step six in glycolysis and is primarily a glucose-dependent metabolic enzyme. Preliminary studies suggest that Mcl-1 and GAPDH are unexpected binding partners within the same multi-protein complex in leukemia cells. It is hypothesized that Mcl-1 binding to GAPDH disrupts its catalytic function.

Mcl-1 had previously been shown to interact with BAK a pro-apoptotic Bcl-2 protein. A region in the carboxy (C) terminus of GAPDH was found to share homology to the putative Mcl-1 binding region in BAK. Deletion of this region in GAPDH eliminated the binding between GAPDH and Mcl-1. To identify the critical residues in the GAPDH C-terminus required for binding, five conserved amino acids were mutated to alanines in GAPDH. First, appropriate primers were designed and DNA fragments harboring these mutations were generated using PCR. These point mutations were cloned into a mammalian expression vector, grown in bacteria and sequenced for correctness before being translated into protein. The mutant proteins were tested for their ability to co-purify with Mcl-1 using a histidine-magnetic dyna beads protocol. Depending on the outcome of these studies the mutant inserts will be subcloned into pET bacterial expression vectors to allow large-scale production of GAPDH mutants. Binding studies will then be carried out using accurate quantifiable methods such as isothermal titration calorimetry, to validate data from the small-scale experiments. These studies could lead to a better understanding of metabolic regulation in cancers.

68. Nam Nguyen

Polymers derived from biorenewable feedstocks

Advisor: Theresa Reineke

Sponsoring Program: UMN Chemistry- Heisig Gleysteen

Home Institution: University of Minnesota

Abstract: Polymers have become inseparable from our daily lives, and the increasing demand for sustainable materials is the motivation for this research. One class of polymeric materials are thermosets, where heat or other chemical means are used to form permanent crosslinks within a material. While the formation of the network within the material yields their exceptional stability, resilience, and mechanical properties, this stability comes at the cost of degradability. Conventional thermosets' are difficult to break down and cannot be recycled. Presented here is preliminary work on synthesizing degradable thermoset materials from the sustainably-derived isosorbide undecenoate (IU). Two routes were explored for thermosetting IU, the first is direct free radical crosslinking of the monomer IU and the second is free radical crosslinking of IU first polymerized to P(IU) via acyclic diene metathesis. Different free radical initiators, benzoyl peroxide, azobisisobutyronitrile, and dicumyl peroxide, were examinedwith differential scanning calorimetry and the extent of radical crosslinking was monitored via infrared spectrometry. Initial studies have shown decomposition of the radical initiators, but these initiation events lead to low levels of crosslinking. Further studies will explore the impact of additional free radical initiators, as well as extended curing times.

69. Nikki Niewold

The Development of a Novel Natural Product Discovery Strategy through Bacterial Isolation

Advisor: Erin Carlson

Sponsoring Program: UMN Chemistry- Heisig Gleysteen

Home Institution: University of Minnesota-Twin Cities

Abstract: The rise of antibiotic-resistant bacteria is of increasing concern due to the lack of effective drugs for treatment. As a result, it is essential that we work to find new therapeutic compounds that may be used to address this growing problem. One potential source of new leads is from bacteria and fungi which produce more than 50% of commercial used antibiotics. These microorganisms were the primary sources used during a major period of antibiotic development from the 1950s and 1960s and their examination is now being revived due to the potential of integrating analytical tools like mass spectrometry and NMR alongside more traditional methods to analyze the secreted natural products. Despite technological advances in the characterization and analysis of bioactive compounds, it is still challenging to find the producers. As a result, we are developing a microbial library containing organisms with the potential to synthesize therapeutically useful bioactive molecules. Organisms selected for inclusion in the library exhibited unique phenotypes or displayed uncommon inter-organismal interactions. We predicted that these organisms have the highest potential to produce novel bioactive compounds. This poster will discuss the development of the microbial library as well as the results of the initial bioactivity studies done on these organisms.

70. Selina Ortiz-Piccard

Improving PLA Processability and Recycling through Branching

Advisor: Christopher Macosko

Sponsoring Program: Center for Sustainable Polymers

Home Institution: University of Puerto Rico at Humacao

Abstract: PLA was branched by melt blending with tri-functional aziridine (T-Az) and pyromellitic dianhydride (PMDA). Gel permeation chromatography (GPC) and rheology were used to characterize the topological structures of the branched PLA. The fast reaction of PLA with T-Az formed 3-arm stars and increased the molecular weight. After modification with PMDA, PLA can react with T-Az on both chain ends and form long chain branched structure. Too much branching resulted in elastomer-like behavior in extensional rheology.

71. James Outlaw

Characterization of Black Phosphorus using Raman Spectroscopy

Advisor: Steven Koester

Sponsoring Program: MRSEC

Home Institution: Saint Augustine's University

Abstract: Over one hundred and one years ago the first successful synthesis of crystalline Black Phosphorus was formed. Crystalline Black Phosphorus is formed by heating white phosphorus, using a mercury catalyst and a seed crystal of black phosphorus. In 2014, black phosphorus was isolated in a two-dimensional form by exfoliation from a bulk crystal and since then there has been large research interest in the electronic and optical properties of the material. Black phosphorus has a direct band gap which is tunable with thickness and a high hole mobility making it interesting for electronic and optical applications. Recently, Professor Stephen in the electrical engineering had has successfully synthesized black phosphorus crystals and is experimenting different doping methods. I will be working on using Raman spectroscopy to characterize the properties of these black phosphorus crystals.

72. James Palesch

Greener Reaction Conditions for Halogenation of Aromatic Compounds using Oxone and Halide Salts for the Organic Chemistry Laboratory

Advisor: Jane Wissinger

Sponsoring Program: UMN Chemistry- Lando

Home Institution: University of Minnesota

Abstract: Electrophilic aromatic substitution (EAS) is an indispensable reaction pathway that is deeply rooted in the field of synthetic chemistry. Historically, mineral acids and Lewis acids were used to generate the required electrophile. These reagents harbor noxious and corrosive qualities detrimental to human and environmental health. Incipient concerns have prompted researchers to explore and develop greener reaction methods for chlorination, bromination and iodination of functionalized aromatic species. Articles of interest employ Oxone® and halide salts in various solvents, including water. The intention of this research was to adopt and modify preexisting literature to formulate a feasible undergraduate lab demonstrating a green halogenation via EAS. From a teaching perspective, versatility and adaptability are attractive characteristics. Therefore, discovering a wide variety of suitable substrates capable of accommodating multiple experimental scenarios was important. A multitude of renewable substrates were investigated to broaden the scope of understanding and catalog viable candidates. Notable compounds included vanillin and 4'-methylacetanilide. Both were capable of illuminating melting point, 1H NMR and mass spectrometry techniques. Additionally, each hold the capacity to supersede existing experiments, translating to greener workups. The aforementioned methodology is slated for trial within a laboratory setting containing a body of 400 undergraduate students. Experiential findings will receive careful consideration and be incorporated into future plans.

73. Luis Pena

Synthesis of water-soluble Distyrylbenzene for application in photovoltaics

Advisor: Marc Hillmyer

Sponsoring Program: MRSEC

Home Institution: University of Texas-Rio Grande Valley

Abstract: Conjugated polymers have been used in a variety of applications due to their semiconducting electronic properties.The synthesis of a conjugated polymer derivative containing the p-anisidine moiety was attempted by a modification of acyclic diene metathesis (ADMET) polymerization for application in photovoltaics. Currently, we are working in the development of a distyrylbenzene derivative containing the p-anisidine functionality. The synthesis is approached by reacting commercially available p-anisidine with trichloroacetic anhydride to produce a trichloro acetamide derivative. The presence of the trichloroacetyl group is required in order to successfully achieve bromomethylation in the subsequent step which verified with the methyl NMR peak. Following bromomethylation, the derivative is allowed to react with triethyl phosphite to produce a diethyl phosphonate derivative which was verified using phosphorus NMR. It is necessary in the next step to cleave the trichloroacetyl group and produce the primary amine derivative. The amine derivative will be reacted with sodium hydride in the presence of terephthaldehyde to produce the desired monomer structure. Proton and carbon NMR was done subsequently after the synthesis of each precursor to verify composition of the molecule.The final DSB structure will be characterized using proton, carbon, and 2D NMR along with FTIR, solution-phase UV-Vis, and fluorescence spectroscopy.

74. Susan Pham

Production of 2-Isopropylmalate through Bioengineered E. Coli: A Bio-based Pathway toward Conjugated Dienes

Advisor: Kechun Zhang

Sponsoring Program: Center for Sustainable Polymers

Home Institution: Oklahoma State University

Abstract: Thirty million metric tons of rubbers are produced yearly worldwide; two-thirds of this amount comes from nonrenewable, petroleum-derived sources. Because of the growing market and the decreasing supply of petroleum and crude oil sources, there comes a need for a sustainable avenue for production. Companies Dupont and Goodyear have produced isoprene, which is a monomer for natural rubber, through a sustainable bio-process. However, only 1 mole of isoprene is produced per 1.5 mole glucose; isoprene is also very volatile, which affects the process' productivity and can cause environmental concerns. To combat this problem, we have developed a bio-based route to produce 2-isopropylmalate, a precursor for a novel isoprene analog. In this work, we designed a biosynthetic route to produce the 2-isopropylmalate precursor from glucose in non-pathogenic Escherichia coli. The genes ilvD, leuA, and alsS were cloned into a pZE vector and transformed into the E. coli strain BW25113. The transformants were incubated overnight at 37 °C. Afterwards, the transformed bacteria was inoculated into a fermentation medium containing 40g/L glucose; this was put in a 30 °C shaker for 48 hours. Through analysis of High Performance Liquid Chromatography data, the titer of 2-isopropylmalate was 8.04g/L and the product yield was 29.1% of the theoretical yield.

75. Theresa Pham

1,3-Bis(picolyl)benzimidazolium as Sensitizers for Lanthanide(III) Ion Luminescence

Advisor: Marites Guino-o

Sponsoring Program: University of St Thomas- Chemistry

Home Institution: University of St. Thomas

Abstract: Trivalent lanthanide complexes are utilized in bioimaging and anti-counterfeit methods. Lanthanide (III) ions alone are weak light absorbers, but complexation with organic molecules cause an "antenna effect," increasing the light absorption coming from the ligand. This allows energy to transfer into the lanthanide ion and initiate emission from the forbidden 4f-f transition. With the goal of increasing lanthanide (III) sensitization, my research aims to synthesize 1,3-bis(picolyl)benzimidazolium ligand, investigate lanthanide (III) coordination, and study sensitization of the ligand in lanthanide (III) ion luminescence.

76. Allison Pine

Predicting Protein Targets of Compounds by Combining Chemical Genomics and Blind Docking

Advisor: Chad Myers

Sponsoring Program: Big Data REU

Home Institution: Tufts University

Abstract: Determination of compounds that target specific diseases or bind to known proteins before expensive clinical trials is a critical and complex problem. The common process of docking generally entails screening a large compound library for energetically favorable poses and scoring the results to determine compounds most likely to bind to a given target protein, and therefore, mostly likely to be effective drugs for the disease implicated by that target. This process, however, requires huge computational power to dock libraries of potentially millions of compounds against hundreds or thousands of possible target proteins as well as detailed information about where on the protein a compound will bind (the protein's binding site). Yeast chemical genomic interaction studies of large compound libraries have identified and scored both compounds' target gene predictions and predictions of what functional processes compounds are likely involved in. We propose a pipeline that combines these two complementary approaches by leveraging the chemical genomic pipeline to generate a list of candidate proteins for each compound of interest based on chemical-genetic interaction profiles. From these candidates, docking can then be used to further identify the correct binding protein. By incorporating chemical genomic functional data, this approach is less computationally intense and more selective than structure-based docking alone. Additionally, by evaluating the entire surface of each protein, or blind docking, this method requires no prior knowledge of the protein's binding site.

77. Jonathan Pizana

Linearly-Actuated Device for Spray-Deposition of Silicon Nano-crystal Films

Advisor: Uwe Kortshagen

Sponsoring Program: MRSEC

Home Institution: University of Texas Rio Grande Valley

Abstract: Silicon nanocrystals (SiNCs) are to be used to make luminescent solar concentrators to complement semiconductor photovoltaics and boost the efficiency of solar cells. Nanocrystals are synthesized in a non-thermal plasma and passivated with organic ligands to allow dispersion into non-polar solvents. The resulting colloidal solutions can be spray coated to form thin, translucent films. We will embed the SiNCs with Poly (methyl methacrylate) (PMMA) to form a solution that will be used to spray a substrate. The solution is to be uniformly deposited onto a large substrate, embedding SiNCs in PMMA. The PMMA acts as part of the waveguide, like an optical fiber, which will also serve as a protection against oxidation. Effective luminescent solar concentrators require smooth and homogeneous silicon nanocrystal films with thicknesses on the order of a few micrometers. In order to achieve this goal, a scalable spray coating mechanism will be designed and built that will allow for the control of the solution deposition onto a linearly-actuated substrate holder. Certain parameters exist that need to be controlled with the air brush mechanism: nanoparticle solution flow rate, the distance at which the air brush is from the glass substrate, pressure differential, air flow rate, and needle size. This mechanism will enable the user to control the speed at which the nanocrystals are deposited, the amount (flow rate, which will control the thickness), and the length of these luminescent solar concentrators.

78. Steven Prinslow

Nanocast Metal-Organic Framework Catalysts for High-Temperature Olefin Production

Advisor: Andreas Stein

Sponsoring Program: UMN Chemistry- Lando

Home Institution: Austin College

Abstract: Current methods of dehydrogenating alkanes to olefins require various toxic and expensive catalysts such as chromium and platinum. Metal organic frameworks (MOFs) contain metal ions or clusters that can pose as a potential alternative source of Lewis acid catalytic activity for dehydrogenation. Because of the presence of organic linkers in their structure however, MOFs are not stable at the high temperatures where dehydrogenation is thermodynamically favored. In order to use the catalytic metal clusters in MOFs at high temperatures, we are taking a nanocasting approach to create a secondary SiO2 backbone that will stabilize the clusters at these temperatures. Thus, the organic linkers can be removed while having the metal nodes anchored to the SiO2 backbone instead of aggregating which leads to loss of catalytic activity. The nanocasting process was successful with the NU-1000 MOF and efforts are currently being undertaken to apply the method to NU-1000 samples that have been modified with various metals by atomic layer deposition (ALD) or solution-based methods.

79. Ellie Raethke

Exploring the structure effects of polymer induced flocculation of charged polystyrene microbeads

Advisor: Cari Dutcher

Sponsoring Program: MRSEC

Home Institution: University of Wisconsin-Stout

Abstract: Flocculated structures are formed when negatively charged particles interact with positively charged polyelectrolytes in aqueous solutions due to charge neutralization and polymer bridging. The size, structure, and strength of the flocculated material (floc) is important in determining removal performance in water treatment. Previous work has established that the formation of optimally structured flocs depends on a variety of parameters including pH, ionic strength, polymeric dosing concentrations, and mixing conditions. In this work, we explore flocculation of micro-beads and their resultant floc structure as a function of chemical and hydrodynamic conditions. One micron fluorescently labeled polystyrene beads were flocculated using a commercially available cationic polyacrylamide. Flocs were formed by varying the concentration of polystyrene beads, the amount of charged polymer flocculent added, and mixing conditions for the solution. The structure of the resulting flocs was then analyzed using microscopy techniques in order to characterize the floc structure. The optimal polymer dosing range and mixing time for 1 μm carboxyl-modified polystyrene beads was determined to improve removal of micro-bead contaminants in water treatment applications.

80. Austin Riedl

Effect of low-temperature illumination and annealing on magnetotransport in very high Landau levels

Advisor: Michael Zudov

Sponsoring Program: Physics REU

Home Institution: University of Wisconsin - Eau Claire

Abstract: When a two-dimensional electron system (2DES) is subject to weak magnetic fields and low temperatures , the longitudinal resistivity exhibits Shubnikov-de Haas oscillations (SdHO), whose period is controlled by the ratio of the Fermi energy to the cyclotron energy. When a 2DES is further exposed to microwave radiation, the resistivity also reveals microwave-induced resistance oscillations (MIRO), with the period set by the ratio of the microwave frequency to the cyclotron frequency. One parameter which enters the amplitude of both SdHO and MIRO is the quantum scattering time, which sensitively depends on the smooth disorder potential due to remote ionized impurities. It is currently believed that it is the parameter which controls the quality of many high-field transport phenomena, including fractional quantum Hall effect (FQHE). It is therefore desirable to examine ways to increase quantum scattering time in a given sample. Recently, it was reported that low-temperature illumination of 2DES and subsequent annealing can lead to dramatic improvement of FQHE [1]. However, the impact of illumination and annealing on quantum lifetime has not been examined. Here, we report on experiments studying the effect of illumination and annealing on SdHO and MIRO, focusing on their impact on quantum scattering time.

81. Nasar Roble

Peer-to-Peer Framework Based On Mobile Distributed Engine

Advisor: Abhishek, Jon Chandra, Weissman

Sponsoring Program: REU: Big Data (CS)

Home Institution: Saint Paul College

Abstract: Smartphones have become pervasive in modern day, and while the technological specifications improve yearly, they continue to experience notable resource constraints and limited battery capacity. Recent wearable smart technology such as Google Glass, though less ubiquitous, share equivalent drawbacks in their resources limitations. This project addresses the issue by creating a peer-to-peer framework that allows users to request pre-cached geo-locations from nearby mobile devices to provide quick, efficient, and fault-tolerant sharing of route information to nearby locations of interest. This framework is built upon an existing three-tiered architecture and middleware that encompasses Amazon EC2 Cloud, Android mobile device, and Google Glass. The Android device and Google Glass relay their geo-coordinates to the cloud, which will create a geo-spacial model containing directions to locations that the user may be interested in. By offloading heavy computations from the end-devices to the cloud power dissipation can be significantly reduced, as well achieving a reduction in latency by pre-fetching and pre-caching results from the cloud onto the mobile device. We enhance this architecture by implementing a peer-to-peer framework that allows sharing of pre-cached data through Wi-Fi Direct. Rather than making a request to the cloud, the user can query whether the desired resource can be obtained from a nearby peer. With the abundance of smart devices presents in public areas, reliable communication and data transfer can be achieved even in the absence of network connectivity. Our evaluation demonstrates the effectiveness of the architecture and middleware in reducing delay in resource retrieval and improving battery longevity on both Android device and Google Glass.

82. Janaya Sachs

A New Naphthyridine-based Dicarboxamide Ligand for Synthesizing Dicopper-Oxygen Complexes That Model Metalloenzyme Intermediates

Advisor: William Tolman

Sponsoring Program: UMN Chemistry- Lando

Home Institution: Eastern Mennonite University

Abstract: Copper oxygen complexes are postulated to be capable of oxidizing strong C-H bonds, including in enzymes. For example, particulate methane monooxygenase (pMMO) is proposed to feature a di-copper active site with a short Cu-Cu distance (~2.7 Å) that activates O2 to yield a reactive intermediate capable of attacking the strong C-H bond of methane. We aim to create dicopper complexes as models of the proposed pMMO active site intermediate. Our strategy involves using a new ligand (Figure 1) comprising a 1,8-naphthyridine unit and two carboxamides with sterically bulky aryl substituents designed to hold two Cu ions in close proximity and stabilize novel targeted copper-oxygen species. We report the successful synthesis of this new ligand, the formulation of which is supported by various spectroscopic data. Initial attempts to generate copper complexes of Figure 1 will be described.

83. Colin Scheibner

Ultrafast Electron Microscopy of Nanomechanical Vibrations in a Prototypical HAMR System
Advisor: David Flannigan
Sponsoring Program: MRSEC
Home Institution: St. Olaf College
Abstract: Heat-Assisted Magnetic Recording (HAMR) is an emerging data-storage technology that has the potential to increase the areal recording density of magnetic media from the current limit of 400 Gb/in2 to a projected range of 1 to 40 Tb/in2. Ultrafast electron microscopy (UEM) provides unprecedented 4D real-space dynamic imaging with femtosecond temporal resolution and nanometer spatial resolution. In this study, we use UEM to image the dynamics of a prototypical HAMR antenna consisting of a gold bead embedded in a thin polycrystalline sapphire (Al2O3) plate with a platinum border. In the resulting images, we observe nanomechanical vibrations in the sapphire surrounding the gold bead with pronounced component frequencies at 33.4, 63.9, 88.3, 114.5, and 119.6 MHz. By comparing these observed frequencies with those predicted by a finite element method (FEM) simulation of the HAMR system, we ascertain that the oscillations in the sapphire surrounding the gold bead are due to flexural vibrations throughout the entire sapphire and platinum plate. Moreover, the strong agreement between the predicted and observed frequencies indicates that the Young's moduli for platinum and polycrystalline sapphire on the nanoscale are comparable to their respective bulk-material values. Hence, the results of our UEM imaging are twofold: we provide both fundamental insight into the material properties of platinum and polycrystalline sapphire and explain previously unobserved nanomechanical vibrations in HAMR technology.

84. Lauren Schlenker

High Temperature Superconductors: Crystal Growth and Characterization
Advisor: Martin Greven
Sponsoring Program: UROP
Home Institution: University of Minnesota Twin Cities
Abstract: The study of ceramic compounds that exhibit technologically valuable superconducting properties at higher temperatures than can be explained by existing physical theories has become the most highly studied area of condensed matter physics, with many research groups across the world employing state of the art methods to better understand these mysterious materials. Working in conjunction with Dr. Martin Greven's research group, this research project has allowed for an opportunity to learn many of these methods of material synthesis and measurement. Most notably, this has included exploring the difficult technique of growing pure, homogeneous single crystals in a travelling-solvent floating-zone furnace. Future techniques to be explored will include magnetic response and DC transport measurements of annealed samples to better illustrate and understand the phase diagram of these materials.

85. Timothy Schuler

Auditory Discrimination in the Human Brain
Advisor: John Broadhurst
Sponsoring Program: Physics REU
Home Institution: SUNY College at Buffalo
Abstract: The purpose of this study was to investigate the temporal processing of auditory information by the cochlea and how that information is interpreted by the brain. A sequence of 'standard' sounds was created that resembled the pluck of a guitar string, with 'deviant' sounds randomly intermixed. Deviant sounds contained the same Fourier components as standards, along with the addition of a short period of an anharmonic frequency with a Gaussian amplitude. Deviant sounds came in two varieties, where the additional frequency played either during the first 50ms of the onset of stimulus or during the last 50ms of the 200ms onset time. The sounds were presented to the subject's right ear at random times with an average of 1 second intervals between each stimulus. The magnetic field response of the brain was recorded using magnetoencephalography. We hope to measure a 'Magnetic Mismatch Negativity' (MMMN) elicited by the changes in the timing of the deviant epochs. By observing a MMMN between the two deviant tones, we hope to observe a real-time analysis being performed in the onset time, shedding light on the cochlea's time domain analysis, in addition to its role as a frequency analyzer.

86. Aastha Sharma
Synthesis of Cu2(Zn1-xCox)SnS4 solid solutions and kinetics of methylene blue adsorption
Advisor: R. Lee Penn
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Wesleyan College
Abstract: In recent years, transition metal sulfides (e.g. Cu2ZnSnS4, Cu2ZnSnSe4) prepared from earth abundant and non-toxic elements have received significant attention as promising materials for thin film solar cells. However, other environmental applications of these materials have not been studied widely. This work explores the kinetics of decolorization of methylene blue dye, a toxic industrial waste, due to adsorption in Cu2ZnSnS4- Cu2CoSnS4 solid solutions. Cu(Zn1-xCox)SnS4, with varying Zn:Co ratio were successfully synthesized using microwave reaction starting from metal salts in ethylene glycol, and thiourea as sulfur source. X-Ray Diffraction, Raman Spectroscopy, BET N2 isotherms, Transmission Electron Microscopy were employed to understand how changes in Zn:Co ratio influenced particle size, phase purity, vibrational modes, surface area and morphology of the synthesized materials. Different kinetic models were fitted to study the decolorization process.

87. Emily Sherman, Steve Kirberger, Peter Ycas, William Pomerantz
Synthesis and PrOF NMR analysis of small molecule BPTF inhibitor analogs
Advisor: William Pomerantz
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Ithaca College
Abstract: BPTF is a bromodomain-containing protein linked to melanoma, leukemia, colorectal, bladder, and breast cancer. Bromodomains are known to bind acetylated lysine residues on histone proteins; this is associated with the dysregulation of gene transcription, potentially leading to an increase of the aforementioned diseases. Our recently developed protein-observed 19F NMR (PrOF NMR) screening method can be used to discover small molecule ligands for bromodomains and demonstrate selectivity between multiple biological targets. We have previously reported compound AU1 as the first small molecule selective for BPTF over Brd4, a representative BET bromodomain with several known inhibitors. The objective of this research is to synthesize a series of AU1 analogs that will be tested against BPTF by PrOF NMR. Results will be used to analyze the structure activity relationship (SAR) between small molecule ligands and the bromodomain binding site with the aim of enhancing binding affinity with BPTF. Several analogs have been synthesized and compared against AU1 via PrOF NMR, some of which show an increase in binding affinity. Subsequent analogs will be used to investigate the SAR so that the BPTF bromodomain can be further explored as a possible drug target.

88. Tyler J. Skluzacek
Multi-Tiered Storage for HDFS using Tiera
Advisor: Abhishek Chandra
Sponsoring Program: Big Data REU
Home Institution: Macalester College
Abstract: The Hadoop Distributed File System (HDFS) is a distributed file system for storing large data sets used by different computing frameworks for big data computing and key-value stores. Traditionally, HDFS has run on commodity hardware native disks, but the advent of new storage devices has motivated the need to run HDFS on different storage devices, including solid state drives (SSDs). The diversity of applications using the storage devices warrants the implementation of unique storage policies derived from the requirements of said applications. Presently, more systems are moving onto the cloud and attempting to utilize new cloud technologies provided by each cloud provider. Hence, it has become of prime importance to provide a standard and easily implementable solution to provide multi-tiered cloud storage for HDFS. In this paper, we first illuminate the need for multi-tiered storage for HDFS by surveying different Hadoop workload studies and Hadoop systems. Then we present a novel solution for multi-tiered storage in HDFS using TieraFUSE. TieraFUSE provides first-class support for encapsulated tiered cloud storage and ease of programmatically, while providing storage policies for these tiers. In the end, we support our design by giving some experimental results for a few example workloads on both single-node and multi-node clusters.

89. Andrey Smirnov

Correlation of centrality measures with the node's influence in the disease spread model

Advisor: Daniel Boley

Sponsoring Program: MRSEC

Home Institution: University of Massachusetts Amherst

Abstract: Centrality indices are important measures of degree involvement in the graph structure. In the past, numerous centrality indices has been developed to identify important properties of the graph nodes that contribute to the cohesiveness of the network. However, studies have shown that centrality indices are application-specific and some centrality indices are more suitable in certain areas than others [1].

In this study, we analyze how well certain centrality measures correlate with a node's prominence in terms of node's influence in the epidemiology model. In particular we examine such standard measures of centrality as betweenness, degree, closeness, and current flow centralities. Furthermore, we expand on the very recent work and evaluate the avoidance-hitting time pivotality metric [2] for application of the epidemiology model using the same analysis. We estimate the contribution of a node to disease spread by simulating the compartmental epidemiology model with and without that node and calculating disease extinction time and the number of diseased agents. We then find the correlation of these results with the centrality measures of a node. Finally, we run our test on both the synthetic examples of a network as well as real life ones such as a subset of a social network from Facebook.

90. Sydney Steger

Synthesis of 1,3-Bis[(2-pyridyl)methyl]-1H-imidazole Ligand and Coordination to Lanthanum (III) ion.

Advisor: Dr. Marites A. Guino-o

Sponsoring Program: University of St Thomas- Chemistry

Home Institution: University of St. Thomas

Abstract: Lanthanides are unique metals with photo-physical properties that are ideal for fields with bio-tagging and anti-counterfeit applications. However, the emitted light from the lanthanide complex has very small absorption cross-sections and low molar absorptivity due to the shielded nature of the f orbitals in the lanthanide atomic core. With the goal of improving luminescent properties of lanthanide (III) complexes, we are interested in employing a new ligand to help with the sensitization through "antenna effect."

Herein, we report the synthesis of 1,3-bis[(2-pyridyl)methyl]-1H-imidazole ligand and its coordination to lanthanum (III) ion.

91. Zach Swingen

Increasing the Adaptability and Reliability of a Sustainable Polymer Experiment for the Teaching Laboratory Including Simple Mechanical and Degradability Testing

Advisor: Jane Wissinger

Sponsoring Program: Center for Sustainable Polymers

Home Institution: Augsburg College

Abstract: The importance of polymer chemistry in the undergraduate curriculum was recently highlighted by the 2015 American Chemical Society (ACS) accreditation requirement to include coverage of the preparation, characterization, and physical properties of synthetic polymers or other macromolecules/nanomaterials. Also highlighted were expectations to incorporate inquiry-based pedagogy into laboratory programs. The previously published sustainable polymer experiment, using the plant-derived monomers, δ-decalactone and L-lactide, was expanded into an inquiry-based lab to include various monomers and catalyst alternatives. Reported herein, are further improvements which were demonstrated to increase the reliability and success rate of triblock formation by the students. These modifications were verified by SEC and 1H –NMR analysis to show increased consistency of the polymerization resulting in copolymers of the target composition. Additionally, a novel mechanical testing method was developed which clearly showed differentiation in physical properties between triblock copolymers composed of δ-decalactone or δ-dodecalactone and various weight percent L-lactide incorporation. This versatile experiment not only teaches students about the fundamentals of polymer chemistry, green reaction conditions, renewable feedstocks, and degradable products, but is also readily adaptable to sophomore level organic chemistry laboratory courses of diverse institutional settings.

92. Chao Tang

Measurements of Flow Field induced by Swimming Microorganisms in Three Dimensions

Advisor: Xiang Cheng

Sponsoring Program: CEMS

Home Institution: University of Minnesota Twin Cities Department of Chemical Engineering & Materials Science

Abstract: Bio-mixing is the enhancement of material transport by motile organisms in nature. Microorganisms experience a low Reynolds number environment and can have a substantial effect on bio-mixing on a cellular level. To understand this effect, it is important to study the flow field generated by individual swimming microorganisms and such investigation can also give us insights into complex biological behaviors including predator-prey interaction and mechanics of beating flagella. Diffusion of tracer particles is one of the most popular technique to track the flow field yet most work done on this area is on quasi-two-dimensional level. In nature, most microorganisms experience a three-dimensional environment. We are interested in investigating the flow field generated by a swimming unicellular algal cell (C.Reinhardtii) by using digitized in-line holography technique, which allows us to track the spherical tracer particles and swimming algae cells in liquid cells on three-dimensional level simultaneously. Our research recovers a complex time-dependent flow structure. More interestingly, the measured flow velocity scales inversely with distance, and the dependency is more substantial on three-dimensional environment than previously uncovered on quasi-two-dimensional level.

93. Sadie Tetrick

Global-scale coherence modulation of radiation-belt electron loss from plasmaspheric hiss: a further analysis

Advisor: Cynthia Cattell

Sponsoring Program: Physics REU

Home Institution: Augsburg College

Abstract: Enhancements of the Earth's radiation belts during geomagnetic storms – an important aspect of space weather – strongly effects the lifetime of orbiting satellites and accuracy of technologies, such as GPS, that our society has come to rely upon. In the high-density plasma region that overlaps with the radiation belts, called the plasmasphere, a wave called plasmaspheric hiss plays a dominant role in reducing radiation belt energy levels back to nominal levels following these enhancements. The recent Nature article "Global-scale coherence modulation of radiation-belt electron loss from plasmaspheric hiss" (Breneman et. al., 2015) showed that changes in the dynamics of electron loss, caused by hiss, occur on timescales as short as one to twenty minutes, and that these loss dynamics are coherent with hiss dynamics on scales comparable to the size of the plasmasphere. The cause of this coherence is due to the large-scale modulation of hiss caused by the propagation of ultra low frequency (ULF) 1-20 min period electromagnetic waves, originating in the solar wind, throughout the radiation belts. This discovery, only made possible through the analysis of simultaneous satellite (Van Allen Probes) and Balloon Array for Radiation Belt Relativistic Electron Losses (BARREL) datasets, has important implications for simulation and prediction of the Earth's radiation belt environment and its effect on satellites. This project's goal was to further our understanding of this nearly global-scale coherence by analyzing the entire balloon dataset. To motivate the larger dataset, we start by presenting observations of large spatial scale coherence of electron loss as a function of MLT and Lshell for a single payload combination (balloons K and L) during a geomagnetically active time on January 7, 2014. This analysis was repeated for all 71 balloon combinations. Plots were filtered so the coherence was above a threshold of 0.7 and both payloads were inside (or outside) the plasmasphere. The results of this project will be compared to ULF wave populations in the solar wind.

94. Miranda Thompson

Electronic Conductance in Silicon Nanocrystalline Films

Advisor: James Kakalios

Sponsoring Program: Physics REU

Home Institution: Harvey Mudd College

Abstract: The importance of polymer chemistry in the undergraduate curriculum was recently highlighted by the 2015 American Chemical Society (ACS) accreditation requirement to include coverage of the preparation, characterization, and physical properties of synthetic polymers or other macromolecules/nanomaterials. Also highlighted were expectations to incorporate inquiry-based pedagogy into laboratory programs. The previously published sustainable polymer experiment, using the plant-derived monomers, δ-decalactone and L-lactide, was expanded into an inquiry-based lab to include various monomers and catalyst alternatives. Reported herein, are further improvements which were demonstrated to increase the reliability and success rate of triblock formation by the students. These modifications were verified by SEC and 1H –NMR analysis to show increased consistency of the polymerization resulting in copolymers of the target composition. Additionally, a novel mechanical testing method was developed which clearly showed differentiation in physical properties between triblock copolymers composed of δ-decalactone or δ-dodecalactone and various weight percent L-lactide incorporation. This versatile experiment not only teaches students about the fundamentals of polymer chemistry, green reaction conditions, renewable feedstocks, and degradable products, but is also readily adaptable to sophomore level organic chemistry laboratory courses of diverse institutional settings.

95. Vinh Tran

Biodegradable Semi-solid Polymer Composites: Improving Injectability and Drug Loading

Advisor: Chun Wang

Sponsoring Program: MRSEC

Home Institution: North Hennepin Community College

Abstract: Highly viscous, hydrophobic, and biocompatible polymers, often called semi-solid polymers (SSPs), have much potential as drug delivery systems. SSPs are readily injectable at room temperature and can be engineered to elute loaded drug molecules with zero order release profiles over extended periods of time. One such polymer, a PCL-PEG copolymer called PA11, was recently developed by Prof. Chun Wang's group. While this polymer has several advantages, practical use of this material is hindered by issues with processing and handling (such as injectability and drug loading). We plan to manipulate the viscosity of the polymer by several methods: (1) changing the reaction time of polymerization, (2) adding Aquespheres—polysaccharide based microparticles, and (3) adding silica nanoparticles to form composites. Some guest molecules, such as model proteins and poorly water-soluble drugs, can be added to the composite. We will use tools such as rheology, differential scanning calorimetry (DSC), and dynamic light scattering (DLS) to help identify the ideal ratio of the polymer-particle mixture to sufficiently improve injectability of the material and loading of various model drugs.

96. Brian Traynor

Control of valley polarization in MoS2, WS2 and heterostructures by optical helicity

Advisor: James Johns

Sponsoring Program: UMN Chemistry- Lando

Home Institution: Trinity College Dublin

Abstract: The use of electron spin as an information carrier in electronic devices, known as spintronics, is being widely considered as the next potential development in information technology. Molybdenum disulfide (MoS2) and tungsten disulfide (WS2) monolayers have recently been demonstrated to exhibit a behaviour known as valley polarization, which occurs as a result of their unusual electronic properties. These materials possess two minima of equal energies but at different positions in momentum space. Valley polarization is achieved when a greater number of electrons reside in one of these valleys. This is achieved by utilising the spin angular momentum of circularly polarized light to selectively excite electrons at different points in momentum space. In this project, I demonstrate the existence of a valley polarization in MoS2 and WS2 through optical excitation. I also investigate the ability of a valley polarization to propagate across a boundary in a MoS2/WS2 heterostructure.

97. Raymond Twumasi

Creating Renewing Anti-Fouling Surfaces

Advisor: Ronald Siegel

Sponsoring Program: MRSEC

Home Institution: Saint John's University

Abstract: Fouling is a nonspecific adhesion of endogenous proteins and cells to the surface of materials in biological environments. Fouling can cause failure of implantable materials and devices as well as compromise their performances. A widely pursued approach is to design an antifouling surface by creating a thin hydrophilic layer for such implantable materials and devices; however, if either the coating or polymer substrate is damaged due to mechanical abrasion, the antifouling capacity can be lost. Poly-ε-caprolactone, PCL, is a well-known biodegradable and biocompatible polyester used in a wide range of medical applications while surfaces doped with hyaluronic acid have been shown to resist nonspecific protein absorption and cell adhesion. The strategy adopted in this project is to augment a bulk PCL matrix with a small volume fraction of nanoparticles consisting of an amphiphilic graft copolymer of hyaluronic acid and poly-ε-caprolactone (HA-g-PCL). Thus, as the surface of the implantable material or device goes through abrasion, the HA-g-PCL graft copolymer nanoparticles will replenish the surface with a hydrophilic slime that continues to resist protein and cell adhesion. This approach provides a means to retain the desired properties of poly-ε-caprolactone while giving it the antifouling surface features of hyaluronic acid.

98. Harrison Van Til

Generation and Analysis of Tungsten Oxide Nanoparticles for Use in Electrochromic Applications

Advisor: Chris Hogan

Sponsoring Program: MRSEC

Home Institution: Gonzaga University

Abstract: Tungsten oxide nanoparticles have desirable characteristics for application in thin film electrochromic devices (e.g. smart windows). Therefore, it is of importance to develop and implement techniques to study the composition of these particles. Due to relative ease of use and potential for scalability, gas phase processes were used in this study. Tungsten oxide nanoparticles were produced using a glowing wire generator. The physical properties of the particles produced were studied by various classification methods, as well as by electron microscopy. A differential mobility analyzer (DMA) was used for size classification, an aerosol particle mass analyzer (APM) was used for mass classification, and when paired with a particle counter, size and mass distributions of the generated particles were constructed. TEM images of size classified particles were analyzed to study their morphology, as well as to compare their measured particle mobility with the predicted mobility as measured by the DMA. Additionally, a program was developed to automate the image analysis process, which significantly decreased analysis time and also improved the accuracy of the results.

99. Xatziri Viveros

Effect of Manganese Impurity on Synthetic Siderite and its Magnetic Properties

Advisor: R. Lee Penn

Sponsoring Program: Project SEED

Home Institution: Class of 2017, Washington Technology Magnet High School, St Paul, MN

Abstract: Identification of siderite (iron (II) carbonate mineral) in sediments is useful for explanations of ancient geochemical processes in ocean and other environments with low oxygen. Until recently, siderite was believed to have a magnetic transition temperature of 37 K. Previous work has shown that synthetic (lab-made) siderite has a transition at ~ 50 K. To determine the cause, synthetic siderite was prepared through different procedures and in the presence of varied amounts of manganese (Mn(II)). The traditional synthesis involved adding FeSO4, Na2CO3, and ascorbic acid to a hydrothermal bomb and heating at 100 °C for 4 h. X-ray diffraction (XRD) and magnetic property measurement system (MPMS) were used to characterize siderite samples. Samples prepared with either no heating stage or in the absence of oxygen did not produce siderite by XRD characterization. Varying amounts of manganese produced siderite with possible Mn(II) impurities as observed by XRD. Magnetic characterization, however, has not yet confirmed that Mn(II) impurity is the cause of the different transition temperature. With a greater number of Mn-containing siderite samples characterized by MPMS, it may become clearer whether impurity leads to changing transition temperatures in siderite.

100. Gloria Wang
Vectors difference in recombinant genes from HbHNL
Advisor: Roma Kazlanskas
Sponsoring Program: Project SEED
Home Institution: 2015 Graduate, Johnson High School, St Paul, MN
Abstract: Currently we are investing HbHNL (Hydroxynitrile Lyase) from the rubber tree Hevea brasiliensis. The gene that codes this protein is in two different plasmids. Both have successfully produced the enzyme in E.Coli, but it is unclear which vector is better. The original vector seemed to have an alternate start site in the DNA that may lead to misreading the gene of HbHNL. This has been corrected in the new vector, but it is unclear that it has increased expression.

101. Henry Ward, Varun Mangalick, Dan Knights
Obesity, Geography and the Comparative Diversities of the Human Gut Microbiome
Advisor: Dan Knights
Sponsoring Program: Big Data REU
Home Institution: Lawrence University
Abstract: In the past two decades, much research has gone into establishing a link between obesity and altered expression of the human gut microbiome (Turnbaugh et al., 2009), as well as into exploring the hygiene hypothesis linking decreased hygiene to improved defense against allergic illness (Schaub, Launer, & von Mutius, 2006). However, relatively few large studies based on fecal sample sequence reads utilize sample BMI measurements as crucial metadata, or measure potential differences in the human microbiome based on geography. Using existing data (Yatsunenko et al., 2012), we performed a range of existing QIIME tests (Caporaso et al., 2010) as well as novel tests, which measure unique vs. shared OTUs between samples, to compare the diversities of the Venezuelan, Malawian and American obese and lean microbiomes.
We provide more evidence for the hygiene hypothesis, showing that while all infants possess highly individual microbiomes, adult microbiomes are far less individualistic. Moreover, American adults share less in common with each other's' microbiomes than adults in the non-Westernized countries. This effect is not driven by obesity. However, American obese adults share more with each other's' microbiomes than lean adults.

102. T. Alexander Wheeler
Varied Titanium Imidos. How Ligand Sterics Affect Catalytic Production of Polysubstituted Pyrroles.
Advisor: Ian Tonks
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota - Twin Cities
Abstract: Abstract:
Testing of different Titanium complexes for catalytic production of pyrrole is discussed. Titanium imido complexes, many previously prepared by Mounford et. al. when in the presence of hex-3-yne and azobenzene at 120°C in Trifluorotoluene were largely unsuccessful in producing pyrrole. However, the 2,6-dimethyl aryloxide bisligated titanium complex successfully underwent catalysis. Regioselective studies using different ligands are to be performed for a substrate scope. The current findings and futures study are key to understanding the effects of sterics on catalysis using early transition metals.

103. Samantha Whitcomb
Solid-State Nitrile Oxide Dimerization: Crystal Structure of bis(4-Methylphenyl)furoxan
Advisor: William Ojala
Sponsoring Program: University of St Thomas- Chemistry
Home Institution: Chemistry Department, University of St. Thomas
Abstract: Nitrile oxides dimerize in solution to yield three possible products: a furoxan, a dioxadiazine, or an oxadiazole-N-oxide. As part of a solid-state study of benzonitrile oxides to determine whether the product of their solid-state dimerization depends on the molecular packing arrangement within the parent benzonitrile oxide crystal, we are examining 4-methylbenzonitrile oxide and its dimers. We report here the X-ray crystal structure of the dimer bis(4-methylphenyl)furoxan, which crystallizes in the monoclinic system, space group P21/c, with four molecules located in general positions in the unit cell. Like the crystal structures of other symmetrically substituted furoxans described in the crystallographic literature, this structure is disordered, the exocyclic oxygen atom being found adjacent to either nitrogen atom. The observed molecular conformation possesses approximate twofold symmetry. Short intermolecular contacts are found between the furoxan endocyclic ring oxygen atom and a methyl hydrogen atom; additional intermolecular close contacts are present between the exocyclic oxygen atom and ring hydrogen atoms. Future work includes determining the crystal structure of the parent nitrile oxide, which we have found to dimerize within 48 hours at room temperature, and the crystal structures of the corresponding dioxadiazine and oxadiazole-N-oxide in order to fully elucidate the course of the solid-state dimerization.

104. **Jacob White,** Sunipa Pramanik, Christy Haynes
Toxicity of Silicon Nanocrystals to Shewanella oneidensis
Advisor: Christy Haynes
Sponsoring Program: MRSEC
Home Institution: Tulane University
Abstract: Jacob White
Tunable size, shape, porosity, and surface composition enable nanoparticles to serve in an ever-expanding number of applications, ranging from every day consumer products like cosmetics, food packaging, and electronics, to the cutting edge with more efficient solar cells, more effective cancer therapies, and enhanced bioimaging techniques. As engineered nanoparticles become more prevalent in consumer products, it is increasingly important to consider the implications of everyday interactions between nanomaterials, people, and the environment. The goal of characterizing the nano/bio interactions is to achieve benign nanoparticles by design. This project contributes to that goal by examining the effect of silicon nanocrystals on the growth of a Gram-negative bacterium, Shewanella oneidensis. Colony counting techniques, optical density measurements, respirometry, and cell membrane integrity assays were employed to investigate possible inhibitory effects of the nanocrystals. For these experiments, healthy bacteria cultures were exposed to the nanocrystals at concentrations of 50 mg/L, 100 mg/L, and 200 mg/L. Differences in growth and viability between exposed and control cell populations were not observed to be statistically significant. Results suggest that no primary mechanism of toxicity exists between these silicon nanocrystals and Shewanella oneidensis and encourage continued development of these materials, especially if they can replace more toxic consumer product components.

105. **Ben Willett**
Histidine Kinase Inhibition By Natural Product Extracts: Development of Potent Antibiotics
Advisor: Erin Carlson
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Luther College
Abstract: Antibacterial resistance has become a global health concern and there is an urgent need for potent antibiotics that will be invulnerable to the development of resistance. Histidine kinases (HKs) are important enzymes that are part of bacterial two-component systems (TCSs), which enable bacteria to respond to changes in their environment. TCSs are ubiquitous in bacteria, yet are not present in mammalian systems. In addition to this, the histidine kinase family contains a highly conserved ATP-binding domain. These features make HKs an attractive target for development of a novel class of antibiotics.
Natural products are a rich source of bioactive compounds and have been historically critical for the development of anticancer and antimicrobial treatments. Using a fluorescent-based assay, we tested the inhibition of HK853 (an HK obtained from Thermatoga maritima) by natural products extracts (NPEs) obtained from various marine microorganisms. Interestingly, some of these NPEs were found to be potent inhibitors and are promising leads. Current efforts are focused on the identification of the bioactive components of the active NPEs and optimization of the identified compounds as potential drug candidates.

106. **Peter Winegar**
Methane to Methanol Catalysis with Cu3O3 and NU-1000
Advisor: Laura Gagliardi
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Methane to Methanol Catalysis with Cu3O3 and NU-1000
Abstract: The methane to methanol catalytic properties of copper deposited on NU-1000, a metal-organic framework (MOF), was investigated using density functional theory (DFT) methods. The reactivity of this model system was investigated, starting with Cu1 systems and building up towards Cu2 and Cu3 systems. Only one Cu system at a certain level of dehydration had an accessible Cu-oxo bond, a moiety which has been shown to be reactive towards C-H bonds. The reaction of this Cu1 system with methane was only slightly uphill thermodynamically, ΔE = 1.7 kcal. Systems of Cu at different levels of dehydration and Cu2 systems did not have an accessible oxo bond and were moderately uphill thermodynamically, ΔE ~ 20-30 kcal, in order to abstract a hydrogen atom from methane.

107. Ka Lia Xiong, Joseph T. Buchman
The Viability Shewanella Oneidensis MR-1 and Bacillus Subtillis SB491 after exposure to Iron Oxide Nanoparticles
Advisor: Christy Haynes
Sponsoring Program: Project SEED
Home Institution: Class of 2017, Washington Technology Magnet, St Paul, MN
Abstract: The toxicity of nanoparticles is investigated to see how the environment will be affected when nanoparticles are released from products that contain them. This is done by checking how the nanoparticles affect a Gram positive and Gram negative environmental bacteria, namely, Bacillus subtilis SB491 and Shewanella oneidensis MR-1. We used two methods in our research to test how the presence of nanoparticles changes the viability of the bacteria. They are the pour plate method, which we use to count colonies of B. subtilis SB491, and drop plate method, which we use to count colonies of S. oneidensis MR-1 after exposure to iron oxide nanoparticles. So far we have seen that the iron oxide nanoparticles are helping B. subtilis SB491 grow rather than killing them and we haven't seen an effect of the nanoparticles to the viability of S. oneidensis MR-1.

108. Kenny Xiong, Matt Huisenga
A Diels Alder Reaction By Mixing a Diene With n-Phenylmalemide
Advisor: Wayland Noland
Sponsoring Program: Project SEED
Home Institution: Class of 2017, Washington Technology Magnet, St Paul, MN
Abstract: This summer, Project SEED has sent me to the department of Chemistry to work in Dr. Noland's research group to do a experiment. His group has been making and finding compounds that shows activity to diseases like Cancer, Tuberculosis, and HIV for over 50 years. For my experiment I am making a compound to have it tested for biology purposes. The name of this compound is 5-(2,5-dioxo-1-phenylpyrrolidin-3-yl)-4-ethyl-5-methyl-2-phenyl-3a,4,5,8b-tetrahydro-1H-thieno[3,2-e]isoindole-1,3(2H)-dione and currently has no common name like Mercury, Iron, etc. The compound also currently has no known affects on the human body and that why I'm making it so it can be tested to see if it does have any effects . To make this compound I did a Diels Aider reaction which is a reaction between a diene or a hydrocarbon with 2 double bonds of carbon and an Alkene which is a compound with at least 1 double carbon bond. For this reaction I first had to made the Diene by first making an Alcohol. Then I mix the alcohol with an acid called p-Toluenesulfonic acid which creates the Diene. Lastly I mix the Diene with the alkene compound n-Phenylmalemide and this finally makes the product that I need. So this is my experiment and what I have done.

109. Peter Yang
Synthesis of Benzamides
Advisor: Paul Boswell
Sponsoring Program: Project SEED
Home Institution: 2015 Graduate, Johnson High School, St Paul, MN
Abstract: N-alkyl benzamides were found to be a useful series of compounds to standardize retention times in liquid chromatography-mass spectrometry. They elute over a wide range of evenly spaced retention time intervals, they are detectable by both electrospray ionization mass spectrometry and by UV absorbance detection, and they elute with good peak shape. Previous efforts to synthesize the series of benzamides did not yield very pure product or required column chromatography to purify them. Here, we describe simple procedures to synthesize each of the N-alkyl benzamides from N-pentylbenzamide to N-hexadecylbenzamide with >99.9% purity as determined by gas chromatography-mass spectrometry

110. Joseph Mullin
Exploring Neutrino Oscillations at the Minos Near Detector
Advisor: Gregory Pawloski
Sponsoring Program: Physics REU
Home Institution: University of California Santa Barbara
Abstract: Typically when analyzing Neutrino Oscillations the oscillations are studied at the far detector located in Soudan Minnesota 735 km from where they are produced. The general approach assumes that no neutrinos oscillate before or within the near detector at Fermi Lab which is about 1 km from their production. Using this method the near detector data is used as the initial composition of the beam that is not affected by oscillations and the far detector studies the oscillations of the neutrinos. This project focuses only on the near detector and analyzes the potential for oscillations to occur before the near detector, between the decay pipe and the detector itself. By analyzing Monte Carlo data that represents the initial content of the beams then applying oscillations to this data it can be fit to the actual data collected at the near detector. This allows for the observation of how sensitive the near detector is to neutrino oscillations.

Poster Presentations for RET Participants
Listed Alphabetically by Presenting Author

111. Cassidy Javner

Incorporating Protein Engineering into a High School Classroom as a Novel Approach to Teach Intermolecular Forces

Advisor: Ben Hackel

Sponsoring Program: MRSEC

Home Institution: Shakopee High School

Abstract: The concept of intermolecular forces is commonly taught in a high school chemistry classroom. However, curricula does not provide many real life applications for the material, therefore making it difficult for students to internalize the concepts. To help cement their understanding, an introduction to biochemistry and protein engineering would provide students with an exciting application of these concepts. Intermolecular forces play an important role in the world of protein engineering; protein-protein interactions are driven by intermolecular forces between functional groups, and scientists often modify these groups in order to increase the functionality of a protein. Specifically in cancer research, the binding site of molecular targeting agents are mutated in order to increase the binding affinity to cancer cell receptors. Based on these ideas, an Enzyme-Linked Immunosorbent Assay (ELISA) was developed in order to demonstrate this important structure-function relationship in proteins. Students will use an ELISA to test the binding affinity of several proteins that have undergone a point-mutation at the binding site. Then they will detect the binding affinity for the mutant proteins using a color changing enzyme and quantify the affinity using smart phone colorimetry. Based on the data, students will be able to infer the intermolecular forces responsible for the protein interactions at the binding site. Through this experiment and the incorporation of a biochemistry unit into the chemistry curriculum, students will be able to apply their knowledge of intermolecular forces to real world cancer research.

112. Cassandra Knutson

Integrating Electronic Lab Notebooks and University Experts in a High School Classroom

Advisor: Lee Penn

Sponsoring Program: MRSEC

Home Institution: White Bear Lake High School

Abstract: Lab notebook practices are evolving from the keeping of a paper notebook to an electronic notebook in many post-secondary and corporate settings. Falsifying the time of an entry is more difficult in digital notebooks than paper versions making them desirable by those interested in publishing and patenting work. Entries can be quickly and easily searched in a digital format. Information can be shared between colleagues and experiments and analysis can be performed collaboratively, yet asynchronously. As post-secondary and corporate practices change, high school students need to be given more authentic experiences to learn the necessary skills to prepare for meeting these digital demands. Advanced chemistry students will keep a digital lab notebook via Google applications during the 2015-16 academic year with a set of digital notebook protocols. Their experience with the digital notebook will be compared to their experiences with a paper notebook they kept during the 2014-15 academic year. University of Minnesota graduate students and faculty will consult with students as experts during experiments throughout the year to introduce students to current methods and topics of research at the University level. The combination of a digital lab notebook with the integration of experts is intended to give the students a meaningful and authentic lab experience.

113. Emily McDonald

Identifying Genes in Genetically Modified Foods in a High School Biology Classroom

Advisor: Ben Hackel

Sponsoring Program: MRSEC

Home Institution: Shakopee High School

Abstract: DNA extraction experiments are common in high school biology classrooms. However once the extraction has been performed students do not get the opportunity to perform laboratory techniques such as PCR, gel electrophoresis, and DNA sequencing due to the lack of resources in the high school classroom. Biotechnology and genetic engineering are concepts covered in the high school classroom. As a result, an experiment was developed so students will get the opportunity to learn about genetic engineering through the extraction and sequencing of DNA from a variety of foods (tortilla chips, Cheetos, corn) known to contain genetically modified genes. After the extraction students are given the opportunity to carry out a PCR reaction so their DNA samples can be sent for sequencing. With the results students will be able to analyze the DNA sequences and find out if their food samples contain genetically modified genes. Students will compare the DNA sequences that were amplified by their PCR to the DNA sequence of a plant that does not contain genetically modified genes. This is done to simulate how scientists use these techniques to test for genetically modified genes.

114. Debra Mixon

DIY Spectrophotometer for Green Fluorescent Protein: For Inquiry Investigations Involving GFP Expression in the 9-12 Classroom

Advisor: Kevin Dorfman

Sponsoring Program: MRSEC

Home Institution: Breck School

Abstract: Green fluorescent protein (GFP) has become an important tool used in various molecular studies to tag proteins and DNA within cells. Various organisms have also been engineered to express GFP making the entire organism fluoresce. GFP is a key marker that allows students to determine the transformation efficiency of the uptake of a plasmid (containing the gene for GFP) by E. coli bacteria. If the E. coli is transformed, the subsequent colonies that are formed will fluoresce. The aim of this project is to provide an inexpensive way to quantify GFP expression by measuring the fluorescence of the transformed E. coli. Fluorescent spectroscopy is a method used to analyze fluorescent solutions but manufactured equipment is costly, somewhere in the range of $2,500.00 or more. The goal of this project is to create a spectrophotometer specific to GFP using inexpensive materials that are easily accessible to high school teachers. The spectrophotometer will provide relative quantification of GFP and can be used by students pursuing inquiry investigations on GFP expression. It will also provide a model for students to understand the basis of spectrophotometry and give them a platform to develop other potential applications of spectrophotometry.

115. Sarah Schoeller

Using Dystopian Literature to Enhance Student Understanding of Chemistry Concepts

Advisor: Christy Haynes

Sponsoring Program: MRSEC

Home Institution: White Bear Lake High School

Abstract: The percentage of students that "meets" academic standards for high school science across the state of Minnesota has averaged 36.7% in the last three years (1). Evidence suggests that student engagement increases with the use of correlative academic lessons designed to relate to youth interests that are perceived as challenging yet also matching student skill level (2). To this end, this research will utilize dystopian literature to engage students with general chemistry concepts and enhance the capacity of the students to relate to and retain these key concepts. Lessons have been developed for the 2015-2016 academic year for general chemistry students of White Bear Lake High School integrating dystopian literature to cover key general chemistry concepts, including nuclear chemistry, phases of matter, and thermochemistry. In each case, the students will read excerpts from dystopian novels and perform related laboratory experiments. These lessons incorporate critical thinking, reading comprehension, and application of chemistry concepts to dystopian literature. Pre- and post-assessments will be used to evaluate the effectiveness of this interdisciplinary approach to chemistry. This experience is intended to initiate and promote critical thinking of the world in terms of chemistry and provide students with an experience in connecting seemingly disparate high school academic subjects to each other and to the world around them. We hypothesize there will be a 30% increase in concept understanding based on comparison of pre- and post-assessment scores.