Materials Research Science and Engineering Center

UNIVERSITY OF MINNESOTA

Driven to Discover℠

Summer Undergraduate Research Expo

August 12, 2010
McNamara Alumni Center
Memorial Hall
4:00-6:00pm

Undergraduate Poster Presentations
Listed Alphabetically by Presenting Author

1. **Nardine Abadeer**, Yu-Shen Lin
Colloidal Stability of Modified Mesoporous Silica Nanoparticles
Summer Advisor: Christy Haynes
Department/Program Sponsor: Heisig/Gleysteen Chemistry Program
Home Institution: University of Minnesota
Abstract:
Mesoporous silica nanoparticles (MSNs) have shown great potential in the area of drug delivery based on the likely biocompatibility of silica, their pore structure and large pore volume/surface area. The colloidal stability of MSNs in biological media at physiological temperature is critical if they are to be utilized for in vivo stealth drug delivery. The work reported herein focuses on this critical characteristic using a procedure recently developed in the Haynes lab for the synthesis and purification of multifunctional and size-tunable MSNs. Compared to bare MSNs, we find that both pegylated MSNs and pegylated MSNs with an inner pore modification exhibit high long-term colloidal stability in biological media after hydrothermal treatment. This advance will facilitate multifunctional MSNs fulfilling their potential as theranostic nanoparticles.

2. **Paul Alperin**, Adam Wohl, Mallory Richards, Dr. Thomas Hoye
Convenient Transport and Delivery Mehod for Anti-Tumor Drugs
Summer Advisor: Thomas Hoye
Department/Program Sponsor: Chemistry, Lando
Home Institution: University of Rochester
Abstract:
Block copolymer protected orthosilicate prodrug containing nanoparticles can be used to carry and deliver anti-cancer drugs to a tumor site. Studies of drug release rate from the orthosilicate prodrug have been started; hydrolysis rates of various functionalized orthosilicates in different acidic environments are being investigated by NMR monitoring. Synthetic approach to fully customizing functionality at four sites on orthosilicate involves simple substitution reactions from SiCl4, and a one-pot approach looks possible.

3. **Abraham Alvarado**
Assembly of Monolayers on Silicon Through Diazonium Displacement
Summer Advisor: Liang Luo, Daniel Frisbie, Jose Gutierrez
Department/Program Sponsor: MRSEC
Home Institution: University of Texas- Pan American
Abstract:
The idea of combining the existing semiconductor electronics with organic molecules aims to result in a whole than is larger than the sum of its components. The coupling of the two compounds may eventually allow the properties of silicon to be improved in its performance. The purpose of this research is to synthesize organic monolayers on silicon surfaces and analyze how it will affect the properties of solid-state electronic devices. The monolayers are covalently bonded to silicon surfaces through diazonium displacement on aromatic compounds. Results show the formation of monolayers and allow for the elongation of the monolayer by forming oligomers through successive reactions between the existing molecule and molecules with functional groups capable of forming the oligomer of desired length.

4. **Tom Baldvins**
Paleoflora of Wild Rice Communities
Summer Advisor: Emi Ito
Department/Program Sponsor: Geology
Home Institution: Berry College
Abstract:
Wild rice (manoomin; Zizania palustris) plays a significant role culturally for the Objibwe, so cores were taken to better understand it past environment. Plant macrofossil analysis of sediment cores from wild rice lakes provides information on past floral plant communities, and shows how the lakes have changed over the Holocene. Results from three wild rice lakes on the Fond Du Lac Reservation (northern Minnesota) show that the lakes, which are now 1-3m deep, were originally 7-10m deep glacial kettles with low biological productivity. As the lakes have filled in with sediment over the past ~9000 years, the community has shifted from primarily aquatic plants such as Najas and Potamogeton to include more sedges such as Carex and Scirpus along with Zizania.

5.	**Shakeyla Barber** ***Selectivity Between Bridge N-H and Bridge C-H in the H-Bond Motifs of Crystalline Phenylhydrazones*** Summer Advisor: William H. Ojala Department/Program Sponsor: Chemistry, Young Scholars Program Home Institution: University of St. Thomas **Abstract:** We use single-crystal X-ray diffraction to determine whether pairs of molecules we have designated "bridge-flipped isomers" can assume identical solid-state packing arrangements. These isomers differ only in the orientation of a bridge of atoms connecting two major portions of the molecule and include phenylhydrazones related by the bridge flip Ar-CH=N-NH-Ar' vs. Ar-NH-N=CH-Ar' (Ar = aryl). To determine whether the difference in H-bond donor strength between the bridge N-H and C-H groups differentiates the crystal structures of these isomers, we are examining cyano-substituted phenylhydrazones. In contrast to certain of our other structures, the structure we describe here, that of 1-naphthaldehyde-4-cyanophenylhydrazone, shows a definite preference for H-bonding through the N-H group, suggesting that its bridge-flipped isomer ultimately will be found to assume a different packing arrangement.
6.	**Bahareh Barzegar**, Katie Crawford ***Cracking Behavior of Polymer Latex Coatings*** Summer Advisor: Lorraine Francis Department/Program Sponsor: MRSEC Home Institution: University of Massachusetts, Amherst **Abstract:** Coatings are used to make and improve many products such as laptops, medical devices and roofs. Polymer latex coatings are ideal because they are water not solvent base. A polymer latex mixture that contains 70% polyvinylidene fluoride and 30% acrylic is ideal for coatings because it is environmentally friendly, has better mechanical properties and has better exterior weather ability. However, this mixture is prone to cracking due to tensile stress and capillary pressure that is developed during the drying process. We studied the effect of coalesce aids and co-binders on the film formation of this mixture. The film formation of the coating improved and the number of cracks decreased when the coalesce aids and co-binders were added.
7.	**Faustina Boa-Amponsem** ***Sterically Hindered Suzuki Coupling Between A Nonaflate and Boronic Acids*** Summer Advisor: Dr. Andrew Harned Department/Program Sponsor: Heisig/Gleysteen Chemistry Program Home Institution: University of Minnesota **Abstract:** There is not much research that has been performed on suzuki coupling reactions of a sterically hindered nonaflates with different boronic acids. Therefore the purpose of this summer research topic was to perform suzuki coupling reactions with a methyl ester or t-butyl ester nonaflate with electron donating and electron withdrawing boronic acids.
8.	**Katie Bolling**, Peter Dosa ***Nasal Delivery of a Diazepam Prodrug for the Treatment of Seizures*** Summer Advisor: Ronald Siegel Department/Program Sponsor: MRSEC Home Institution: Winthrop University **Abstract:** Benzodiazepines are widely used in the treatment of seizure emergencies. Previously, an intranasal formulation of diazepam (DZP), a benzodiazepine, was developed where DZP was dissolved in a glycofurol-water cosolvent system. However, this drug is no longer being developed due to the pain associated with administration of this formulation. Our goal is to develop a prodrug of DZP that will be highly soluble in water to reduce the chance of causing irritation to the nose. Avizafone will be synthesized because it has been reported in several scientific journals as being water-soluble. After administering the prodrug to the nasal mucosa, aminopeptidase, an enzyme in the blood, will convert it to an intermediate structure that will then undergo Schiff-base formation to furnish diazepam. After synthesizing Avizafone, we will check its solubility.

9.	**Erinn Brigham**, Jacqui Tehranchi ***Mimicking Nitrous Oxide Reductase: Dinuclear Copper(II) Sulfur Complexes*** Summer Advisor: William B. Tolman Department/Program Sponsor: Chemistry, Lando Home Institution: New College of Florida **Abstract:** In the nitrogen cycle, denitrifying bacteria use nitrous oxide reductase (N2OR) to convert N2O, a potent greenhouse gas, into environmentally benign dinitrogen and water. This chemical reaction is thermodynamically favorable, however, a catalyst is needed to overcome the large kinetic barrier. Current synthetic catalytic systems require high temperatures, whereas N2OR is active under ambient conditions. The catalytic center of N2OR is the CuZ site which contains four copper atoms ligated by histidine residues and coordinated to a central sulfide, although DFT calculations suggest only two copper atoms bind N2O. This work aims to create small molecule mimics of the CuZ site by using low dentate, N-donor ligands to synthesize dinuclear copper(II) complexes and explore reactivity with inorganic sulfur sources.
10.	**Megan Brown** ***Comparison of Trapping and Desorbing Methods for Integrating Signal from Micrcodialysis Extractions*** Summer Advisor: Tony Borgerding Department/Program Sponsor: Chemistry Home Institution: University of St. Thomas **Abstract:** Gas-phase microdialysis sampling is useful in detecting volatile compounds in small environments. By coupling extraction probes with a trap and gas chromatography, we have increased the sensitivity of measurements made using microdialysis and GC by a factor of 10-100. To generate reproducible peaks, we constructed a heater that rapidly desorbs a carbon nanotube-coated trap in one second. Using this technique of rapid desorption coupled with microdialysis we have obtained distinct reproducible peaks for various concentrations as low as 1mM ethanol, 1mM isobutyraldehyde, and 0.1mM Toluene. We have also used a small section (~2 in) of thick film polysiloxane GC Column as trap. We have successfully achieved a desorption of the thick film column in two seconds.
11.	**Jenna Buffington**, Keying Ding ***Insertion Of Transition Metals Into Elusive C-C Bonds*** Summer Advisor: Connie Lu Department/Program Sponsor: Chemistry, Lando Home Institution: University of Wyoming **Abstract:** Activation of carbon-carbon single bonds is valuable because of the synthetic and petroleum applications. For intermolecular substrate activation, a bidentate phosphine ligand with a wide bite angle (>120°) would be favorable for metal insertion. The rigid trans-spanning ligand, 4,6-bis(3-diisopropylphosphinophenyl)dibenzofuran (abbreviated as L) has already been explored with noble transition metals, resulting in the complexes: [LRh(nbd)]BF4, [LRh(CH3CN)2]BF4, and [LPd(CH3CN)2][BF4]2. Reaction of L with MnBr(CO)5 gives a nearly quantitative product. The product is characterized by 31PNMR and IR spectroscopy. Reaction of L with FeCl2 gives a paramagnetic 1HNMR. Crystallizations of the transition metal products are in progress, and their reactivities will be investigated in the future.
12.	**James R. Byrnes** ***Viability of Ozonation as a Water Treatment Method for the Elimination of the Antibiotic Roxithromycin*** Summer Advisor: Kristine H. Wammer Department/Program Sponsor: Chemistry, Young Scholars Program Home Institution: University of St. Thomas **Abstract:** The occurrence of antibacterial resistance in populations of environmental bacteria has gained increased attention over the past several years. Once potential facet of the cause of resistance is the presence of antibiotically active molecules in both drinking water and treated wastewater. This study examines the effects of ozonation, a process used to treat water, on the antibiotic roxithromycin. Previous studies have produced evidence suggesting these ozonation products will retain their antibacterial activity, a possibility further investigated by this study. Samples of roxithromycin were ozonated and the degradation products were analyzed using high performance liquid chromatography. These ozonation mixtures were then tested for antibacterial activity using a biological assay. Thus far, no evidence has been found to suggest that roxithromycin ozonation products retain antibacterial activity.

13. **Talia Clark**

Assessing Problem Solving Abilities in Introductory Level Mechanics Courses

Summer Advisor: Kenneth Heller
Department/Program Sponsor: Physics REU
Home Institution: Barnard College, Columbia University

Abstract:

An important goal in undergraduate physics courses is to increase problem solving skills applicable to many disciplines. A recently developed rubric is used to assess problem solving in an introductory level calculus based Mechanics course for Science and Engineering majors. A set of solutions from students' work throughout a semester is evaluated to pinpoint trends, dependencies and areas of weakness. Dependence on gender, Force Concept Inventory (FCI) performance and math skills are examined. Increase in rubric scores from the beginning of the semester to the final exam will be used to establish a baseline for future research.

14. **Sara Diener**

Microdialysis Extraction Interfaced with EESI-MS and PTR-MS

Summer Advisor: Anthony Borgerding
Department/Program Sponsor: Chemistry, Young Scholars Program
Home Institution: University of St. Thomas

Abstract:

Gas phase microdialysis probes are fast (steady state<5 sec) and noninvasive (200µm X 3µm). The use of these probes has been combined with two different ionization techniques to analyze gas phase extraction streams. An extractive electrospray ionization (EESI) source was constructed by placing the extracted stream into an ESI source. We compared the performance of this system to a proton transfer mass spectrometer. Using EESI-MS, We were able to detect ketones at concentrations as low as 10µM, ethers as low as 1 mM, and hetracycles as low as 1 mM. Using PTR-MS ketones were detected at 1µM concentrations, acetone at 100 µM, and hetracycles at 100 µM.

15. **Sarah Fink**

Hydrogen Bonding in the Crystal Structures of Some Substituted Benzylideneanilines

Summer Advisor: William H. Ojala
Department/Program Sponsor: Chemistry, Young Scholars Program
Home Institution: University of St. Thomas

Abstract:

We are investigating the solid-state structures and molecular packing preferences of molecules we have designated "bridge-flipped isomers," molecules differing only in the orientation of a bridge of atoms connecting two major portions of the molecule. Examples are found among the benzylideneanilines, in which the isomerism is Ar-CH=N-Ar' vs. Ar-N=CH-Ar' (Ar = aryl). In previous work, we examined and compared the crystal structures of two bridge-flipped isomeric benzylideneanilines bearing a carboxyl group; we have now determined and describe here the crystal structure of the corresponding amide of one of these isomers. Although its cell constants resemble those of the bridge-flipped isomeric carboxylic acid, its H-bonding pattern differs, with amide N-H bonds assuming the role played by phenyl C-H bonds in the carboxylic acid.

16. **Grant Frost**

Improved Procedure for the Synthesis of a Functionalized Polylactide Copolymer

Summer Advisor: J. Thomas Ippoliti
Department/Program Sponsor: UST Chemistry
Home Institution: University of St. Thomas

Abstract:

The purpose for my project was to develop an improved procedure for the synthesis of a functionalized polylactide copolymer and then proceed to attach a variety of useful molecules to the functional region. This functionalized copolymer could have many possible medical applications depending on what is attached at the functional region. The first application for the copolymer could be that it is used as an adhesive to seal anti-inflammatory drugs on to an intravascular stent. This would potentially be accomplished by attaching the amino acid DOPA to the functional region. This method of drug delivery would allow for the procedure of using a stent to be far less harmful to the health of the patient receiving the treatment.

17. **Claire Funke**

Design, Modeling and Control of Hybrid Vehicles Using a Hydrostatic Dynamometer

Summer Advisor: Zongxuan Sun, Yu Wang
Department/Program Sponsor: University of Minnesota
Home Institution: Iowa State University

Abstract:

In today's world, the need for more efficient usage of energy resources is becoming increasingly obvious. Therefore, it is unsurprising that much research is being done concerning the design of hybrid vehicles. However, building and testing prototypes of hybrid vehicles is time and cost prohibitive, so one should first build and optimize a model of the hybrid drivetrain. This poster presents the author's work of updating a Simulink model of an electric hybrid drivetrain to ensure accuracy and converting the model from an electric hybrid into a hydraulic hybrid to confirm the feasibility of using fluid power in a passenger vehicle. These models can then be used in conjunction with a hydrostatic dynamometer and an internal combustion engine to confirm the modeled drivetrains' performances.

18. **Anne Gambrel**

The EBEX Focal Plane Visualizer

Summer Advisor: Shaul Hanany
Department/Program Sponsor: Physics REU
Home Institution: University of Tulsa

Abstract:

EBEX is a balloon-borne polarimeter designed to measure the intensity and polarization of the cosmic microwave background. These measurements should provide new and valuable information about the inflationary epoch that occurred shortly after the big bang. To detect the CMB, the EBEX apparatus employs more than a thousand transition edge bolometric detectors situated on two focal planes. In order to view the output from all of the detectors at once, a graphical display was created in a web interface. This interface displays the two focal planes and provides a color mapping function showing the relative levels of each detector for a particular data file. These data files are updated at 10 Hz, allowing for a continuous display of detector data during the instrument's flight.

19. **Christine Gerbode**, Paola Ardia

Impact of Quench Rate and Equilibration Time on Vanadium K-edge XANES Spectra and Use of V as a High-Pressure Oxybarometer

Summer Advisor: Marc Hirschmann
Department/Program Sponsor: Geology and Geophysics
Home Institution: Rice University

Abstract:

We present two experimental series relevant to the application and interpretation of vanadium oxybarometry to high-pressure petrological experiments. Samples of synthetic andesitic composition, buffered by the Ni+NiO system, were taken to 1400˚C and 1.5 GPa for 4 hours and quenched to room temperature at rates ranging from ~200˚C/sec to 150˚C/min. Samples of iron-free haplobasalt were brought to the same P/T/fO2 conditions and allowed to equilibrate for between 5 minutes and 6 hours before quenching. All samples were doped with vanadium (~0.5 wt.%) as an oxybarometer. Trends in V- and Fe-XANES spectra of these series show that these variables impact the observed valence/coordination state, and thus chemical interpretation, of samples. These observations may have implications for V-XANES spectra of natural samples as well.

20. **Michael Grahl**

Centrosymmetry in the Solid-State Molecular Packing of bis-Benzylideneanilines

Summer Advisor: William H. Ojala
Department/Program Sponsor: Chemistry, Young Scholars Program
Home Institution: University of St. Thomas

Abstract:
Pairs of molecules we have designated "bridge-flipped isomers" differ only in the orientation of a bridge of atoms connecting two major portions of the molecule. Examples exist among the benzylideneanilines, the isomerism being Ar-CH=N-Ar' vs. Ar-N=CH-Ar' (Ar = aryl). We use single-crystal X-ray diffraction to determine whether these isomers can assume identical solid-state molecular packing arrangements. We are currently examining isomeric bis-benzylideneanilines composed of a terephthalaldehyde or phenylenediamine core to determine whether molecular centrosymmetry in both isomers leads to similar crystal structures. Studies by other researchers show that terephthalaldehyde-based bis-benzylideneanilines assume non-centrosymmetric conformations in the crystal more frequently than their phenylenediamine analogues. We describe here the crystal structure of a centrosymmetric terephthalaldehyde bis-benzylideneaniline that could ultimately prove to be isostructural with its dual bridge-flipped isomer.

21. **Chris Granstrom-Arndt**

Creation and Detection of Low Temperature Helium Vapor Pulses Emitted by a Laser and Sent Through a Thin Film of Superfluid Helium to Study Bose-Einstein Condensation

Summer Advisor: J.W. Halley
Department/Program Sponsor: Physics REU
Home Institution: University of Minnesota

Abstract:
Bose-Einstein condensation occurs when a large fraction of bosons collapse into the ground state of a confining external potential, making quantum effects at the macroscopic scale apparent. Although evidence is inferential, superfluid helium is thought to be a consequence of Bose-Einstein condensation. In this study, laser-produced helium vapor pulses are sent via fiber optic cable through a thin film of superfluid helium, then are detected by bolometers. The self-balancing bridge circuit used to hold the bolometers in their superconducting state was tested, as was the LabVIEW program that sends the optical pulses and detects the bolometers' response. Additionally, heat diffusion through the fiber optic cable was modeled. Future comparisons between simulations and earlier experiments that used a resistor in place of a laser are planned.

22. **Niya G. Grozeva**, Drew D. Syverson

Magnesium-Hydroxide-Sulfate Formation At 200°C: Implications For Sulfur Geochemistry At The Lost City Hydrothermal Field

Summer Advisor: William E. Seyfried, Jr.
Department/Program Sponsor: Geology and Geophysics
Home Institution: Stony Brook University

Abstract:
The high sulfate content of serpentinites beneath the Lost City hydrothermal field suggests a sulfate phase precipitates at depth from low-temperature hydrothermal fluids. The lack of detected sulfate minerals, however, has hampered characterization of the sulfur geochemistry of hydrothermal alteration products. Examining the stability of sulfate phases, such as a magnesium-hydroxide-sulfate (MHS), would therefore yield a better understanding of S-fixation in the oceanic crust. To investigate the potential for MHS formation at Lost City, a solution containing MgSO4 was heated to 200°C for several days. Results suggest removal of SO4-- with precipitation of Mg(OH)2 from solution. Since thermodynamic calculations indicate that formation of previously characterized MHSs is unfavorable under the reaction conditions, our findings point to a more extensive solid solution between Mg(OH)2 and MgSO4.

23. **Brian Hake**

Optical Polarimeter Instrument Control

Summer Advisor: Terry J. Jones
Department/Program Sponsor: Physics and Astronomy REU
Home Institution: Point Loma Nazarene University

Abstract:

OptiPol is an optical imaging polarimeter used by the University of Minnesota department of Astronomy at the Mount Lemmon Observing Facility to measure the polarization of celestial objects. It is useful in studying polarization due to scattering by dust in stars, interstellar medium, and solar system objects as well as studying magnetic fields in the ISM. I fabricated a zero index device and mounting hardware for OptiPol and created a C++ MFC application in the Microsoft Visual Studio IDE for control by the astronomer through a serial port. This GUI controls the stepper motor used to rotate the half-wave plate, an essential optical component in the polarimeter.

24. **Leanne Hancock**, Sannie Olson

Colonization and Alteration of Calcium Carbonate by the Sulfur-Oxidizing Bacteria Halothiobacillus neapolitanus and Thiomicrospira crunogena

Summer Advisor: Jake Bailey
Department/Program Sponsor: NSF- REU Geology and Geophysics
Home Institution: University of Georgia

Abstract:

Sulfur-oxidizing chemotrophic bacteria are sometimes observed to colonize calcium carbonate substrates in deep ocean settings around methane seep systems. In some cases, these carbonate substrates appear to be weathered, and we are interested in the possibility that these acid-producing bacteria are contributing to this effect. In our experiments, limestone chips were added to a growth medium for two sulfur bacteria, Halothiobacillus neapolitanus and Thiomicrospira crunogena to observe the effects of their acidic metabolic waste products on weathering of carbonate rocks. Our observations using scanning electron microscopy show pits in the rocks due to dissolution. We also observed that these bacteria prefer limestone as a surface on which to grow.

25. **Zach Henseler**

Improvements on Microdialysis Extraction for Analysis of Nitric Oxide Using MOF

Summer Advisor: Anthony Borgerding
Department/Program Sponsor: UST Chemistry
Home Institution: University of St. Thomas

Abstract:

Nitric oxide is an important neurotransmitter which has been linked to memory, pain, learning, stroke and Alzheimer's disease. Measuring nitric oxide levels in vivo is challenging due to its short half life and low concentrations in the body. Using microdialysis extraction with chemiluminescence detection, we are able to measure 1 uM NO. We aim to lower this detection limit by concentrating NO and rapidly desorbing it. To do this, a trap was constructed filled with a metal organic framework (MOF) and plumbed into the system. This trap has been shown to contain all NO extracted from a 10 uM solution at 1 ml/min for at least an hour. Rapid desorption of NO from the MOF remains a challenge.

26. **Amy Hillis**, Joshua Feinberg

Magnetic Sourcing of Stone Age Obsidian Artifacts

Other Authors: Joshua Feinberg, Ellery Frahm, Charissa Johnson
Department/Program Sponsor: Geology REU
Home Institution: Macalester College

Abstract:

Obsidian artifacts are found at stone age sites throughout the world. Determining the geologic provenance of these artifacts is important for understanding the geographic ranges and trading routes of ancient communities. The most commonly used obsidian sourcing techniques are geochemical and geochronological. These techniques are all time consuming, expensive, and destructive. Magnetic measurements hold several advantages over more traditional methods in that the measurements are non-destructive, fast, and inexpensive. This study aims to characterize obsidian samples based on their magnetic properties, and addresses two fundamental questions: 1) Can rock magnetic measurements be used as a screening tool to identify groups of obsidian samples from a common source? 2) Can rock magnetic measurements be used to link an obsidian artifact to a specific geologic source?

27. **Amy Howard**

Disorder in the Co-Crystallization of 4,5-Dichlorophthalic Anhydride with 5,6-Dichlorobenzofurazan Oxide

Summer Advisor: William H. Ojala
Department/Program Sponsor: Chemistry, Young Scholars Program
Home Institution: University of St. Thomas

Abstract:

We have designated as "strict isosteres" those molecules possessing a close atom-for-atom correspondence with regard to both van der Waals radii and atomic connectivity. Molecules possessing this relationship only through disorder in their crystal structures we designate as "crystallographic surrogates." Strict isosteres and crystallographic surrogates should show extensive mutual solid-state solubility. We are examining those that undergo a solid-state phase transition upon heating or cooling with the goal of modifying or even controlling the phase-transition behavior of one compound by co-crystallizing it with varied proportions of the other. Using single-crystal X-ray diffraction, we are currently examining the disordered structure of a crystal containing the crystallographic surrogates 5,6-dichlorobenzofurazan oxide (known to undergo solid-state phase transitions) and 4,5-dichlorophthalic anhydride, and we describe the results here.

28. **Eleanor Hoyt**

Rheological Properties During Natural Deformation from Fold Shape and Fabric

Summer Advisor: Peter Hudleston
Department/Program Sponsor: Geology and Geophysics
Home Institution: Colby College

Abstract:

Geometric parameters of fold shape and fabric can provide information on rheological properties during deformation which can be used to further understand deformation associated with tectonic processes. This study applies the analysis of fold shape to isolated buckled layers (quartz veins in schist). Measurements of wavelength, thickness, limb dip, and curvature are used to estimate the viscosity contrast and power law exponent of the layer. Application of a strain contour map along with the removal of a homogenous flattening event provide lower boundary strain estimates of both the amplification and kinematic growth stages of fold development. In addition, fold fabric can provide information on folding mechanisms. EBSD analysis allows for the interpretation of crystallographic orientations associated with different deformation processes.

29. **Jeremy Hrudka**

Synthesis of a New Antibiotic containing a Novel Ring System

Summer Advisor: Thomas J. Ippoliti
Department/Program Sponsor: Chemistry
Home Institution: University of Saint Thomas

Abstract:

Anti-Bacterial drugs are a huge help in today's healthcare system. As time goes on, bacteria grows resistant to simple antibiotics. Oxazolidinone's have been proven biologically to sufficiently destroy drug-resistant bacteria. There is a lot more known about this class of compounds than in the past. Zyvox™ is a well known and widely used "last resort" antibiotic. The compound I focus on synthesizing is that of a similar oxazolidinone. However, this compound will be different than that of any other compound. The compound I will synthesize over multiple steps will be that of a thianthrene oxazolidinone (A fused ring system containing sulfur atoms attached onto an oxazolidinone ring). This sulfur containing system will have the same spatial relations as previous compounds, but will alter electronically. This will enable different pi stacking of the molecules, therefore creating an altered level of activity against the enzymatic activity of the bacteria.

30. **Trevor Hutchinson**

Electronic Properties of Mixed Phase Semiconductor Thin Films

Summer Advisor: James Kakalios
Department/Program Sponsor: Physics REU
Home Institution: Lewis & Clark

Abstract:

Amorphous silicon has gathered significant interest due to its applications in solar and TFT technology. One practical barrier remains: light induced defect formation. A proposed solution includes inclusion of crystalline nanoparticles, whose properties are investigated here. The theoretical prediction is compared to experiment with the conclusion that higher crystalline percentages increases the metastable thermal equilibrium temperature. Interesting from a theoretical standpoint, this information will ultimately produce benefits to solar cell efficiency.

31.	**Robert Jacobberger**, Steven Koester ***Synthesis and Chemical Doping of Graphene*** Summer Advisor: Steven Koester Department/Program Sponsor: MRSEC Home Institution: University of Nebraska-Lincoln **Abstract:** Graphene is a promising candidate material for nanoelectronic devices because of its monolayer thickness, high carrier mobility, thermal conductivity, and mechanical strength. The production of high quality graphene with a charge neutral Fermi level is important for the fabrication of devices such as field effect transistors and sensors with enhanced electrical properties. Here, we report a procedure to fabricate large pieces of graphene via mechanical exfoliation. Raman spectroscopy and AFM reveal that these samples have very few defects and low levels of intrinsic doping. In addition, we explore methods of chemical doping with tetrafluorotetracyanoquinodimethane (F4-TCNQ) to modify the electrical properties of graphene, increasing its potential applications.
32.	**Charles James Sr.** ***Strain Tracking Using Polydimethysiloxane (PDMS) Cruciforms*** Summer Advisor: Victor Barocas, Cody Martin Department/Program Sponsor: MRSEC Home Institution: College of Menominee Nation **Abstract:** Polydimethylsiloxane(PDMS) cruciform samples are used for strain tracking in place of actual tissue, due to its linearly elasticity. Strain tracking calculates the strain on the sample. For this, we need fine, evenly coated markers on the sample. Current strain tracking technique is inaccurate which involves Verhoeff Stain. My project this summer was to enhance this technique. Current method has defects such as it produces blotches and gives insufficient results. I constructed a stage involving spray paint and 2 chambers with a distance of 15 inches from spray to sample. The spray paint produced a blanket of fine specks on the PDMS. However, spray paint doesn't stain the tissue. Thus, we need to enhance Verhoeff stain by using an airbrush to produce fine specks on sample.
33.	**Lucas Janes**, Ryan Knutson ***Microwave Assisted Solvothermal Synthesis of Copper Sulfide Nanoparticles.*** Summer Advisor: R. Lee Penn Department/Program Sponsor: MRSEC Home Institution: Swarthmore College **Abstract:** Copper sulfide nanoparticles exhibit characteristics attractive for solar cell use. They have an indirect band gap of 1.2eV, and are made from abundant, easily obtained, benign materials. We characterized the phases of copper sulfide produced in various microwave assisted solvothermal synthesis methods. We examined how synthesis time and precursor concentrations affect the size and phase of synthesized nanoparticles using X-ray diffraction, TEM microscopy and UV-Vis spectroscopy. This helped illuminate the relationship between microwave synthesis and more conventional bomb synthesis methods and can be used to help predict the response of other microwave driven synthesis methods.
34.	**Hannah Joy-Warren** ***Analysis of the Potential for Iron Fertilization to Slow Global Warming*** Summer Advisor: Katsumi Matsumoto Department/Program Sponsor: Geology and Geophysics - NSF REU Home Institution: University of Chicago **Abstract:** Atmospheric carbon dioxide (pCO2) is a key factor driving global warming, thus strategies to reduce pCO2 are important. Phytoplankton consume CO2 and create a net transport of CO2 from the atmosphere and into the deep oceans. Their growth, and hence CO2 consumption, is generally iron-limited. To test the hypothesis that iron fertilization in the ocean could have long term effects on pCO2, I added new components to MESMO, a computer model of biogeochemical cycling in oceans. I added phytoplankton composition and response to iron to allow a simulation of the effects of iron fertilization on phytoplankton abundance, composition, and pCO2, as well as other changes in ocean chemistry that may affect the ecosystem, including lower levels of dissolved oxygen, acidification, and decreased nutrient concentrations.

35. **Zofia Kaminski**
Tracking Fluorescent Microspheres
Summer Advisor: Joachim Mueller
Department/Program Sponsor: Physics REU
Home Institution: University of Dallas
Abstract:
Fluorescent microscopy is used to study proteins and other fluorescent particles. Among these are fluorescent microspheres, which are artificially made, but by working to properly measure the known properties of these microspheres we can use the same techniques to eventually make measurements of the HIV-1 Gag proteins which transport the virus.

36. **Luke Kassekert**
Synthesis of an Antiviral Compound
Summer Advisor: Dr. J. Thomas Ippoliti
Department/Program Sponsor: UST Chemistry Department
Home Institution: University of St. Thomas
Abstract:
Recently, a pandemic was announced by the World Health Organization. Influenza A subtype H1N1 broke out and was threatening the welfare of U.S. citizens. As new viruses continue to mutate, multiply, and threaten the well-being of the human population, new antivirals must be explored and synthesized. Presently, sesquiterpene coumarin ethers are believed to possess properties needed to treat viruses. A compound that has been extracted from a plant has shown antiviral potency. If this compound can be successfully mass-produced, broader and more intensive tests may be run to further identify its properties. The main initiative of my research is to synthesize this compound in purity and high yield. I will also synthesize compounds with various coumarin derivatives which can be tested to determine their unique medicinal properties.

37. **Hanna Key**
A Golden Step to a Versatile Natural Product Platform
Summer Advisor: Andrew Harned
Department/Program Sponsor: LANDO/NSF Program
Home Institution: Grinnell College
Abstract:
Over the past five years, gold-catalyzed allene cyclization has become an increasingly efficient method for synthesizing stereospecific heterocycles. Toward natural product targets, gold-catalyzed cyclization via nucleophilic attack of beta ester moieties onto allenes could be used to generate diarylheptanoid tetrahydropyrans, which form the core structure of centrolobines, diospongins, and other biologically-active compounds. By this method, an unsaturated lactone platform toward building these natural products has been synthesized with specific functionality in place for 2,4,6 elaboration around the ring structure via direct addition to the ester carbonyl, Michael addition through the unsaturated 4-carbon, and relay cross metathesis using built-in functionality at the 2-position. Work is currently being undertaken to carry out the necessary aryl elaborations to create a racemic version of (-)-centrolobine.

38. **Ross Kerner**
Continuously Graded Donor-acceptor Heterojunction Applied to Organic Photovoltaic Cells
Summer Advisor: Russell Holmes
Department/Program Sponsor: UROP
Home Institution: University of Minnesota
Abstract:
Organic photovoltaics (OPVs) are attractive as a source of renewable energy due to their compatibility with high-throughput roll-to-roll fabrication process. Photon absorption in an organic semiconductor leads to the creation of tightly bound electron-hole pairs (excitons) that are dissociated at the donor-acceptor (D-A) heterojunction. Typically, the absorption length in organic semiconductors is much longer than the exciton diffusion length. Consequently, not all the photogenerated excitons are dissociated. This work presents an alternative approach for the design of OPVs based on continuously graded D-A heterojunctions (GHJs). In these GHJs, the large D-A heterojunction area increases the exciton diffusion efficiency relative to the planar heterojunction while improving the charge collection efficiency compared to the mixed heterojunction. This study explores the use of aluminum phthalocyanine chloride (ClAlPc) and C60 as the donor and acceptor materials, respectively.

39.	**Jennifer Koezly**, Evan Weitz, Valerie C Pierre ***Iron Oxide / Gold Nanoparticles Arrays as Multimodal Imaging Agents*** Summer Advisor: Valerie C Pierre Department/Program Sponsor: Lando/NSF Chemistry Summer Research Program Home Institution: Saint Mary's University of Minnesota **Abstract:** Magnetic Iron Oxide Nanoparticles (MIONs) are extensively used as contrast agents for in vivo MRI. Unfortunately, the low sensitivity (millimolar range) of MIONs and the low resolution (millimeter) of MRI limits the application of this class of imaging agents. Gold nanoparticles, on the other hand, are used extensively in cellular imaging techniques taking advantage of their plasmonic properties. Dark field spectroscopy, for instance, enables single molecule detection at the nanometer range. It would therefore be beneficial to synergistically couple the in vivo imaging capabilities of MIONs with the sensitivity and resolution offered by gold nanoparticles in a system that would remain biocompatible with low cellular toxicity. The synthesis of a ligand enabling dual functionalization of gold and iron oxide nanoparticles and its application in the self-assembly of multimodal and multimetallic nanoparticle arrays will be presented. The properties of the arrays, and their efficacy as plasmonic and MRI contrast agents will be discussed.
40.	**Bryce W. Koprucki**, Audrey A. Eigner, Brynna H. Jones, Chris J. Huber ***Analysis of Structural Dynamics in Conducting Polymers*** Summer Advisor: Professor Aaron Massari Department/Program Sponsor: Chemistry, UROP Home Institution: University of Minnesota (Twin Cities) **Abstract:** Polyaniline (PANI) is one of a few polymers capable of conducting a current. With its ease of synthesis and room temperature stability, polyaniline is one of the most investigated organic semiconductors in modern research. The structural dynamics of polyaniline were analyzed using two-dimensional infrared (2D-IR) vibrational echo spectroscopy. The polymer was made conductive by doping the sample with two different acids, the dynamics of which were compared later. These two acids are camphor sulfonic acid (CSA) and dinonylnapthalene sulfonic acid (DNNSA). The conducting polymers were blended with 2,3,7,8,12,13,17,18-octaethyl-21H,23H-porphine ruthenium(II)carbonyl (RuOEP) for the purpose of using the carbonyl stretch of RuOEP as an indicator/antennae for the changing structural dynamics of the doped polyaniline.
41.	**Katherine A. Kuehn**, Madhukar Reddy ***Galfenol Nanowires for Touch Sensors and Electroplated Thin Films*** Summer Advisor: Bethanie J. H. Stadler Department/Program Sponsor: MRSEC Home Institution: University of Wisconsin Eau Claire **Abstract:** Galfenol (FeGa) is a relatively new material composed of Iron and Gallium that has a unique property in that it changes its magnetization direction in response to compression and deformation 230 times more than any other material that has been previously studied. This change in magnetization direction can be detected by electronics and thus makes Galfenol an ideal material for creating touch sensors by synthesizing nanowires. Similar materials containing Gallium were also studied by electroplating them onto brass substrates. Materials such as Cobalt Gallium, Nickel Manganese Gallium, and Iron Manganese Gallium were electroplated into thin films and characterized using an SEM and Energy Dispersive X-Ray Spectroscopy.

42. **Ozge Kurtulus**
Fabrication, Characterization, and Application of Glancing Angle Deposition SERS Substrates
Summer Advisor: Christy L. Haynes
Department/Program Sponsor: Lando/NSF Summer Program
Home Institution: University of Minnesota
Abstract:
Surface-enhanced Raman scattering (SERS) is a powerful signal transduction mechanism, which requires a nanoroughened noble metal surface for the formation of localized surface plasmons. Glancing angle deposition (GLAD) substrates are being utilized as an alternative to the traditional Ag-film-over-nanospheres in recent years. This project explores the SERS scattering efficiency of GLAD substrates fabricated with various deposition thicknesses and rates. Based on calculated SERS enhancement factors, the most promising substrate is a 600-nm-thick GLAD substrate fabricated at an 86° degree angle to the deposition source at a deposition rate of 0.6 Å/s. Modification of the substrates with an alkanethiol partition layer allowed for the detection of prostaglandin D2 (PGD2), one of the major species secreted by mast cells, signifying the power of SERS to obtain molecular fingerprints from biomolecules.

43. **Bethany Ladd**
Groundwater Dye Trace in Southeast Minnesota
Summer Advisor: Calvin Alexander
Department/Program Sponsor: Geology and Geophysics
Home Institution: Brown University
Abstract:
Southeast Minnesota's karst lands support many trout streams, which depend on the cool and clear water sourced by springs. These springs are under increasing pressure from various human activities that withdraw large amounts of groundwater. Because it is very difficult to establish protective measures for trout streams without an idea of the layout of the groundwater flow system, this study aims to delineate the springshed surrounding the Crystal Springs State Fish Hatchery in Altura, Minnesota. By pouring fluorescent dye into two stream sinks and placing detectors in ten different springs in the area, an initial idea of the groundwater flow paths may be obtained. Results are forthcoming, however, dye is expected to appear within a matter of days in the springs at the Fish Hatchery.

44. **May-Ling Li**
The Effect of a Strong Electric Field on the Lambda Transition of Liquid Helium
Summer Advisor: William Zimmermann
Department/Program Sponsor: Physics
Home Institution: Reed College
Abstract:
This experiment searches for the effects of a strong electric field on superfluid liquid helium using second sound to detect the effects of an electric field in porous-membrane transducers.

45. **Julian Lo**, Susan Brown, Elena Sizova
Synthetic Efforts Toward Phomopsichalasin
Summer Advisor: Thomas R. Hoye
Department/Program Sponsor: Heisig-Gleysteen Research Fellowship
Home Institution: University of Minnesota
Abstract:
Phomopsichalasin is a novel antimicrobial agent that shows activity against Bacillus subtilis, Salmonella gallinarum, Staphylococcus aureus and Candida tropicalis in disk diffusion assays. Our biosynthetic hypothesis of phomopsichalasin can be traced to a pair of spontaneous intramolecular Diels-Alder (IMDA) cycloadditions that occur within a polyene precursor. This critical precursor has a methyl-bearing stereocenter, which we believe exhibits diastereoselective control in the formation of 9 new stereocenters during the IMDAs. Synthesis of the polyene precursor involves the unification of three fragments via a Suzuki and a Grignard coupling reaction.

46.	**Matthew Lynch**, Rahul Dutta ***Implementation of a Hydrostatic Transmission into a Wind Turbine*** Summer Advisor: Kim Stelson Department/Program Sponsor: Center for Compact and Efficient Fluid Power Home Institution: University of Minnesota **Abstract:** It has become a necessity to weed our energy consumption away from traditional fossil fuel sources. Thus, alternative energies have become prominent in the energy equation for the future. Wind power is a major factor in this shift towards clean energy sources. However, wind power manufacturers always want to make turbines lighter, more cost efficient and reliable. The mechanical gearbox within the turbine is one component that could be improved to accomplish these goals. Thus, the proposition is to use a hydrostatic transmission instead of the traditional mechanical gearbox, which could prove to be easily manufactured, have a longer life through increased reliability, and be more efficient. This summer, research was conducted to accurately model the dynamics of such a hydrostatic transmission within a wind turbine using Simulink and MATLAB. Subsequently, closed loop feedback control methods where utilized to control the system. The models can he! lp validate the benefits of its use within the turbine as well as give guidance for the construction of a 50 KW prototype.
47.	**Paige Martin**, Zeb Krahn ***Exploring a Passive Cooling Method for Electronics Heat Dissipation in the NOvA Experiment Detector*** Summer Advisor: Kenneth Heller Department/Program Sponsor: Physics REU Home Institution: Harvard University **Abstract:** Thought to play an important role in the history and evolution of the universe, neutrinos are small, neutral particles that come in three flavors: electron, muon, and tau. Currently under construction, the NuMI Off-Axis electron neutrino Appearance (NOvA) Experiment will look for neutrino oscillations,or a switching between flavors. The NOvA detector will capture light from particle interactions, and send the light to photodiodes, which are to be kept at -15C by thermoelectric coolers (TECs). To remove heat generated from the TECs, the current plan uses a chilled water technique. I explore an alternative passive cooling method that employs thermal radiation to dissipate heat, which would require less installation and maintenance, and thus be more cost-effective than the chilled water method.
48.	**Sarah McKnight** ***Titanium-in-quartz thermomechanics of the Ruby Mountains Detachment System at Lamoille Canyon, NV*** Summer Advisor: Christian Teyssier, Donna Whitney Department/Program Sponsor: NSF REU Program Home Institution: Mount Holyoke College **Abstract:** Quartz, an abundant mineral in the continental crust, is often used as a indicator for temperature and pressure during deformation. Detachment systems provide insight into the deformation patterns of quartz because detachments experience a large gradient in temperature and little variation in pressure. Titanium thermometry studies show a large thermal gradient in detachment systems. Despite the thermal gradient, the quartz recrystallization trends do not vary depending on the temperature. We collected samples from the Ruby Mountains for microstuctural analysis to further investigate the relationship between quartz deformation and titanium distribution. Our analysis indicates that recrystallization does not create variations in the detachment's deformational fabric. Our next step is to test for the thermal gradient and determine whether our data concurs with previous studies.

49.	**Sinead Murphy**, Will Gramlich ***Graft Polymerization of Polylactide onto a Polyisoprene Backbone*** Summer Advisor: Marc Hillymer Department/Program Sponsor: MRSEC REU Home Institution: Amherst College **Abstract:** In light of our current national oil dependence and push toward ecologically conscious goods, the need for renewable consumer resources is an ever-pressing issue. Polylactide, a renewable and biodegradable polymer, is currently employed in medical and packaging industries, though its uses are limited because of its low glass transition temperature and brittleness. However, when polylactide is blended with stronger, more durable polymers, the new material formed exhibits favorable characteristics. By blending polylactide and polyisoprene, another potentially renewable polymer, we can make a more commercially useful and ecofriendly plastic. This will be done through the exploration of the creation of a graft copolymer with a polyisoprene backbone and polylactide graft branches.
50.	**Ryan Neilson**, Amanda Dillman, Lars Hansen ***Contribution of Grain Boundary Sliding to Total Strain on Forsterite in Diffusion Creep*** Summer Advisor: David L. Kohlstedt Department/Program Sponsor: Geology & Geophysics, NSF (REU) Home Institution: Colorado School of Mines **Abstract:** Diffusion creep in minerals is thought to be accompanied by grain boundary sliding (GBS). Although percentages of total strain due to GBS have been measured for some metallic alloys and ceramics, few direct measurements of GBS have been reported for geological materials and none have been reported for olivine. I deformed samples of fine-grained forsterite under uniaxial compression at atmospheric pressure, analyzed polished surfaces marked with cuts to measure offsets between neighboring grains, and computed the strain due to GBS. Percentages of total strain due to GBS decrease with increasing strain, suggesting that GBS is more important at lower strains on olivine. The methodology developed here will potentially be useful for measurements of GBS in higher stress conditions as well as in other geological materials.
51.	**Joseph Nelson** ***Numerical Simulation Of Supercritical CO2 Flow And Plume Evolution In The Mt. Simon Formation Of The Illinois Basin*** Summer Advisor: Martin Saar, Jimmy Randolph Department/Program Sponsor: Geology and Geophysics REU Home Institution: University of Virginia **Abstract:** Geothermal energy production utilizes the Earth's natural heat flow, traditionally with water as the working fluid. With CO2 as the working fluid, geothermal resources inaccessible with water can be mined. Furthermore, CO2-geothermal has the added benefit of sequestering CO2, which helps eliminate anthropogenic atmospheric emissions. The most probable locations for this approach are saline aquifers in regions with moderately high geothermal gradients. Before such a process can be implemented, the hydrodynamic interactions and geochemical properties of the system must be numerically simulated with basin specific input data. TOUGH software permits such modeling of a CO2 plume moving through saline aquifers. Simulations of supercritical CO2 flow through the Mt. Simon formation of the Illinois Basin elucidate the importance of buoyancy and relative permeability.
52.	**Nakisha Newell** ***LCST Phase Behavior of PEO in Ionic Liquid*** Summer Advisor: Timothy P. Lodge Department/Program Sponsor: MRSEC Home Institution: University of Minnesota-Twin Cities **Abstract:** We examine lower critical solution temperature (LCST) phase-behavior of poly(ethylene oxide) (PEO) with low molecular weights (Mw = 2000 and 3,400); dissolved in ionic liquid (IL),1-ethly-3-methlyimidazolium tetrafluoroborate ([EMIM][BF_4]). Phase transition is determined using cloud point measurements. In similar experiments with higher molecular weight PEO (Mw = 5000 and 20,000), liquid-liquid phase separation was observed at temperatures between 130-170 °C. Experiments with low Mw PEO showed dual critical concentration points with liquid-liquid phase separation at temperatures between 180-215 °C.

53. **Sannie Olson**, Leanne Hancock
Growth of Thiomicrospira crunogena Using Calcium Carbonate as Its Sole Carbon Source
Summer Advisor: Jake Bailey
Department/Program Sponsor: NSF REU Geology and Geophysics
Home Institution: College of St. Scholastica
Abstract:
Chemoautotrophic sulfur-oxidizing bacteria, such as Thiomicrospira crunogena, fix carbon from bicarbonate sources, such as ocean water, for growth. In a series of experiments, we have eliminated carbon dioxide and bicarbonate, as well as other buffers, from the growth tubes of T. crunogena, and provided only calcium carbonate rock as a potential carbon source. Our turbidity and pH measurements suggest that these bacteria are indeed able to grow solely off of carbon obtained from the calcium carbonate rocks. The mechanism for obtaining carbon is likely through rock dissolution induced by T. crunogena's acidic metabolic waste products.

54. **Nwamaka Onyeozili**, Kamlesh Shroff, Nelly Mateeva
Improved Delivery Of Therapeutic Drugs to $\alpha_5\beta_1$ Integrin Expressing Cell Line
Summer Advisor: Efrosini Kokkoli, Nelly Mateeva
Department/Program Sponsor: MRSEC
Home Institution: Florida Agricultural and Mechanical University
Abstract:
Liposomes are potential vessels for carrying and delivering therapeutic drugs to cancer cells. The main goal of this project is to deliver therapeutic drugs to the breast cancer cell line that expresses the $\alpha_5\beta_1$ integrin. This is to be done via poly(ethylene glycol) (PEG)-containing liposomes, which will carry the encapsulated drugs, target the $\alpha_5\beta_1$ subunits of the tumor cells, and release the drugs into the cells. Fibronectin-mimetic peptides attached to the liposomes are ligands for the $\alpha_5\beta_1$ subunits and are responsible for targeting the appropriate cells. Since liposomes have a hydrophobic exterior and hydrophilic interior, the hydrophobic drugs being used easily become encapsulated within the hydrophobic bilayer of the liposome.

55. **Eric Petersen**, Steven Warren, Evan Skillman, Juergen Ott, Adrienne Stilp, Julianne Dalcanton, Fabian Walter
Tracing Cold Neutral Hydrogen in Low Metallicity Galaxies
Summer Advisor: Evan Skillman
Department/Program Sponsor: Physics REU
Home Institution: Michigan Technological University
Abstract:
Star formation occurs in clouds rich in dust and molecular gas (usually traced by CO). In a low metallicity system, the CO content drops and the cloud becomes difficult to trace. One solution is to locate regions where the neutral hydrogen (HI) has a cold (~100 K) component, which may be a precursor to molecular clouds. Separating the narrow/cold component (sigma ~3 km/s) from the broad/warm component (sigma ~10 km/s) requires high spectral resolution. High spectral/spatial resolution data from the VLA-ANGST and THINGS surveys allows us to locate regions of cold HI in ~40 nearby low metallicity galaxies. These regions can be compared to known tracers of star formation (young stars, H-alpha, warm dust, etc.) to elucidate the role of cold HI in stellar formation.

56. **Rachel Pricer**
Modification of Glucose-Dependent Insulinotropic Polypeptide
Summer Advisor: Mark Distefano
Department/Program Sponsor: Heisig/Gleysteen Chemistry Program
Home Institution: University of Minnesota
Abstract:
Glucose-dependent insulinotropic polypeptide (GIP) is a 42 amino acid polypeptide under research for diabetes treatment. GIP is produced by endocrine K-cells to regulate glucose production. Two disadvantages of this polypeptide as a treatment are a short lifetime due to proteolytic degradation and swift clearage from the kidney tubules. A PEG addition has been shown to improve polypeptide retention and lifetime. A bioorthogonal method to attach PEG groups to GIP is enzymatically with farnesyltransferase (FTase). FTase can add prenyl groups to peptides if a CAAX box is present. The proposed project is to modify GIP-CAAX with a prenyl analog that could undergo a click reaction with a PEG group. Modifying the polypeptide this way allows selective enzymatic modification with a four residue tag.

57. **Jean-Claude Rock**, Brenen Thul
Controls Hardware
Summer Advisor: Kim Stelson
Department/Program Sponsor: Center for Compact and Efficient Fluid Power
Home Institution: University of Minnesota
Abstract:
Controls hardware uses xPC Target that enables to execute Simulink and Stateflow models on a Target Computer and hardware-in-the-loop simulation.

58. **Emily Rohkohl**
Bridge N-H vs. Bridge C-H as an H-Bond Donor in the Crystal Structures of Phenylhydrazones
Summer Advisor: William H. Ojala
Department/Program Sponsor: Chemistry, Young Scholars Program
Home Institution: University of St. Thomas
Abstract:
Molecules we have designated "bridge-flipped isomers" differ only in the orientation of a bridge of atoms connecting two major portions of the molecule. Examples are found among the phenylhydrazones, in which the isomerism is Ar-CH=N-NH-Ar' vs. Ar-NH-N=CH-Ar' (Ar = aryl). We are conducting a solid-state study to determine whether these isomers can assume identical molecular packing arrangements. A potential differentiating factor is the difference in H-bond donor strength between the bridge N-H and C-H groups; reversing the bridge orientation would disrupt the packing if an H-bond acceptor on a neighboring molecule interacted more strongly with the N-H group. We have determined and describe here the crystal structure of a cyano-substituted phenylhydrazone in which the H-bond acceptor interacts nearly equally with the N-H and C-H groups.

59. **Peter Rosenberg**, E.S. Bowman, J. Kapusta
The Linear Sigma Model with Bosonic Chemical Potential
Summer Advisor: J. Kapusta
Department/Program Sponsor: Physics and Astronomy
Home Institution: SUNY Geneseo
Abstract:
We study the O(4) Linear Sigma Model with the addition of a bosonic chemical potential. This model is an effective field theory for low energy QCD and the addition of a chemical potential allows us to study pion condensation, which is useful to heavy ion collisions and to the physics of neutron stars. The model is first studied at zero temperature. We calculate the mean fields, masses and dispersion relations. The calculations are extended to finite temperature to study the model's phase diagram at finite temperature and chemical potential

60. **Rebecca Ruckdashel**, Matthew Parker
Exploring Population Oscillations through the Lotka-Volterra Model
Summer Advisor: Alex Kamenev
Department/Program Sponsor: Physics REU
Home Institution: Cornell University
Abstract:
Mathematical modeling of population and determining bounds on population survival times are important for predicting the dynamics of populations. Such modeling must include stochastic aspects to capture the random nature of demographic events. Predator-prey communities are especially interesting, since they are known to exhibit oscillatory dynamics. We analyze the oscillations of predator-prey systems described by the Lotka-Volterra equations. A single patch of predators and prey tends toward extinction linearly with the population size. However, when the predators are allowed to migrate between two patches the time to extinction grows exponentially with sample size. We use an idealized model of two patch predator-prey interactions to understand groups in nature.

61. **Paul Sanstead**, Kyle Schwartz
OLED Class Ir(III) Cyclometalates: In Depth Investigation of Ligand Substitution and Resulting Geometric Isomerism
Summer Advisor: Kent R. Mann
Department/Program Sponsor: Lando/NSF
Home Institution: Iona College
Abstract:
Interest in cyclometalated Ir(III) complexes has soared over the past decade, due to their suitability as phosphorescent dopants in OLED applications. Reactivity and ligand substitution pathways of these complexes have been given little attention despite the known isolation of byproducts. Selective control of ligand substitution could lead to a functionally diverse set of molecules. Previous work in our lab found a mixture of N,N-trans-Ir(ppy)2(dbm), N,C-trans-Ir(ppy)2(dbm), and Ir(ppy)(dbm)2 (ppy = 2-phenylpyridine, dbm = dibenzoylmethane) formed upon reaction of Hppy with IrCl3•3H2O followed by two equivalents of Hdbm. Inhibition of side product formation was achieved through slow ligand addition and an external Cl- source, yielding Ir(ppy)(dbm)2 as the major product. Subsequent reaction of Ir(ppy)(dbm)2 with additional Hppy to obtain N,N-trans or N,C-trans products is currently underway.

62. **Jon Michael Santos**
Pedicab with a Fluid Power Regenerative Braking
Summer Advisor: William Durfee
Department/Program Sponsor: Center for Compact and Efficient Fluid Powers
Home Institution: University of Arizona
Abstract:
Cycle rickshaw (pedicab) is a human-powered, type of tricycle designed to carry passengers in addition to the driver. The purpose of this particular pedicab is to use its regenerative braking system that takes energy that is being either being created or lost by the driver. To assist in situations where it takes a sufficient amount of energy to move in situations where it can possibly strain the driver. The objective of this project was to modify a computer simulated model, so that it will be able to produce results that are similar to possible experimental data that would be collected during experiments. With the simulation developed its purpose was to allow the user to enter in specific values such as the total weight of the pedicab or the amount of energy charged in the accumulator to predict what would possible occur in a real life situation.

63. **Erica Schuff**
3D Testing of a Steel Braced Frame
Summer Advisor: Carol Shield
Department/Program Sponsor: NEES MAST Lab- Civil Engineering
Home Institution: University of Nevada, Reno
Abstract:
There has been little experimental research done on full-scale concentrically braced frames even though it is well known that large displacements in the bracing can cause pre-mature failure in the brace member and the gusset plate connections. The University of Minnesota MAST Lab recently tested a one-bay by one-bay, two-story steel frame as part of a research collaboration with several universities. This was the first three-dimensional test of a steel frame with concentric bracing. Results from the test will be used to look at the performance of the gusset plate connection between the bracing members and the frame. There will also be a comparison of the test results and the current specifications for special concentrically braced frames (SCBFs).

64. **Kwame Sefah**
Spin Resonance: A Pump-probe experiment
Summer Advisor: Paul Crowell
Department/Program Sponsor: MRSEC
Home Institution: Anoka Ramsey Community College
Abstract:
Spin is the magnetic moment of a particle. For example, an elementary particle such as the electron possesses spin angular momentum although it is a point particle. Spin resonance provides a means of probing a very small population of spins that can be introduced into a medium by either a charge current (spin injection) or optical pumping. The idea of my experiment is to measure a very small number of spins which are generated by optical pumping. Optical pumping uses a beam of circularly polarized light to "pump" one spin state in a dilute gas of Rb vapor. The unique aspect of my experiment is that a second tunable light source (a "probe" beam) is used to detect the spins by Faraday rotation, which is the rotation of the plane of polarization of light. The Faraday rotation is measured using a very sensitive, high frequency technique that is suitable for observing spin resonance. We have developed this technique and have used it to measure the resonances of the Zeem!
an-split 5S states of 85Rb and 87Rb. In the future, this technique will be adapted for the measurement of spin resonance in a ferromagnet-semiconductor device.

65. **Nicholas A. Serratore**
Synthesis of Novel Luminol Derivatives
Summer Advisor: J. Thomas Ippoliti
Department/Program Sponsor: Chemistry
Home Institution: University of St. Thomas
Abstract:
The goal of this research was to synthesize and characterize new luminol derivatives. The purpose of making these luminol derivatives was to replace the NH2 group of luminol with different sized nitrogen containing rings and characterize the effects on the chemiluminescence of the molecule. The process developed for the synthesis of these five new derivatives is very versatile and can be applied to multiple ring structures containing amines. A microwave reactor is used as a primary means of synthesizing these molecules. Five novel luminol derivatives were synthesized including a polymerizable derivative and a water soluble derivative. The chemiluminescence of the derivatives were measured and compared to luminol.

66. **Matthew Shea**, Ankur Khare
Synthesis and Characterization of Cu2ZnSnS4 Thin Films
Summer Advisor: Eray Aydil
Department/Program Sponsor: MRSEC
Home Institution: University of Nebraska - Lincoln
Abstract:
Cu2ZnSnS4 (CZTS) is an environmentally friendly and inexpensive material proven to be a feasible replacement for current CdTe- and Si-based solar cells. Its constituent elements are among the most common in the earth's crust, and its 1.45eV band gap is ideal for capturing solar radiation. CZTS was formed in situ by annealing a solution of copper, tin, and zinc complexes. Specifically, stoichiometric amounts of the desired complexes were dissolved in chloroform, and the solution was drop-coated on a metal-coated glass substrate. The resulting film was heated and annealed at 600°C. Confirmation of the kesterite structure associated with CZTS was proven by identification of the unique Raman scattering peak associated with CZTS between 334 and 338 cm-1.

67. **Colin Smith**, Andrew Rice
Energy Storage In Open Air Accumulators
Summer Advisor: Perry Li, Terry Simon
Department/Program Sponsor: Center for Compact and Efficient Fluid Power
Home Institution: University of Minnesota
Abstract:
In actuators and accumulators it is often that compressed gas is held against a liquid interface at high pressures. Under these conditions an amount of the compressed gas may dissolve into the liquid layer. This is problematic because any gas that dissolves in the liquid will later not be readily available for expansion and essentially becomes lost energy. This summer we looked into modeling the flow of air into water under various conditions that simulated what might appear in common energy storage applications. We sought to discover the profile of the flux to determine to what extent dissolution was a problem. To do so numerical and analytical models were examined, and an apparatus was designed and constructed such that we could determine the flux experimentally.

68. **Kane Smith**
FES Hybrid Energy Storing Orthosis
Summer Advisor: William Durfee
Department/Program Sponsor: Center for Compact and Efficient Fluid Power
Home Institution: University of Minnesota
Abstract:
Paraplegia is a condition where a patient loses motor and sensory function of the lower extremities due to spinal trauma, typically between the thoracic vertebrae. There is no current cure for this disease so instead the patient must subject themselves to permanent lifestyle changes. In some cases rehabilitation with long braces may allow the patient to regain some mobility outside of a wheelchair but this walking is done between two parallel bars and is extremely unnatural. The concept we are exploring combines Functional Electrical Stimulation (FES) with an orthosis to restore gait for paraplegic persons. Stimulation of the quadriceps coupled with a pneumatic system storing compressed air drives the walking cycle. Range of motion is controlled by the orthosis along with brakes at both the knee and hip to prevent collapsing.

69. **Joseph Sobek**
Surface Waves in the Current Sheet of Earth's Geomagnetic Tail
Summer Advisor: John Wygant
Department/Program Sponsor: Physics REU
Home Institution: Winona State University
Abstract:
On October 1st, 2001 the European Space Agency's Cluster spacecraft encountered a reconnection event at 22.4 MLT near 18 Earth radii in the geomagnetic tail. This event is significant because the current sheet exhibited flapping motion and passed over the tetrahedral Cluster arrangement many times, providing multiple observations of the electric fields, magnetic fields, and particle behavior near the decoupling region. While the large scale motion that allowed this has been documented, we searched for small magnetohydrodynamic waves propagating along the surface of the current sheet. These waves could help identify possible mechanisms for the breaking of flux freezing in plasmas, a necessary step during the reconnection of magnetic field lines.

70. **Joshua Sobrin**
Payload Recovery of the EBEX Experiment
Summer Advisor: Shaul Hanany
Department/Program Sponsor: Physics REU
Home Institution: Fordham University
Abstract:
EBEX is a NASA-funded balloon-borne experiment designed to measure the polarization of the cosmic microwave background (CMB). An engineering flight was launched in June, 2009, from Ft. Sumner, NM, and the long duration science flight in Antarctica is scheduled for December, 2011. Upon completion of its flight, the balloon and attached payload will descend and land at an undetermined location on the ice. This report outlines the initial work completed this summer to compile a payload recovery procedure for the scheduled 2011 flight. The report includes relevant specifications for the BT-67 plane (which will be used for the recovery), an initial payload disassembly procedure, and visualizations showing the fittings of the payload pieces through the plane's door and fuselage.

71. **Haidy E. Soto**, SooHyung Choi
Poly(styrene-b-ethylene-alt-propylene) Diblock Copolymer Phase Diagrams
Summer Advisor: Tim Lodge
Department/Program Sponsor: MRSEC
Home Institution: University of Texas-Pan American
Abstract:
Micelles were observed when dissolving the diblock copolymer Poly(styrene-b-ethylene-alt-propylene), SEP, in Squalane. These micelles self-arrange into a Body Centered Cubic (BCC) lattice given proper temperature conditions. This arrangement is an ordered state: material behaves in an elastic manner. When increasing solution temperature, the micelles disassemble into a disordered formation exhibiting viscous behavior. The temperature at which micelles form and move freely within the solvent is the critical micelle temperature (CMT). The temperature at which micelles form and arrange themselves into a BCC formation is the order-disorder transition temperature (ODTT). Dynamic light scattering and rheology testing were used to determine the CMT and ODTT respectively for SEP with molecular weights of (17-73) and (26-66). Using data collected from different polymer-to-solvent concentrations, a phase diagram was created.

72. **Ivan Spector**
A Very Acidic Hydrocarbon
Summer Advisor: Steven Kass
Department/Program Sponsor: Lando Program
Home Institution: Saint Cloud State University
Abstract:
Buckminster fullerenes, and fullerenes in general are becoming increasingly interesting. Fullerenes have existed as long as campfires, and presently have a wide variety of potential uses from materials science to drug delivery. The Buckminster fullerene is a potential hydrogen vehicle. C60's hydrogenated analog is very acidic. It's heat of hydrogenation is unknown. It is the goal of this research to measure the heat of hydrogenation of C60H2. This will be done utilizing a thermodynamic cycle. Measurements will be carried out on a Fourier transform mass spectrometer.

73. **Rachel Stegeman**
Synthesis of a Novel Topologically Designed Antibiotic
Summer Advisor: J. Thomas Ippoliti
Department/Program Sponsor: UST Chemistry
Home Institution: University of St. Thomas
Abstract:
The increasing number of drug-resistant bacteria is a rising health concern. It is necessary to generate new antibiotics that are different enough to work effectively and similar enough to safeguard against long-term adverse effects. The goal of this research is to synthesize a novel antibiotic that is calculated by Molecular Topography to have an 85% chance of being effective. The novel antibiotic will be made through a convergent synthetic route. The product of each step will be purified and characterized, using 1H NMR and the final compound will be purified and characterized using 1H NMR, HPLC-MS and 13C NMR to confirm the novel antibiotic. After successfully synthesizing and confirming the novel antibiotic it will be tested for its effectiveness.

74. **Cathryn Stevenson**, Gernerique Stewart, Jia Ou
DNA Tethering to an Ultra-hydrophobic Surface
Summer Advisor: Kevin Dorfman, Gernerique Stewart
Department/Program Sponsor: MRSEC
Home Institution: Grambling State University
Abstract:
Ultra-hydrophobic surfaces, similar to the lotus leaf, contain hydrophobic micron-size features which form a shear-fee gas-liquid interface between the features when in contact with a liquid. The slip velocity has been measured at the shear-free interface and proved as the mechanism of the ultra-hydrophobic surface's mixing enhancement effect. Complex small scale helical flows were predicted by numerical model, but traditional micro-PIV measurement could not visualize such flow structures. A cross-layered, ultra-hydrophobic polydimethylsiloxane chip was fabricated in effort to mimic the hydrophobic morphology of the nanoscaled roughness of the lotus leaf. DNA was tethered to the interior surface of the ultra-hydrophobic micro-channel and the predicted small helical flow near the surface was observed via the extension of the DNA

75. **Phillip Stewart**
3-D Modeling of Krypton Data in Real Time
Summer Advisor: Mitch Reierson, Drew Daugherty
Department/Program Sponsor: NEES@UMN
Home Institution: Temple University
Abstract:
By incorporating the visualization of 3-D data in the Real-Time Data Viewer (RDV), researchers are presented with a whole new world of visual data to explore. At the MAST Research Lab at the University of Minnesota, streaming live three-dimensional data from a Metris K600 Optical Coordinate Measuring Machine into a graphical representation has become a reality. Coordinates read in from LEDs placed along a structure are fed into the Ring Buffered Network Bus (RBNB) server and then broadcast to live feeds accessible around the world. With this new 3-D visualization tool, researchers can now view changes that otherwise could not be viewed.

76.	**Michael Stillwagon** ***The Effects of Magnetic Interactions and Varying Concentrations on Remanent Magnetization and Magnetic Fabrics*** Summer Advisor: Bruce Moskowitz Department/Program Sponsor: NSF, Institute for Rock Magnetism Home Institution: Western Carolina University **Abstract:** The anhysteretic remanent magnetism (ARM)/saturation isothermal remanent magnetism (SIRM) ratio is commonly used as an indicator of magnetic grain size in environmental magnetism research. The concentration, magnetic interactions and grain size of magnetic particles affect this ARM/SIRM ratio. The understanding of these three variables will also aid in paleointensity interpretations and rock petrofabric analysis. Magnetic interactions may in some cases produce magnetic fabrics in a rock that is not related in a simple or direct way to the rock fabric or to the preferred orientations of magnetic particles. These two problems are researched here with an experimental study on how the concentration of magnetic grains in various synthetic magnetite and hematite dispersions affect the ARM/SIRM, ARM/IRM ratios and the magnetic fabrics through magnetic interactions between particles.
77.	**Becky Strauss**, Joshua Feinberg, Maxwell Brown, Julie Bowles ***Linking Rock Magnetic Properties To The Outcome Of Paleointensity Experiments From The 1995 Lava Flow, Fogo, Cape Verde*** Summer Advisor: Joshua Feinberg Department/Program Sponsor: NSF REU: Geology & Geophysics Home Institution: Oberlin College **Abstract:** As volcanic rocks cool, they record the Earth's magnetic field, preserving information about convection in the core and conditions at the core-mantle boundary. While the direction of the ancient magnetic field may be readily determined, calculation of its intensity is more complex and requires the use of new methods that are still being calibrated. We test the validity of a variety of paleointensity methods using samples from a 1995 lava flow on the island of Fogo, Cape Verde and compare our results to the known intensity of the Earth's magnetic field at the time of the flow. This enables us to identify which paleointensity techniques most effectively produce accurate estimates of the strength of the Earth's magnetic field.
78.	**Elliott Surber** ***Electrophoresis Using Nanoporous Structures Contained Within Microfluidic Channels*** Summer Advisor: Kevin Dorfman Department/Program Sponsor: MRSEC Home Institution: University of Minnesota **Abstract:** An incredibly compelling topic of Bio and Biochemical Engineering as of late is the construction and usage of microfluidic biochips. The various systems that employ microfluidic technology serve to enhance the precision and efficiency of chemical and biochemical assessment, cell growth cultures, electrophoresis, as well as various analytical processes. Needless to say, accurate and proven theoretical models are essential to catalyze the further progression of this field. As such, these models are greatly desired and highly sought after. The project we have chosen to embark upon entails the use of soft lithographic techniques to create a shifted-T microfluidic channel. Evaporation assisted self-assembly is used to grow periodic, 900nm silica colloid crystals. From this crystal, a well-ordered inverse-opal nanoporous structure can be created through thorough saturation of photoresist and subsequent strategic photo-masking. The resultant nanoporous structure can then be used to cleave DNA through electrophoretic experimentation. We postulate that the architecture of the structure is such that the kinetics the forward as well as—upon the inversion of charge—reverse mobility of the DNA can be delineated and offered as support of the currently proposed functional models.

79. **David Swenson**
Exploring the Upper Mantle with ScS Reverberations
Summer Advisor: Justin Revenaugh
Department/Program Sponsor:
Home Institution: Bethel University
Abstract:
We investigated the nature of mantle layering by utilizing the multiple ScS phases and other higher order reverberations. These shear waves were isolated by studying SH-polarized seismograms. We focused our research on the Pacific region with paths leading out to the Hawaiian island seismometers and California. We examined multiple ScS reverberations from over thirty-five years worth of earthquakes. Our ultimate goal was to confirm or correct previous results using the ScS reverberation method developed by Dr. Revenaugh.

80. **Claire Teresi**
Transmission Electron Microscopy Simulations of MoS2 Nanotubes
Summer Advisor: Dr. K. Andre Mkhoyan
Department/Program Sponsor: MRSEC
Home Institution: Clemson University
Abstract:
Molybdenum disulfide (MoS2) nanotubes (NT) are currently being studied for their potential uses in electronic and optoelectronic applications. Two chiral MoS2 NTs with different helical angles were examined using transmission electron microscopy (TEM). TEM uses a beam of electrons to create images with much higher magnification than what is possible with an optical microscope. This magnification allows the viewer to see atomic level projections of solid samples. Using a program to theoretically simulate TEM, the NTs have been examined with diffraction patterns, conventional TEM, and scanning TEM images to see if the two forms can be distinguished. The imaging conditions have been optimized for future experimental TEM studies of MoS2 NTs.

81. **Eric Torres**, David Ellison
Correlation of Structure and Electrical Behavior in Organic Electronic Devices
Summer Advisor: C. Daniel Frisbie
Department/Program Sponsor: MRSEC
Home Institution: University of Texas Pan-American
Abstract:
The morphology of thin film organic semiconductor layers at various insulating and conducting interfaces determines the extent of inter- and intramolecular overlap. This determines the electrical properties of operating organic thin film devices, such as organic field effect transistors (OFET). Structural information with Atomic Force Microscopy (AFM) and electrostatic information from Kelvin Force Microscopy (KFM) can be used as complementary techniques to probe the structural and electrostatic complexity of the organic layers. AFM is a form of high resolution scanning probe microscopy (SPM), wherein a nanometer-scale probe is sensitive to forces at the sample surface whether from height or electrostatic variation. KFM is a non-contact surface sensitive technique that maps out the surface potential variation within organic thin films. The surface potential distribution of these films, which is directly related to the packing structure and electronic states of the organic molecules, greatly affects the charge transport. Providing clear structure / property relationships for organic semiconductors by AFM and KFM we can essentially explain the nature of charge transport mechanisms and their inherent electrostatic bottlenecks within the active layers.

82. **Maria Tribelhorn**
Assessment of Punching Shear Vulnerability
Summer Advisor: Carol Shield
Department/Program Sponsor: NEES/Civil Engineering
Home Institution: University of Idaho
Abstract:
Reinforced concrete slab-column connections are susceptible to punching shear failure and for the past decade engineers have used shear stud reinforcement (SSR) to mitigate this failure. However, based on a recent test at the University of Minnesota NEES-MAST (Network for Earthquake Engineering Simulation - Multi-Axial Subassemblage Testing) Laboratory, SSR may not be as effective as previously believed. A reinforced concrete slab-column connection will be tested to further investigate SSR behavior under a combination of gravity loading and biaxial lateral loading. To accurately estimate the gravity load applied to the specimen, the prestressing strand was loaded in tension and the load-strain relationship in the strand was approximated based on strain gauge and extensometer readings.

83.	**Chelsea Vandegrift**, Alayne Schroll ***Synthesis and Crystallographic Structure of Bis[isopropoxy(thiocarbonyl)]sulfide*** Summer Advisor: George Barany Department/Program Sponsor: Lando Home Institution: University of Dallas **Abstract:** Bis[isopropoxy(thiocarbonyl)]sulfide, iPrO(C=S)S(C=S)OiPr, is useful in a variety of applications ranging from peptide chemistry to rubber manufacture. A number of synthesis methods have been described in the literature, but many are undesirable due to the use of toxic reagents. We have studied a convenient method using two equivalents of an isopropyl xanthate salt with one equivalent of ethyl chloroformate. This procedure was optimized by varying the concentration of the reaction solution, as well as the ratio of water to isopropanol in the solvent. Depending on conditions, the reaction can be made to stop at the intermediate iPrO(C=S)S(C=O)OEt. Purities were determined by UV spectrophotometry. Bis[isopropoxy(thiocarbonyl)]sulfide was easily crystallized and an x-ray crystallographic structure was obtained. This revealed a crystallographic two-fold axis of symmetry, as well as the conformation of the compound and its packing.
84.	**Pashound Vue**, Aaron Massari ***Using Polyaniline to Grab Metal Ions*** Summer Advisor: Aaron Massari Department/Program Sponsor: ACS Seed Program Home Institution: University of Minnesota **Abstract:** Aniline in 1 M HCl solution was grown onto Indium Tin Oxide (ITO) through Electrochemistry. Growing aniline through electrochemistry allowed the aniline to make it longer, creating repeated chains of its structure. ITO was used as an electrode because of it's conductive property which is important because conductive polymers has the potential to replace conventional wires in circuits. The purpose of this project was to prepare a polymer whose properties could be altered by grabbing onto metals. Therefore, 2-pyridin-4-yl-phenalymine was polymerized into aniline and 1M HCl solution in order to give the polyaniline the ability to bind onto metal ions from solution and incorporate them into the film.
85.	**Sarah Wegwerth**, Elizabeht Lugert, Louis Pitet ***Modification of Fluorous Oligoethers for use in Ion-Selective Electrodes*** Summer Advisor: Philippe Buhlmann, Marc Hillmyer Department/Program Sponsor: Chemistry LANDO/NSF Home Institution: Saint Cloud State University **Abstract:** Ion-selective electrodes (ISEs) are used daily in clinical chemistry, the food industry, and for environmental monitoring. Overtime the membranes of these electrodes experience biofouling and leach into the sample, which reduces the selectivity, range, and lifetime of the electrode. Fluorous compounds are ideal membrane materials because they have unique properties such as low polarity and chemical inertness, which may help reduce the extraction and solvation of undesired compounds into the membrane. Recently, the Buhlmann group has demonstrated that fluorous matrices increase the selectivity and measuring range of ISEs. Currently work is being done to develop a more mechanically stable membrane matrix through use of a chemically cross-linked fluorous oligoether. It is expected that this membrane will reduce leaching and have a longer lifetime.

86. **Natalie Weisse**

Expression and Manipulation of AquaporinZ Using a Cell Free System

Summer Advisor: Vincent Noireaux
Department/Program Sponsor: Physics REU
Home Institution: University of Dallas

Abstract:
Trans-membrane proteins represent a large amount of the proteins expressed by cells. However, their expression and manipulation in vitro remains a challenge. Numerous approaches have been developed, cell free expression being one of the most promising. Cell free expression is based on a transcription-translation system that has been extracted from E. Coli bacteria. Adding the desired DNA allows expression in large proportion of a selected protein; and in the presence of phospholipids the expression of trans-membrane proteins becomes possible. In order to verify that the expressed proteins are functional using this system, we have selected a trans-membrane protein, AquaporinZ, which represents a large interest for its potential benefits including a more efficient and cost effective water purification system as well as numerous medical applications. Have successfully expressed an AquaporinZ mutant, tagged with a synthetic Green Fluorescent Protein (eGFP), these proteocells will serve as an experimental platform for testing the viability of the expressed AqpZ-eGFP. If the cells can be fused to the surface of the slide using the well known streptavidin-biotin bond without bursting, the environment surrounding the synthetic cells can be changed to test the endurance of the synthetic cells and the function of the AquaporinZ proteins.

87. **Steve Zambrano**, Aijie Han

Synthesis and Characterization of Three-Dimensionally Ordered Macroporous (3DOM) Materials

Summer Advisor: Andreas Stein, Aijie Han
Department/Program Sponsor: MRSEC
Home Institution: University of Texas-Pan American

Abstract:
In the past decade, the synthesis of nanoporous materials with controlled porosity on various length scales has emerged as an important field in materials science. Among different types of materials with controlled pore architectures, mesoporous solids, prepared by surfactant templating, and three-dimensionally ordered macroporous (3DOM) materials or inverse opals, prepared by colloidal crystal templating, have been widely investigated because of their potential applications in absorption, separation, catalysis, photonic crystals, power sources, sensors, porous electrodes, and energy storage. Our goal is to synthesize 3DOM materials, such as carbon and silica, with hierarchical pore structures and to characterize their distinctive structural features, which include both the internal architecture of 3DOM materials and their external morphology. These 3DOM materials possess both meso- and macropores. Mesopores, ca. 3 nm in diameter are obtained by adding block-copolymer chains (e.g. F127, a nonionic surfactant) to the precursor mixtures. Macropores, ca. 300 nm in diameter are produced by infiltrating a periodic array of uniform polymer spheres (e.g. poly(methyl methacrylate)) with a precursor. With the increased development of synthesis techniques for engineering of 3DOM materials, their pore sizes, surface areas, pore volumes, and skeletal geometries will be easily tailored by controlling the synthesis conditions. The basic synthetic methodology employs infiltration, polymerization, vacuum drying, centrifugation, and carbonization. Analyses of 3DOM materials will include XRD, thermal analysis, porosity analysis, SEM and TEM.

88. **Yue Zhou**, Eric D. Smolensky

Dual Functional Fluoromagnetic Imaging Agents: Lanthanide-based Iron Oxide Nanoparticle Sensors

Summer Advisor: Valerie C. Pierre
Department/Program Sponsor: Heisig/Gleysteen Chemistry Summer Program
Home Institution: University of Minnesota

Abstract:
The development of dual functional fluoromagnetic imaging agents is becoming increasingly more prevalent due to their ability to effectively image biological processes in two different modes. Magnetic imaging is intrinsically hindered by low sensitivity (usually in the mM range), and one way to overcome this limitation is to incorporate a fluorescent component with a much higher sensitivity (usually in the pM range). However, the design of effective fluorescent sensors is classically limited by interference from background fluorescence. Advantageously, the luminescence lifetimes of lanthanide complexes are much longer than that of biological media, and therefore, allow for a delay in signal detection. As such, a dual functional sensor was developed in which a lanthanide metal was complexed and tethered to iron oxide nanoparticles. In this fashion, the incorporation of a time-gated fluorescent component allowed for higher sensitivity, while the iron oxide nanoparticles provided a magnetically responsive element.

Poster Presentations for RET Participants
Listed Alphabetically by Presenting Author

89. **David Brown**
Alternative Solar Cells - for High School Students
Summer Advisor: Eray Aydil
Department/Program Sponsor: MRSEC
Home Institution: Bridges ALC
Abstract:
High School students have a limited understanding of the concepts and process involving energy conversions using solar cells. Additionally, there is a rudimentary understanding of the limitations regarding the science behind the current technology. My work helps to address these issues for better success an understanding of high school students.

90. **Michelle Dwyer**
Comparing Cell Uptake with Fluorescent Polymers
Summer Advisor: Chun Wang
Department/Program Sponsor: MRSEC
Home Institution: Chicago
Abstract:
Different cell types take up foreign particles with different ability and frequency. In the Biomedical Engineering labs at the University of Minnesota, research is currently underway to compare the uptake of polymers for delivery of DNA vaccines in different cell types. In this lab, students will analyze cell transport in two types of cells lines: Immune cells (Dendritic) and Human Tumor cells (Glimoal). Students will visualize the uptake with fluorosphere polymers of different sizes. The fluorospheres will then be analyzed and photographed using a fluorescent microscope.

91. **Joshua Ellis**, Z. Chen, E.D. Dahlberg
Quantitative Measurement of Diamagnetism and Paramagnetism of H2O, NaCl, and CuSO4
Summer Advisor: E.D. Dahlberg
Department/Program Sponsor: MRSEC
Home Institution: University of Minnesota
Abstract:
We sought to develop a quantitative demonstration of the diamagnetic property of H2O that could be easily conducted in a high school classroom with a minimum of available materials and mathematical knowledge. Additionally, we investigated the effects of a magnetic field on H2O solutions containing NaCl and CuSO4. By mapping the deflection of an incident laser, we were able to determine both the size and shape of the deformation on the surface of the solution. Our findings strongly suggest that the change in gravitational energy density for each solution is due entirely to the effect of the magnetic field.

92. **Ahmad Harb**
Quantom Dots
Summer Advisor: Uwe Kortshagen
Department/Program Sponsor: MRSEC
Home Institution: Veterans Memorial HS , UTPA
Abstract:
Introducing Nano crystal technology and its application to high school students through studying the effect of light emission that quantum dots produce based on their different nano scale size.

93.	**Claire Hypolite** ***Engineering for the New Standards*** Summer Advisor: Kevin Dorfman Department/Program Sponsor: MRSEC Home Institution: Edison High School **Abstract:** Like other states, Minnesota is incorporating engineering into the state science standards. This is a big step forward for STEM. Unfortunately, many K-12 educators feel ill-equipped to teach these standards because they have never had experience in any of the engineering disciplines, and, until recently, engineering has not been part of teacher prepartation. Also, much of the emphasis in engineering in the K-12 setting has focused on robotics (suitable for high school physics courses). The author has developed lessons that can be used by teachers to address the engineering standards through both chemistry and life science courses offered in high schools, allowing for more flexibilty in meeting the engineering standards.
94.	**Melissa Murray** ***Cool Roof Coatings in the Classroom*** Summer Advisor: Lorraine F. Francis Department/Program Sponsor: MRSEC Home Institution: University of Minnesota, Twin Cities **Abstract:** I've designed an adaptable curriculum unit that uses cutting-edge research in cool roof coatings to meet new engineering-oriented Minnesota Academic Standards in Science. In this unit, students learn about materials scientists and environmental engineers, research background information and motivations for cool roof coatings, design and test their own coating formulation using engineering principles, and participate in a poster session to share and discuss their results.