UNIVERSITY OF MINNESOTA

Materials Research Science and Engineering Center

Summer Undergraduate Research Expo

August 6, 2009
McNamara Alumni Center
Memorial Hall
4:30-7:00 pm

Poster Presentations in Chemistry

Listed by presenting author

1. **Logan Bodnia**
Analysis of Algal Toxins in Minnesota Waters Using LC-MS-MS
Summer Advisor: Tony Borgerding
Department/Program Sponsor: Young Scholars, Chemistry Department
Home Institution: University of St. Thomas
Abstract:
Liquid chromatography coupled with tandem mass spectrometry is a very powerful instrumental method. This method can be applied to detecting toxins from cyanobacteria, specifically microcystin-LR and anatoxin-a, found in various aquatic environments throughout the world. These toxins can cause disastrous effects to the environment as well as to humans. It is hard to detect these compounds sensitively and selectively using other common instrumental techniques. LC-MS-MS allows for selective detection based on the mass of the ions from the toxins. There have been several studies of these compounds in parts of the US, but there have been no studies of microcystin-LR and anatoxin-a in the state of Minnesota.

2. **Megan Brown**
Improving the Sensitivity of Measurements Made Using Microdialysis and Gas Chromatography
Summer Advisor: Dr. Tony Borgerding
Department/Program Sponsor: NSF-STEP, Chemistry Department
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 carbon nanotube-coated 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 the carbon nanotube-coated trap in one second. Using this technique of rapid desorbtion coupled with microdialysis we have obtained distinct reproducible peaks for various concentrations of toluene, ethanol, and isobutyraldehyde.

3. **Gregory Crane**
Real-Time qPCR Analysis of mRNA Concentrations in Alzheimer's Infected Mice Brain Cells
Summer Advisor: Katherine Olson
Department/Program Sponsor: Chemistry Department
Home Institution: University of St. Thomas
Abstract:
One way to distinguish between different neurodegenerative diseases (diseases which involve the degeneration of the nervous system) is by identifying proteins that are up or down regulated in a predictable manner among all cells afflicted with the same disease, thus creating a unique, disease-specific "protein profile." For this study, an attempt was made to form one such profile for Alzheimer's disease. Samples of mRNA were extracted from brain cells of both healthy mice and mice exhibiting Alzheimer's symptoms. Reverse transcription converted this into cDNA, and real-time qPCR was used to quantitate the cellular concentrations of specific mRNA molecules. Results showed that concentrations of mRNA encoding for Hspa4, Hspa8, Cd68, Hexb, Gh, H2-T23, Rtp4, and Usp18 are not altered in Alzheimer's infected brain cells.

4. **Michael Capp**, Michael Wentzel
Rhodium Catalyzed C-C Sigma-Bond Activation: Intramolecular Carboacylation of Alkynes
Summer Advisor: Chris Douglas
Department/Program Sponsor: Lando, Chemistry Department
Home Institution: Montana State University
Abstract:
Carbon-carbon sigma-bond activation is a little-explored area of chemistry that has the potential to be a powerful addition to the synthetic chemist's toolbox. It has recently been shown that direct addition of a C-CO bond across alkenes (carboacylation) can be achieved by activating C-C sigma bonds, facilitated by the formation of a 5-membered metallacycle. Here, it is shown that the intramolecular carboacylation of alkynes is also possible. Current work is focused on optimizing the process by using different catalysts, solvents, and temperatures while exploring the scope of the process with different substrates.

5. **Nathan Connell**, Aaron E. May, Heidi A. Dahlmann, Thomas R. Hoye

Magnesium Chloride Catalyzed Anti-Aldol Reaction: Extension to Enolizable Aldehydes and Investigation into Useful Reaction Byproducts

Summer Advisor: Thomas R. Hoye
Department/Program Sponsor: Lando
Home Institution: St. Norbert College

Abstract:

Over the past few decades the aldol coupling reaction has emerged as one of the most useful carbon-carbon bond forming processes. Many syn selective procedures are known; however, the methods that have been developed to obtain anti adducts are plagued by serious drawbacks. The most convenient anti selective method, developed by Evans et. al., is based on a readily available oxazolidinone chiral auxiliary and catalytic magnesium chloride. However, this method is incompatible with enolizable aldehydes, drastically limiting its synthetic utility. We have successfully extended this methodology to enolizable aldehydes and report the preparation of anti-aldol adducts in high yields and diastereoselectivities. This method should see broad use across the fields of medicinal chemistry and organic synthesis, particularly in the context of polyketides.

6. **Caitlin Dado**, Maivboon Vang

Development of a Method for Microscopic Titration

Summer Advisor: Gary Mabbott
Department/Program Sponsor: Chemistry Department
Home Institution: University of St. Thomas

Abstract:

One underdeveloped research area involves the uptake of drugs at the single cell level. Microscopic quantitative analysis methods are needed to analyze volumes on the sub-nanoliter scale. The goal of this project is to develop a microscopic titration technique using fluorescence to measure titration progress that can be applied to individual biological cells. Our first microscopic demonstration system uses a solution of EDTA as the titrant and a solution of calcein, calcium, and KOH buffer as the target sample. Future demonstration systems will use fluorescently tagged antibodies as the titrant and protein covered beads and yeast cells as the target samples. The study of the uptake of the anti-cancer chemotherapy drug doxorubicin into multidrug resistant cancer cells will be of interest in the future.

7. **Wendu Ding**, Donald G Truhlar, Aleksandr Marenich

Methodological Considerations for the Prediction of Dicarboxylic Acid Dissociation Constants

Summer Advisor: Christopher J Cramer
Department/Program Sponsor: Lando/NSF
Home Institution: Butler University

Abstract:

First and second dissociation constants (pKa values) were computed for oxalic acid, malonic acid, succinic acid, and glutaric acid, using a variety of theoretical protocols based on density functional theory. The predicted values were found to be quite sensitive to the influence of functional, basis set, continuum model, microsolvation, and molecular conformer population. No combination of protocols ensured quantitative accuracy in every instance, but improved values were associated with the use of augmented basis sets for the computation of the gas-phase deprotonation free energy and the inclusion of one or more first-shell explicit solvent molecules in the computation of anionic solvation free energies.

8. **Adam Dittmer**, Wayland E. Noland

Synthesis of Sulfur-Containing Heterocycles as Potential Biologically Active Molecules

Summer Advisor: Dr. Wayland E. Noland
Department/Program Sponsor: Lando/NSF
Home Institution: Augustana College

Abstract:

Thiophenes are inexpensive and important compounds being used as building blocks in many pharmaceutical syntheses. A synthetic methodology was developed for creating thiophene analogs of confirmed biologically active pyrrole heterocycles. The sulfur-containing compounds were prepared by utilizing nucleophilic addition to both straight chain and aromatic ketones using a thiophene ring. Dehydration of the resulting alcohols to form dienes was followed by Diels-Alder chemistry to produce the desired tricyclic compounds. Future biological testing will be performed to determine the viability of these heterocycles as potential pharmaceutical intermediates.

9.	**Anya Dmytrenko**, Brynna Jones, Audrey Eigner ***Investigation of Doped Polymer Films' Structure and Dynamics using Multidimensional Infrared Spectropy*** Summer Advisor: Aaron Massari Department/Program Sponsor: Heisig/Gleynsteen Home Institution: University of Minnesota **Abstract:** Poly-3-hexylthiophene (P3HT) polymer films were doped with various concentrations of iodine in both its aqueous and gaseous phases. Doping these films altered the electrical and optical properties of the polymer as was observed using 4-point probe conductivity measurements and infrared spectroscopy. Because molecular structure affects charge distribution and conduction, changes in molecular structure and the structural dynamics were investigated using two-dimensional infrared (2D-IR) spectroscopy to see how the introduction of the dopant into the polymer could affect these properties. The ultimate goal of this project was to better understand how conduction of a polymer film is related to its structural dynamics and how these dynamics are in turn affected by the presence of iodine.
10.	**Cassandra Ernst** ***Synthesis and Characterization of Dendrimer Encapsulated Iron Nanoparticles (Fe-DEN)*** Summer Advisor: Dr. Vivian Feng and Dr. R. Lee Penn Department/Program Sponsor: MRSEC REU Home Institution: Augsburg College **Abstract:** Dendrimers are three-dimensional polymers that can be used as nano-reactors to aid the synthesis of monodispersive metal nanoparticles. Our goal is to synthesize and characterize zero-valence monometallic Fe, and bimetallic FeAu core-shell nanoparticles using the dendrimer encapsulation method. The size distribution, chemical composition, and the oxidation behaviors of these monometallic and bimetallic particles are evaluated. Fe- and FeAu-DENs could have potential applications in biomedical application due to their abundant functional groups on the dendrimer surfaces and the magnetic cores. These particles could also be of interest in the applications of environmental remediation.
11.	**Sarah Fink** ***Solid-State Hydrogen Bonding and Molecular Packing: Two "Bridge-Flipped" Isomeric Carboxylic Acids*** Summer Advisor: William H. Ojala, Ph.D. Department/Program Sponsor: Chemistry Department Home Institution: University of St. Thomas **Abstract:** We designate as "bridge-flipped isomers" those 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). Because isomers of this type assuming the same solid-state molecular packing arrangement might be co-crystallizable to form new solid materials, we are conducting a solid-state study of factors encouraging isostructuralism. Because these include similarity in H-bonding motifs, we have determined and describe here the crystal structure of a carboxyl-substituted benzylideneaniline to examine additional factors that cause it to assume a crystal structure different from that of its isomer. Our determination comes over forty years after initial cell data were first reported for this compound.

12. **Heather Gagnon**

Analysis of Phytoremediation Processes in Poplar Saplings with the Use of Microdialysis Probes and Gas Chromatography

Summer Advisor: Dr. Anthony Borgerding
Department/Program Sponsor: NSF-STEP, Chemistry Department
Home Institution: University of St. Thomas

Abstract:
Studies of phytoremediation and phytotransformation processes may lead to new information about pollution clean-up solutions and issues dealing with food contamination. This study of phytoremediation processes employs microdialysis probes to measure chemical up-take by poplars. Cuttings were grown hydroponically, and trichloroethylene was used to spike the water. Microdialysis probes were used to sample from various places where 1mm holes were drilled in the poplars. The small size of the probes allowed for non-intrusive, real-time measurements of the trichloroethylene as it was taken up and metabolized by the poplars. The chemical extracts taken with the probe were analyzed using on-line gas chromatography, an electron capture detector, and carbon nanotube-coated traps. This study shows the extent to which the probes can be used to sample from plants.

13. **Anthony Gerten**

Solid-State Conformation and Molecular Packing: Two bis-Schiff Bases Related by Dual Imino-Group Reversals

Summer Advisor: William H. Ojala, Ph.D.
Department/Program Sponsor: Chemistry Department
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). Isomers of this type that are isostructural might be co-crystallizable to form new and useful solids. As a result of a solid-state search for isostructural isomers of this type, we report here the crystal structures of two bis-benzylideneanilines both capable of assuming a centrosymmetric conformation. Their occupancy of crystallographic inversion centers might have encouraged their isostructuralism. Instead, we find that they assume different packing arrangements involving a striking difference in molecular conformation.

16.* **Aaron D. Gronseth**, Jo Jo A. Nemec, Abby H. Schutt

Triclosan Resistance within Bacterial Communities in Natural Waters: Microbial Diversity and Community Composition

Summer Advisor: Dr Kristine Wammer
Department/Program Sponsor: Chemistry Department
Home Institution: University of St Thomas

Abstract:
Selective pressure from triclosan, a common antibacterial agent used in many personal care products, is of concern in natural waters due to the potential risk of increased bacterial resistance to triclosan as well as cross-resistance to medically-important antibiotics. The goal of this project was to study effects on the community structure of Mississippi River bacteria exposed to low levels of triclosan by using Automated Ribosomal Intergenic Spacer Analysis (ARISA). ARISA is a method of community analysis in which PCR amplified DNA fragments of the highly variable 16S 23S intergenic spacer region (ISR) of the prokaryotic rRNA codon are separated using capillary electrophoresis. Here, we present efforts to correlate shifts in community structure with increases in observed resistance to triclosan.

17. **Eric Hagee**

The Uses of Microwave Spectroscopy for Weakly-Bound Complexes

Summer Advisor: Dr. Kenneth Leopold
Department/Program Sponsor: Lando, Chemistry Department
Home Institution: Rutgers University

Abstract:
The basics of rotational spectroscopy will be presented. Information about the group's current carbon dioxide-benzene research will be discussed. So to will investigations to prepare rods of ionic solids for laser ablation in future experiments.

18. **Mary Hammer**

Analysis of Atrazine using LC-MS-MS

Summer Advisor: Dr. Tony Borgerding
Department/Program Sponsor: Chemistry Department, Merck-AAAS
Home Institution: University of St. Thomas

Abstract:
Atrazine is a commonly used herbicide in the United States and it has accumulated in many lakes and streams. Atrazine samples were collected and concentrations were found using an internal standard, terbuthylazine. Atrazine was extracted from 500mL samples with 5mL of methanol in C18 cartridges. The extracts were analyzed using an MSMS triple quad with Q1 masses set to 216 m/z for atrazine and 230 m/z for the internal standard terbuthylazine. The Q3 mass for both compounds was set to 174 m/z. Atrazine concentrations were found to be from 0.1ppb to 5ppb.

19. **Michael Harris**

Progress toward an Iron Mediated Route for the Copolymerization of Immines and Carbon Monoxide to form Polypeptides

Summer Advisor: Connie Lu
Department/Program Sponsor: Lando
Home Institution: Willamette University

Abstract:
Recent investigations have shown that the copolymerization of immines and carbon monoxide is a promising method for preparing polypeptides. To date, only one catalyst, a cobalt acyl carbonyl complex, is known to promote this process. However, the cobalt catalyst's use of carbonyls as ligands has limited the stereochemical control of the copolymerization. Ligands that are both chiral and sterically bulky could provide control over the stereochemical outcome of the copolymerization. This research is designed to provide such control through the use and modification of the iron catalyst developed by Pat Holland. Synthesis of the iron catalyst with a â-Diketiminate ligand was successful and preliminary analysis of its effectiveness for copolymerization is underway.

20. **Jaryd Heyer**

Analysis of Perfluorinated Compounds (PFCs) in Water, Plants, and Crayfish in an Aquatic Food Chain Study of Lake Johanna

Summer Advisor: Tony Borgerding
Department/Program Sponsor: Chemistry Department, MN Pollution Control Agency
Home Institution: University of St. Thomas

Abstract:
In this study water, plant, and crayfish samples were analyzed to determine the concentration and fate of PFCs in an aquatic food chain. The samples were taken from Lake Johanna in St. Paul, MN. Water samples were extracted using solid phase extraction; plants and crayfish were homogenized in a blender and extracted with methanol, and concentrations were determined using isotopically labeled internal and surrogate standards. Results show average levels of PFDA in water, plants and crayfish to be 13.3, 7.2, and 17.7 ng/ml respectively. Average levels of PFOS in water, plant, and crayfish samples were found to be 395.4, 7.3, and 22.8 ng/ml respectively. These samples were compared with fish and sediment samples to determine the fate of PFCs in an aquatic food chain.

21. **Shane Hogle**, Genqiang Xue

A Synthetic Model for the Electronic and Structural Characterization of the Fe(III)Fe(IV) (µ-O) Bridged Core proposed for Intermediate X

Summer Advisor: Dr. Lawrence Que, Jr.
Department/Program Sponsor: Lando/NSF
Home Institution: Earlham College

Abstract:
Ribonucleotide reductase catalyzes the rate-limiting step of DNA biosynthesis in all organisms, with the binuclear FeII active site of the R2 subunit reductively activating O2 and ultimately inducing nucleotide reduction. Intermediate X is the tyrosine-oxidizing species in the enzymatic pathway of the R2 subunit of RNR and facilitates the subsequent enzymatic steps of the R1 subunit. Intermediate X is proposed to have an FeIIIFeIV (µ-O) bridged core, and in an effort to develop a synthetic model for the core, we are pursuing the synthesis and structural/electronic characterization of a diiron complex with a FeIIIFeIV(µ-O) core electronically stabilized by a variant of the tetradentate TPA ligand and fluoride.

22. **Patrick Homyak**, Dr. Sudheer Chava
Synthesis of an Iridium Complex with a Benzoquinoxaline Ligand
Summer Advisor: Prof. Chris Douglas
Department/Program Sponsor: MRSEC REU
Home Institution: Winona State University
Abstract:
Solar energy is an important resource for the world as traditional energy supplies dwindle. One prospect for the future of solar energy is organic photovoltaic cells. They can be printed on large-area, flexible substrates, and seem to be much more cost-effective than traditional silicon solar cells. Although the best organic solar cells currently are around 5-6% efficient, recent advances show promise for the future. In this research, an iridium complex with a benzoquinoxaline ligand was synthesized and employed as a phosphorescent sensitizer in the donor layer of a bi-layer organic photovoltaic device. It has been shown that a guest phosphorescent sensitizer can allow for a long-lived triplet state in the host compound. This will enhance the exciton diffusion length as well as the overall efficiency.

23. **Matthew Humbert**
Gas Phase Microdialysis Extraction: a Versatile Tool for the Extraction of Volatile Compounds into the Gas Phase
Summer Advisor: Tony Borgerding
Department/Program Sponsor: Chemistry Department
Home Institution: University of St. Thomas
Abstract:
Gas phase microdialysis probes are a small (200um x 3mm), fast (response time <5 sec), and sensitive means of extracting volatile compounds from solution. Gas phase microdialysis probes have been interfaced with a chemiluminescence detector to measure aqueous nitric oxide with limit of detection of 5 uM. The probes have also been interfaced with a proton transfer reaction mass spectrometer to dynamically monitor products and reactants of the oxidation of n-butanol, as well as measure aqueous H2S at 14.7 mM.

24. **Steven Jerome**
Charge Model 5 and Intermolecular Charge Polarization
Summer Advisor: Dr. Donald G. Truhlar, Dr. Christopher Cramer, Dr. Alek Marenich
Department/Program Sponsor: Lando
Home Institution: Northeastern Illinois University
Abstract:
Partial charges provide a unique insight into the nature of chemical reactivity and are widely used in molecular modeling. Many methods exist for computing these charges including class IV charge models that map class II charges to reproduce experimental observables. One such model, Charge Model 4 (CM4), was designed to map Lowdin charges to reproduce experimental dipole moments using a function of the Mayer bond order, which is the dominant source of instability in the model. We propose a new charge model called Charge Model 5 that replaces the Mayer bond orders with Pauling bond orders, which have the advantage of being only dependent on geometry. At the present stage of optimization with M06-2X/6-31G(d), the mean unsigned error in dipole moments is 0.28D.

25. **Melissa Joyce**, Dr. Joseph Brom
A Computational Study of TiH5+ and CH5+
Summer Advisor: Dr. Joseph Brom
Department/Program Sponsor: Chemistry Department
Home Institution: University of St. Thomas
Abstract:
An interest in three-center-two-electron bonding leads to a study of CH5+ and TiH5+. The electronic structures of TiH5+ and CH5+ were examined using GAMESS (General Atomic Electronic Structure System). Full-valence MCSCF (Multiconfiguration Self Consistent Field) calculations for both CH5+ and TiH5+ have been completed. CH5+ was analyzed using a 6-311 G(d) basis set. For TiH5+ a 6s4p4d2f basis set was employed for titanium, and a 5s2p was employed for the hydrogens. The Cs point group resulted in two conformations for CH5+ and three conformations of a completely different structure for TiH5+. One of the conformations found for TiH5+ is a TiH+(H2)2 complex. Three-center-two electron bonding was found in CH5+ while this particular type of bonding was not seen in the TiH5+ species.

26. **Godino Kalungi**

Analysis of PFCs in Fish Samples from Lake Johanna as Part of an Aquatic Food Chain Study

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

Abstract:
Perfluorochemicals (PFCs) were analyzed in fish from Lake Johanna as part of a larger food chain study. The PFCs were extracted from fish by solid phase extraction (SPE) using methanol, and then analyzed using the liquid chromatography with mass spectrometry detection (LC-MS/MS). The concentrations of PFCs in fish were between 2 to 5000ng/ml. Generally, the acids showed a higher concentration than the sulfonates with the highest concentration of 5000ng/ml and 1090ng/ml respectively. On average, bigger fish such as northern pike had high PFC concentration than small fish such as bluegill. The fish results are being compared to PFC concentration in bugs, water, plants and sediments from the same lake.

27. **Luke Kassekert**

Development of a Nanopore for Protein Characterization

Summer Advisor: Gary Mabbott
Department/Program Sponsor: Chemistry Department
Home Institution: University of St. Thomas

Abstract:
The overall goal of the project was to create a pore with a size selectable aperture that can be reproducibly manipulated in diameter at the nanometer scale. The pore may act as a gate that allows particles of predetermined size to pass through. Our approach is based on casting a pore in PDMS using an electrochemically sharpened tungsten needle to define the pore. As particles pass through the opening they can be counted from the pulses that they create in the electrical resistance of the pore (Coulter principle). These pulses are proportional to the size of the particle and directly related to the translocation of particles. Experimental results will be applied towards the characterization of nanoparticles by size and quantifying antibody/antigen reactions.

28. **Emily Kawesa-Bass**

Identifying Fabric Dyes using Negative Ion Mode ESI Mass Spectrometry (QTOF2) for Forensic Science Purposes

Summer Advisor: Dr. Gary Mabbott
Department/Program Sponsor: NSF STEP Grant
Home Institution: University of St. Thomas

Abstract:
The goal of this research project is to be able to simply and accurately identify a dye molecule by interpreting negative ion spectra obtained from a QTOF2 mass spectrometer. For the sulfonated dyes in this study, the base peaks were easily identifiable as the parent molecule minus a hydrogen or a sodium. The observed base peaks, isotope peak ratios and mass fragment calculator helped in identifying the molecules. In terms of analysis of fibers in forensic science this protocol will save forensic scientists time and enable positive identification of the dyes in the fibers collected.

29. **Albert Kertho**

Analysis of Perfluorochemicals (PFCs) in Sediment Samples from Lake Johanna

Summer Advisor: Dr. Anthony Borgerding
Department/Program Sponsor: Chemistry Department, NSF STEP Grant
Home Institution: University of St. Thomas

Abstract:
The concentration of selected perfluoroalkyl sulfonates and acids were determined in sediments to investigate the fate of PFCs in aquatic environment. The sediment samples were collected from a core and surface points on Lake Johanna. Extraction was done by solvent extraction with methanol. The analytes were then identified using liquid chromatography tandem mass spectrometry (LC-MS-MS) system. The concentration of sulfonates and acids ranged between 2-3400ng/ml and 2-5400ng/ml, respectively. Surface has slightly higher concentrations of PFCs except in PFHxS, PFHpA and PFOS. The concentration of PFOS increases with the depth of the core. PFOS and PFOA were the major PFCs detected. The sediment values are also being compared to water, fish, plant and bug data from the same lake ecosystem.

30. **Amber Koenig**, Kris Murphy, Steven Kass
The Utilization of Intramolecular Hydrogen Bonding in Novel Acids
Summer Advisor: Steven Kass
Department/Program Sponsor: Lando/NSF REU
Home Institution: Lakeland College
Abstract:
Intramolecular hydrogen bonding is found in many natural compounds, and also has the potential to be useful in the creation of novel acids. Intramolecular hydrogen bonds can potentially be used to stabilize anions of polyols, making the neutral molecule very acidic in the gas phase and aprotic solvents. The synthetic route of the heptol begins with 1-butenoic acid and converts the acid into 1-bromo-2,4-butandiol. This diol is then made into a Grignard, which can be added to dimethyl carbonate to reach the target molecule.

31. **Peter Lawrence**
Synthesis and Analysis of Block Copolymers
Summer Advisor: Louis Pitet, Dr. Marc Hillmyer
Department/Program Sponsor: Lando
Home Institution: Minneapolis Community and Technical College
Abstract:
One interest in the Hillmyer group is the synthesis of block copolymers from ring opening metathesis polymerization (ROMP) of cyclic olefins followed by the subsequent addition of polylactide via one of a few chain transfer agents (CTA). The design of the CTA is used to control moleculare weight and architecture of the block-copolymer. By controlling composition and design structure we are able to accurately synthesis desired moleculare weights and architectures of biorenewable polymers that can potentially have a wide range of commercial and industrial uses.

32. **Ivan Lenov**, Kyle C. Bantz, Nathan J. Wittenberg, Christy L. Haynes
Potential Assisted Formation of Alkanethiol Monolayers on Ag Electrodes
Summer Advisor: Christy L. Haynes
Department/Program Sponsor: Lando
Home Institution: Truman State University
Abstract:
The formation of a self-assembled monolayer (SAM) on an Ag metal surface creates a partition layer to facilitate detection of analytes using surface enhanced Raman spectroscopy (SERS). Traditional means of SAM assembly call for open circuit potential (OCP) monolayer assembly greater than 24 hours to minimize defects. The application of a small anodic potential to the metal while in the alkanethiol solution shows great promise at decreasing assembly times and is the focus of this work. The time of potential packing and potential applied to the electrodes during SAM formation were optimized and found to yield comparable results to those of monolayers formed by 24 hour incubation at OCP in only 15 minutes and at 400 mV vs Ag/AgCl, respectively, indicating a well-packed decanethiol monolayer.

33. **Selamawit Melka**
Synthesis of Cell Penetrating Peptide- CRRRC
Summer Advisor: James Wollack
Department/Program Sponsor: Hamline University
Home Institution: Hamline University
Abstract:
Cell penetrating peptides (CPPs) are peptides that facilitate the uptake of various types of chemical and biological cargo across the plasma membrane of cells. They are of different size and amino acid sequence but all have the ability to transport cargo ranging from small molecules like drugs to large molecules like proteins. A new class of CPPs has been discovered that have shown to have higher uptake levels in cells. These prenylated cell penetrating peptides (pCPPs) have many advantages compared to CPPs. They have short sequence requirements, low toxicity and have an energy independent pathway. In this research a cell penetrating peptide with sequence CRRRC is synthesized which will then be used to study the uptake of pCPP drug conjugates into cells.

34. **Andrew Michel**

The Synthesis of a Thiadiazole Functionalized Oxazolidinone

Summer Advisor: Dr. J. Thomas Ippoliti

Department/Program Sponsor: Chemistry Department

Home Institution: University of St. Thomas

Abstract:

Bacteria continue to mutate, multiply, and gain multidrug resilience, therefore new antibiotics need to be explored and synthesized. Oxazolidinones are a class of synthetic antibiotics proven to combat these resilient bacteria. An Oxazolidinone functionalized with a thiadiazole group was successfully synthesized in six steps and tested for antibacterial properties. 2-amino-5(4-methoxyphenyl)-1,3,4-thiadiazole is reacted with benzyl chloroformate in base to form an amide linkage. This product is then reacted with R(-)-glycidyl butyrate and lithium bis(trimethyl-silyl) amide to produce the oxazolidinone ring with an alcohol side chain. The alcohol is then converted to a sulfonate, creating a good leaving group for the following reaction with sodium azide. This azide intermediate is reduced to the amine. Finally the amine is turned into an amide to create the final product.

35. **Katie Miller**

Nitrogen Homeostasis in the Invasive Argentine ant, Linepithema humile.

Summer Advisor: Dr. Thomas C. Marsh

Department/Program Sponsor: Young Scholars Research Program

Home Institution: University of St. Thomas

Abstract:

Homeostasis of macronutrients is vital to the success of many organisms including ants. Many insects have been shown to respond physiologically to different macronutrient ratios but most of these studies have focused on nitrogen and phosphorus as limiting macronutrients. Here we examine the effects on the Argentine ant species Linepithema humile when carbon is a limiting macronutrient and how this can lead to increased levels of nitrogen to the point where nitrogen toxicity increases mortality among these ants. We are interested in discovering the exact biomolecule that causes this increased mortality and its other effects on the biochemistry of Argentine ants when they are reared on low carbon: high nitrogen ratios.

36. **Benjamin Monson**, James Wollack

Bioorthogonal Conjugation with Geranyl Diphosphate Analog Functionalized for Tetrazine Ligation

Summer Advisor: James Wollack

Department/Program Sponsor: Department of Chemistry

Home Institution: Hamline University

Abstract:

Protein farnesyl transferase (PFTase) covalently attaches farnesyl diphosphate (FPP), its natural substrate, to a cysteine in a four amino acid recognition sequence. PFTase has also been shown to transfer non-natural isoprenoid diphosphate analogs to recombinant proteins or peptides with the amino acid tag (CVIA). Proteins or peptides tagged with functionalized analogs can be attached to biomolecules and surfaces using fast bioorthogonal reactions e.g. click chemistry. We synthesized isoprenoids with a cyclooctene moiety that are substrates for PFTase. Cyclooctenes bioorthogonally react with aryl-substituted tetrazines through an inverse-electron-demand Diels–Alder mechanism with a rate similar to copper-catalyzed click reactions. Protein or peptides prenylated with this geranyl diphosphate analog can quickly undergo tetrazine ligation without the constraint of cytotoxic copper.

37. **Basant Nassar**

Terminally Functionalized Oligothiophenes for Molecular Wires

Summer Advisor: Professor Mamoun Bader, Professor C. Daniel Frisbie
Department/Program Sponsor: MRSEC REU
Home Institution: Penn State, Hazleton

Abstract:
Organic molecular wires consist of long conjugated capable of charge transport. We propose to prepare new thiophene- based molecular wires. Our strategy will have the following components: (1) Preparation of the thioaldehyde for anchoring onto a gold surface (self-assembled monolayer); HS-T-CHO, (2) Preparation of thiophene dialdehydes and acetonitriles for the step-wise synthesis of molecular wires by means of Knovenagle reaction. (3) A similar strategy will be used for building molecular wires utilizing Schiff base (imine) chemistry for which we will prepare the diaminothiophenes.Advantages of the Knovenagle approach include the lowering of the LUMO levels due to the strong election accepting nature of the cyano group, and the planar structures anticipated due to the CNâ€|S interactions we observed in our lab working with the TCE and DCV chemistry. Synthesis of the dialdehydes is to be achieved following literature procedures, while that of the diaminothiophenes is less well-known as these molecules are unstable. We will attempt alternate routes such as the addition of electron withdrawing groups and phenyl spacers. Basic synthetic methodology employs bromination, Suzuki coupling, Stille Coupling, and Knovenagle reactions. Analysis of Polymers will include, NMR, X-ray crystallography, IR, thermal analysis and Mass spectroscopy data.

38. **Michelle C. Neary**, Eric D. Smolensky, Yue Zhou, Hee-Yun E. Park, Valarie C. Pierre

DNA-Functionalized Iron Oxide Nanoparticles as Potential MRI Contrast Agents

Summer Advisor: Valarie C. Pierre
Department/Program Sponsor: Lando/NSF
Home Institution: Macalester College

Abstract:
Iron oxide nanoparticles have found extensive use as contrast agents for Magnetic Resonance Imaging due to their strong relaxivity. However, their current design does not allow for the synthesis of high-sensitivity targeted or responsive agents that incorporate biomolecules such as DNA or proteins. Although oligonucleotides are attractive targeting vectors, they readily react with iron oxide surfaces. Therefore, the nanoparticles need to first be coated with a layer, such as gold, onto which the DNA can anchor. Herein we present a novel and robust synthesis of Fe3O4@Au@DNA. This system has superior magnetization and relaxivity due to an intermediate phosphate layer. The development of these DNA-functionalized nanoparticles opens up numerous possibilities for the design of responsive contrast agents.

39. **Andrew Nelson**

Synthesis of Beta-Iminocarboxamide Ligands and Their Cu, Ni, and Zn Complexes

Summer Advisor: Bill Tolman
Department/Program Sponsor: Lando/NSF REU
Home Institution: The College of St. Scholastica

Abstract:
Copper-containing enzymes are not fully understood in their functionality. The goal of this research is to attempt to model copper-containing enzymes to see how they react with dioxygen. Novel beta-iminocarboxamide ligands were proposed to model the active site of several copper-containing enzymes and were synthesized in three steps. In addition to using copper to model the enzyme, zinc and nickel complexes were prepared to investigate the binding of the ligand due to two possible coordination modes. These complexes were characterized to determine if one coordination mode was preferred. Future work will include studying the reactivity of the resulting metal complexes.

15.* **Jo Jo A. Nemec**, Aaron D. Gronseth, Abby H. Schutt

Triclosan Resistance within Bacterial Communities in Natural Waters: A Survey of Existing Resistance Levels

Summer Advisor: Dr. Kristine Wammer

Department/Program Sponsor: Chemistry Department

Home Institution: University of St. Thomas

Abstract:

Triclosan is an antibacterial agent that has been reported present in low concentrations in many natural waters. There are concerns that exposure to triclosan could lead to higher levels of resistance within the bacterial communities due to a selective pressure. The main objective of this project is to obtain a survey of existing resistance levels in bacterial communities from a variety of water sources in order to determine if there is a correlation between potential human impacts and current resistance levels. Bacteria were grown on solid media with varying triclosan concentrations. Growth measured as percent of control (no triclosan in the media) was used as the measure of resistance. To date, we have seen no evidence of elevated resistance in human-impacted areas.

40. **Ashley Patraw**

A Computational Study of "Bridge-Flipped Isomers"

Summer Advisor: Dr. Joseph Brom

Department/Program Sponsor: Chemistry Department

Home Institution: University of St. Thomas

Abstract:

In this work, we study the effects of intermolecular interactions in "bridge-flipped isomers" by use of computational chemistry. In particular, the aim was to learn the nature of intermolecular interactions in bridge-flipped isomeric benzylideneanilines. Geometry optimization calculations were carried out on monomer and dimer structures using restricted Hartree-Fock (RHF) theory with the 6-31G* basis set. Intermolecular interactions examined are between halogen atoms, nitrile groups and ring hydrogen atoms.

41. **Alexandre Henrique Pinto**, R Lee Penn

Hydrothermal Synthesis of Tetragonal Lead (II) Oxide with Preferred Orientation

Summer Advisor: R Lee Penn

Department/Program Sponsor: Chemistry Department

Home Institution: Universidade Federal de Sao Carlos - Brazil

Abstract:

Lead (II) Oxide has two crystalline structures, the tetragonal structure is known as litharge, which at 490 º C, undergoes a transition to a orthorrombic structure, known as massicot. Then, in this work the litharge phase of PbO was synthesized through a hydrothermal method, at three different temperatures and different times of hydrothermal aging (from 4 to 48h). The X-Ray Diffraction analysis revealed that the tetragonal phase of PbO was obtained with strong preferred orientation in the planes (002), further analysis were carried out by the means of Scherrer Equation, in order to determine the size of crystallographic coherence dominium, and by the means of Lotgering Equation, in order to give a semi-quantitative idea about the degree of preferred orientation of each sample.

42. **Eric Popczun**

Color Intensification of 3DOM Zirconia for Pigments

Summer Advisor: Dr. Andreas Stein

Department/Program Sponsor: Lando, Chemistry Department

Home Institution: Mount Union College

Abstract:

Three-dimensionally ordered macroporous (3DOM) zirconia was produced by infiltrating colloidal crystal templates with a zirconium precursor and then converting the composite to zirconia by pyrolysis. The periodicity of the 3DOM zirconia structure yielded a product that reflected light in the visible spectrum, producing bright and vibrant colors, whereas untemplated zirconia was normally white. The color could be tuned by adjusting the pore size (by changing the template sphere size) or the refractive index (by wetting the 3DOM zirconia with a liquid). In order to fabricate 3DOM zirconia with more intense and vibrant colors, effects of temperature control, the periodicity and sphere size of the PMMA templates and the size of particles undergoing pyrolysis were studied. The ratio of precursor volume to template volume was also studied.

43. **Ryan Roberts**
Thermochemical Ablation Potential of H2SO4 and H3PO4, Polyprotic Mineral Acids
Summer Advisor: John Bischof, Erik Cressman, Mithun Shenoi
Department/Program Sponsor: MRSEC REU
Home Institution: The University of Alabama
Abstract:
Thermochemical Ablation Potential of H2SO4 and H3PO4, Polyprotic Acids. Thermochemical ablation is the use of reaction energy to generate enough heat to destroy cells. This practice is being tested to create a means of destroying tumor cells that are currently inoperable due to surgical limitations. The purpose of this experiment is to determine the amount of heat that can be generated by strong polyprotic acids, such as H2SO4 or H3PO4, when mixed with a strong base, such as NaOH or NH4OH. By sequentially injecting acid and then base into an in vitro gel phantom and measuring the temperature profile inside the reaction bubble, the amount of heat the reaction is generating can be determined and utilized for the most efficient ablation of harmful tumor cells.

44. **Joelle Rolfs**, Eric Castro
NyeBar Coating on Bare Fused Silica Capillary for Protein Separations using Capillary Electrophoresis
Summer Advisor: Dr. Michael Bowser
Department/Program Sponsor: Lando/NSF, Chemistry Department
Home Institution: Minnesota State University Moorhead
Abstract:
Separation of proteins and biomolecules by capillary electrophoresis is central to many fields of research. Protein adsorption to capillary walls leads to band broadening and poor resolution. Many techniques are used to mitigate this problem, including permanent or semipermanent (dynamic) coatings that reduce solute-wall interactions. This study looked at the effects on protein adsorption in capillaries coated with a commercial lubricant barrier film, NyeBar. This coating is dissolved in a perfluorous solvent, which evaporates readily leaving a film of perfluorous polymer. NyeBar should provide a stable surface with little protein retention. Results show NyeBar coating is stable for at least 3 days and lowers electro-osmotic flow (EOF) inside the capillary. Improved peak efficiency has been observed for basic proteins when compared to an uncoated capillary.

45. **Emmanuella Rony**
Gelatin Crosslinked by Genipin or D, LGlyceraldehyde: Compositional Effects on Porosity
Summer Advisor: Jessy Edwards and Ron Seigel
Department/Program Sponsor: MRSEC REU
Home Institution: Florida Agriculture and Mechanical University
Abstract:
Polymer matrix systems have received increasing attention in the past few decades in areas of drug delivery, bone tissue engineering, biosensing, and catalysis. It has been shown that polymer and crosslinker compositions can influence the pore sizes in a matrix. In this study we investigated these phenomena in gelatin crosslinked with genipin or D, L-glyceraldehyde. We also explored the use of microwave radiation to physically crosslink the gelatin. Lyophilization after gel formation and salt incorporation follow by leaching were the two methods were employed to create pores. The detailed morphology of these pores were examined by Scanning Electron Microscopy. We also successfully crosslinked gelatin with D, L-glyceraldehyde, however, swelling test showed lack of stability at our present concentrations. Salt leaching method was only successful in producing pores on the surface of the gelatin, but combining lyophilization with increased lyophilization times produced larger and longer pores in our genipin crosslinked samples. These studies have been planned and tested to be continued at Florida A&M University.

46. **Andrew Ross**, Karen Beckman, Dr. Andrew Harned
Synthesis of a Novel Cyclic Hypervalent Iodine Oxidant for use in Enantioselective Dearomatization Reactions
Summer Advisor: Dr. Andrew Harned
Department/Program Sponsor: Department of Chemistry- Lando/NSF
Home Institution: Earlham College
Abstract:
Cyclohexadienones are common building blocks in natural product synthesis; however, there are few known methodologies to construct the desired cyclohexadienone functional group. One such methodology employs hypervalent iodine species to dearomatize phenol substrates. Only a small number of cyclic hypervalent iodine compounds have been reported in the literature. To this end, our focus is on the synthesis of a cyclic hypervalent iodine oxidant to efficiently convert simple phenols into desirable cyclohexadienone building blocks. These studies will serve as a basis for further development of enantioselective reagents.

14.*	**Abby H. Schutt**, Aaron D. Gronseth, Jo Jo A. Nemec ***Triclosan Resistance within Bacterial Communities in Natural Waters: Selection for Resistant Bacteria due to Long-Term Exposure*** Summer Advisor: Dr. Kristine H. Wammer Department/Program Sponsor: Chemistry Department Home Institution: University of St. Thomas **Abstract:** Triclosan warrants investigation as it is the active ingredient in many personal care products. The aim of this study is to investigate the effects on environmental bacteria caused by long-term exposure to the antibacterial. Environmental bacteria were collected from natural waters and maintained in chemostats, where they were subjected to known triclosan concentrations in a controlled setting. Weekly resistance tests were performed where bacteria from chemostat effluent were grown on elevated concentrations of triclosan (10 μM and 50 μM) in liquid media. The OD600 was measured to observe bacteria growth in the presence of triclosan with respect to a positive control. Prolonged exposure was shown to produce selection for resistant bacteria; however, the concentrations used are higher than those currently found in environmental waters.
47.	**Mona Shrestha**, Dr. Jane Wissinger and Mark Martello ***Efforts Toward a Green Synthesis of a Biodegradable Polymer, Polymenthide*** Summer Advisor: Prof. Marc Hillmyer Department/Program Sponsor: Lando/NSF, Chemistry Department Home Institution: Wesleyan College **Abstract:** Biodegradable polymers, being ideal alternatives for petroleum based plastics, have been of great scientific interest. One such polymer is polymenthide, a derivative of (-)-menthol, which has been synthesized from (-)-menthide (lactone) that is obtained by Baeyer-Villiger oxidation of (-)-menthone (ketone). The main objectives of our research were to develop a greener synthesis for polymenthide starting from its alcohol derivative, (-)-menthol, and to simultaneously develop a sophomore level organic chemistry experiment that teaches green chemistry principles and polymerization. Oxone, a newer green oxidizing agent, was explored to convert (-)-menthol to (-)-menthone followed by a clean Baeyer-Villiger oxidation to synthesize the (-)-menthide monomer unit. Novel method for ring-opening polymerization of (-)-menthide completed the synthesis. Product formation was verified with NMR spectroscopy and IR spectroscopy.
48.	**Daniel Sjolund** ***Photo-Induced Electron Transfer and Reduction of Pyrromethene with Quencher Molecules in Transient Absorption Spectroscopy*** Summer Advisor: Dr. Joseph Brom Department/Program Sponsor: Young Scholars Grant, Chemistry Department Home Institution: University of St. Thomas **Abstract:** This research project is primarily concerned with obtaining the UV-Vis absorption spectrum of the Pyrromethene 567 radical anion. Photo-induced electron transfer reactions of Pyrromethene 567 will be investigated with transient absorption spectroscopy. In order to perform transient absorption spectroscopy, one utilizes a laser-generated burst of photons directed through a sample of Pyrromethene 567 along with an electron donor species. This technique, in conjunction with appropriate equipment, enables the observer to determine whether the photo-induced reaction products of interest have been generated. This project will initially focus on developing reproducible methods for generating ground electronic state Pyrromethene 567 radical anions, and will continue by employing transient absorption spectroscopy to record the absorption spectrum.

49.	**Matthew T. Slattery**, Amanda M. Stemig ***Analysis Of The Antibacterial Properties Of Tetracycline And Its Photoproducts*** Summer Advisor: Kristine H. Wammer Department/Program Sponsor: Young Scholars Grant, Chemistry Department Home Institution: University of Saint Thomas **Abstract:** In this study the photodegradation of tetracycline under environmentally-relevant conditions was examined to determine the environmental significance of its photoproducts. Tetracycline, is known to degrade by direct photolysis into at least 7 different photoproducts under varying conditions. Water hardness and pH are two characteristics of a natural environment that can alter the decomposition pathway of tetracycline. Here, the growth of the bacterial strains E. coli DH5á and Vibrio fisheri was measured by UV-vis spectrophotometry (600 nm) in the presence of varied concentrations of both photolyzed and unphotolyzed tetracycline to determine the potential antibacterial activity of its photoproducts in diverse waters and conditions. In all cases studied to date, we have determined that the photoproducts retain no significant antibacterial activity.
50.	**Tyler Stack** ***Efforts Towards a Green Baeyer-Villiger Oxidation*** Summer Advisor: Marc Hillmyer Department/Program Sponsor: Heisig-Glysteen Home Institution: University of Minnesota-Twin Cities **Abstract:** The Baeyer-Villiger (BV) oxidation of cyclic ketones to cyclic esters is an important synthetic transformation to create biorenewable polyesters from abundant natural products. The BV oxidation is commonly accomplished using meta-chloroperbenzoic acid: a toxic, expensive reagent with poor atom economy in a chlorinated solvent. Efforts towards a green BV oxidation on a model substrate have been pursued using molecular oxygen, hydrogen peroxide, urea-hydrogen peroxide, and Oxone. Molecular oxygen with a sacrificial aldehyde, benzaldehyde, in chlorinated solvent yielded the lactone n high conversion, 95%. Aqueous hydrogen peroxide proved ineffective, but urea-hydrogen peroxide with maleic anhydride, in dichloroethane, afforded the lactone with 96% conversion. Oxone in aqueous methanol in the presence of a weak base produced the lactone quantitatively.
51.	**Amanda Stemig**, Lanhua Hu, Timothy J. Strathmann, Kristine H. Wammer ***Antibacterial Activity of Pharmaceuticals Treated with Potassium Permanganate*** Summer Advisor: Kristine H. Wammer Department/Program Sponsor: Chemistry Department Home Institution: University of St. Thomas **Abstract:** If pharmaceuticals are not removed in wastewater treatment plants, they will eventually end up in the environment when the effluent is released into natural waters. The overall goal of this project is to determine if a current water treatment technique, that uses potassium permanganate, will be effective in removing selected pharmaceuticals from the water. This portion of the project studies the antibacterial activity of three antibiotics used to treat bacterial infections in humans (ciprofloxacin, trimethoprim and lincomycin) both before and after degradation with potassium permanganate. We have found that the degradation products of these drugs have little to no activity when compared to the parent compound. Thus, this technique shows promise for removing these compounds from wastewater or drinking water without creating undesirable byproducts.

52. **Leah Streitman**

Hydrogen Bonding in Carbohydrate Derivatives: Crystal Structure of a Glucose Cyanophenylhydrazine

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

Abstract:
Our interest in solid-state hydrogen bonding has led us to conduct a crystallographic study of derivatives of monosaccharides, perhaps the ultimate in hydrogen-bonded solids. Reaction of a monosaccharide with a nitrogenous base can yield an open-chain derivative (a Schiff base) or a cyclic derivative (a glycosylamine). We are examining base/monosaccharide combinations to determine in each case which derivative is obtained as the crystalline product and to examine the hydrogen-bonding scheme assumed in the solid state. Here we describe the crystal and molecular structure of the glycosylamine formed by reaction between D-glucose and 4-cyanophenylhydrazine. In the crystal structure, the hydrophobic cyanophenyl moiety bridges hydrophilic glucopyranosyl regions of the crystal through a hydrogen bond between the nitrile group and the O-2 hydroxyl of a neighboring molecule.

53. **Jacob E. Sundberg**

Enrofloxacin and the Antibacterial Activity of Its Photoproducts

Summer Advisor: Dr. Kristine H. Wammer
Department/Program Sponsor: Chemistry Department
Home Institution: University of St. Thomas

Abstract:
Enrofloxacin, a drug from a class of antibiotics known as fluoroquinolones, has been widely used on domestic animals for its activity against a broad spectrum of bacteria. Previous work in our lab has shown that enrofloxacin breaks down by direct photolysis, yielding a variety of photoproducts. Selected photoproducts were isolated using HPLC equipped with a preparative column and were manually collected. Antibacterial activity testing was performed by measuring the growth of E. coli exposed to varying concentrations of enrofloxacin or its photoproducts. Testing was done over six hours and measured using UV-Vis spectrophotometry at 600nm. Through antibacterial activity testing, one of the photoproducts of enrofloxacin was found to be biologically active. LC-MS and NMR were used to help identify the structure of that photoproduct.

54. **Vladimir Vinnik**

A Novel bis-sulfide en Route to the Synthesis of 4,4-bipyrazolyl

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

Abstract:
A new synthetic route to 4,4-bipyrazolyl, a molecule potentially useful toward the research of metal-organic frameworks, was the original goal of this research. The synthetic route to 4,4-bipyrazolyl starts with the reduction of Dimethyl-3,4-furandicarboxylate to the diol. The next step was a modified Swern oxidation of the diol to the dialdehyde, furan-3,4-dicarbaldehyde. The oxidation step was done using sulfur trioxide pyridine complex in dimethyl sulfoxide and triethylamine. It was in the optimization of the reaction conditions for the oxidation that an interesting discovery was made which lead to the isolation of a novel bis-sulfide that was characterized via NMR and X-ray crystallography. The synthesis was finished by hydrolyzing the dialdehyde to the tetraldehyde, 1,1,2,2-Ethanetetracarboxaldehyde, which was subsequently reacted with hydrazine to form 4,4-bipyrazolyl.

55. **Macklin Warrington**

Biocompatible Cleavage of α-azidoethers as a Mechanism for Bioconjugate and Polymer Degradation

Summer Advisor: Dr. Taton
Department/Program Sponsor: Chemistry Department
Home Institution: Nebraska Wesleyan University

Abstract:
Spontaneous degradation of polymers is an important tool for a variety of technological applications of biomaterials. Our research is working with PEG hydrogels. There are many examples of Peg hydrogels that decompose when exposed to heat, pH, light, and enzymes. Our research is to make PEG hydrogel that can be decomposed when expose to a specific chemical reagent by attaching an azide group to it.

56. **Benjamin Weigel**, Dan Mullen

Assays for Rapid, Simultaneous Screening of Prenyltransferase Substrate Specificities

Summer Advisor: Mark D. Distefano

Department/Program Sponsor: Lando/NSF

Home Institution: Martin-Luther-Universität Halle-Wittenberg Institute for Biochemistry and Biotechnology, Halle (Germany)

Abstract:

This work describes two approaches to create peptide libraries with free C-termini to study substrate specificities of prenyltransferases for Ca1a2X box sequences. Both a one-bead-one-compound library (OBOC) and a SPOT-library were synthesized for biological evaluation. Free C-termini were obtained by cyclization and subsequent inversion of peptides while attached to the solid support. A novel method to assay the libraries on the solid surface was developed in which a modified prenyl substrate, that contained a bio-orthogonal alkyne functional group, was transferred to the peptide using a prenyltransferase. Sequences that were substrates for the enzyme were labeled by covalently attaching an azide containing fluorophore employing Click chemistry. OBOC libraries were screened using fluorescence microscopy and FACS while the SPOT-library was colorimetrically evaluated.

57. **Daniel Wiebe**, Matt McCuen

A Computer Simulation of a Control-Oriented HCCI Engine Model

Summer Advisor: Dr. Zongxuan Sun

Department/Program Sponsor: Mechanical Engineering REU

Home Institution: St. Olaf College

Abstract:

Homogeneous Charge Compression Ignition (HCCI) engines are the next generation of automobile engines, promising a 15-20% increase in fuel efficiency and reduced emissions. In order to make HCCI engines economically viable, we are continuing research in the area of combustion timing control. Specifically, residual-affected HCCI engines have a limited load and engine speed operating range due to poor mixing of the gases in the cylinder. To improve the mixing, and therefore the operating range, we utilize a modified intake valve timing strategy. To test this strategy, we implemented a control-oriented HCCI engine model in Matlab. We validated the model against previous work and tested it in steady state engine conditions.

58. **Mo Zhang**

Reactivity Study of a (N4Py)FeIV=O Complex with Various Substrates in the Presence of Acid

Summer Advisor: Larry Que. Jr.

Department/Program Sponsor: Chemistry Department

Home Institution: Viterbo University

Abstract:

Mononuclear nonheme iron enzymes are involved in oxidative metabolism pathways in nature. High-valent iron-oxo species have been invoked as intermediates in the reactions of these nonheme iron enzymes with substrate. Synthetic oxoiron (IV) analogs are also oxygen activating reagents. The oxoiron(IV) complex that was used in this study is that formed from [(Fe(II)N4py(CH3CN)], N4Py = N,N-bis(2-pyridylmethyl)-N-bis(2-pyridyl)methylamine). The reactivity of (N4Py)Fe(IV)=O with various substrates including hydrocarbons, alcohols, water, and single electron reductants in the presence of acid has been systematically studied.

Poster Presentations in Materials

Listed by presenting author

59. **Aaron Besaw**, Lee Weinkes

Conductivity and Optical Absorption of Mixed-Phase Thin Film Semiconductors

Summer Advisor: Dr. James Kakalios

Department/Program Sponsor: MRSEC REU

Home Institution: College of the Menominee Nation

Abstract:

My summer research has been the optical characterization of mixed-phase thin film semiconductors by the constant photocurrent method (CPM). I look at how exposing samples of amorphous silicon with various amounts of nanoparticles to light effects the optical absorption of the films. The goal is to look at the relationship between nanocrystal percentage and optical characteristics of the samples. This can establish the correlation between nanoparticle concentration and optical absorption and help decide if the addition of nanocrystals in amorphous silicon enhances or contracts from optical properties of the films, or to find an optimal amount of nanoparticles to put on a film for desired properties. This information can also allow for a better understanding of the physics behind the experiment.

60. **Thomas Briese**, Rebecca Anthony

Functionalization of Silicon Nanoparticles for Purposes of Bio-Imaging

Summer Advisor: Prof. Uwe Kortshagen

Department/Program Sponsor: MRSEC REU

Home Institution: Saint Mary's University of Minnesota

Abstract:

One of the most exciting characteristics of silicon nanoparticles is their size-dependent ability to fluoresce in the visible spectrum under ultraviolet excitation. This quality, combined with silicon's biocompatible nature, makes silicon nanoparticles an attractive option for bio-imaging applications. The goal of this project was to explore the potential of silicon nanoparticles for purposes of bio-imaging. The first step was to functionalize said nanoparticles in order to make them readily dispersible in aqueous solutions. To accomplish this hydrophilicity, plasma-prepared silica (SiO_2) nanoparticles were surface-modified with amine and methyl phosphonate functional groups via the organosilane compounds 3-(aminopropyl)triethoxysilane (APTES) and 3-(trihydroxysilyl)propylmethylphosphonate (THPMP). While complete solubility in water has yet to be achieved, much has been learned about the fluorescence behavior of silicon nanoparticles with varying degrees of oxidation.

61. **Gabriel Burch**, Tanner Schulz

Magnetic Field vs. Lift Height Response of Thin Films

Summer Advisor: Dan Dahlberg

Department/Program Sponsor: MRSEC REU

Home Institution: UC Berkeley

Abstract:

While measuring the interaction between the tip of a magnetic force microscope (MFM) and the field produced by a thin film of ferromagnetic material with magnetic moments parallel to its surface, one may initially expect to observe a different response of magnetic interaction as a function of the distance between the tip and the sample (lift height), because different materials have a different inherent magnetization. However, calculations have predicted that the responses are not dependent on the type of ferromagnetic material. This research aimed to validate this prediction by placing different metals adjacent to each other on a substrate sample, then measuring their magnetic interactions with the MFM as a function of lift height. The experiment succeeded in substantiating the calculations by measuring aligned responses.

62. **Chad Carls**
Toughening Epoxies
Summer Advisor: Zack Thompson, Frank Bates
Department/Program Sponsor: MRSEC RET
Home Institution: Champlin Park High School
Abstract:
Researchers have been working to toughen epoxies for over 40 years. I assisted Zack Thompson of the Bates Group with cutting edge research. I investigated the relationship between the toughness of epoxies and the mass percent and type of block copolymers, and the effect of the varying crosslink densities of different polymer-epoxy mixtures. The toughness testing process involves expensive analytical equipment, so translating this research experience to a high school classroom requires significant changes. In this project, students will make 'super' balls from different polymers. They will use a spherical mold to standardize the volume of the ball. Instead of measuring the force required to propagate a crack through a uniform polymer sample, my students will test the 'super' balls' durability and relate their findings to crosslink density of the materials used for each type of ball.

63. **Bradley Christensen**
Analysis of Prescreening High Purity Germanium Detector
Summer Advisor: Prof. Priscilla Cushman
Department/Program Sponsor: Physics REU
Home Institution: University of Rochester
Abstract:
An analysis of a High Purity Germanium detector used for prescreening of materials for the Cryogenic Dark Matter Search experiment was conducted to reduce background levels. Initial results indicated a potential irradiated lead brick, but further analysis determined this incorrect. A check for electronic noise also proved to be negligible. Additional screening of the lead bricks used in the shield presented evidence of the contamination from Pb-210. Currently steps are being taken to clean the lead bricks and restack the shield. Estimates place the background reduction by a factor of two, but the target decrease is by a factor of ten. Monte Carlo simulations have begun in an attempt to determine other causes for further reduction.

64. **Lillivette Colon**, Jared Stoeger
Synthesis and Characterization of C-oriented MFI Membranes
Summer Advisor: Michael Tsapatsis
Department/Program Sponsor: MRSEC REU
Home Institution: University of Puerto Rico at Mayaguez
Abstract:
MFI membranes have been widely investigated because of their potential applications for energy efficient separation processes. Interest in such materials rests in their ability to discriminate molecules based on size and shape as well as their high thermal and chemical stability. MFI membranes are synthesized under hydrothermal conditions in order to form a continuous zeolite layer on the substrate surface and following the deposition of 100 nanometers of zeolite particles. Zeolites particle morphology and concentration can affect the zeolite crystal orientation in the layer. C-oriented MFI membranes are interested because of their pore orientation, which is perpendicular to the support. A rapid calcination technique may be used to remove organic molecules occluded in the MFI pore structure, as well as limit debilitating crack formation, resulting in a higher quality membrane for separations applications.

65. **Ryan Davis**, Rick Liptak, An-Jen Cheng, Prof. Stephen Campbell
Refinement of Quantum Dot Light Emitting Diodes
Summer Advisor: Prof. Stephen Campbell
Department/Program Sponsor: MRSEC REU
Home Institution: University of Wisconsin- Eau Claire
Abstract:
Electro optical devices such as LEDs that incorporate nanoparticles as luminescent elements require several layers to function appropriately. These may include electrodes, electron transport layers, hole transport layers, windows, and other blocking layers. Each layer must be chosen with the appropriate energy levels and transport properties, so that the layers can work together to form a well-functioning device, where current flows uniformly through the device while efficiently generating light. Even when chosen appropriately, however, there can still be problems with the layers, which can cause them to short, burn out, or redirect current in an undesirable way. This project focuses on the refinement of two device layers planned for use in silicon quantum dot light emitting diodes: Titanium Oxide (TiO2), and nanoparticle doped Silicon Dioxide.

66. **Sean Dobberstein**

Cataloging HII Regions of Nearby Galaxies: Preliminary Results

Summer Advisor: Evan Skillman
Department/Program Sponsor: Physics REU
Home Institution: Northern Michigan University

Abstract:
Information about the chemical evolution of spiral galaxies can be gathered by examining HII regions. Spectra of HII regions provide information on the chemical abundances and age of stars in the galaxy being analyzed. To study chemical evolution, we have begun to create a catalog detailing the HII regions of 23 nearby spiral galaxies (distance < 30 Mpc). We took initial data from the SINGS database and used it to create line and continuum images. These images were then used to conduct automatic photometry using HIIphot, an IDL program. This poster presents the initial data from this catalog.

67. **Matthew Drake**

Electric Fields and He4 at the Lambda Transition

Summer Advisor: William Zimmerman
Department/Program Sponsor: Physics REU
Home Institution: University of Massachusetts Amherst

Abstract:
This project was concerned with observing the lambda transition of He4 and finding what effects can be created with the application of large electric fields. Preliminary results have shown us that we can create fields on the order of E=200MV/m. Soon, an apparatus will be finished that can regulate temperature and find changes in flow rate and lambda transition temperature.

68. **Michelle Dwyer**

Adapting Biomedical Engineering for the High School Classroom

Summer Advisor: Chun Wang
Department/Program Sponsor: MRSEC RET
Home Institution: Chicago Hope Academy

Abstract:
In current research at the University, DNA plasmids are delivered to mammalian cells using a polymer for efficient uptake for development of DNA vaccines. Transfection is observed using a GFP (Green Fluorescent Protein) on the plasmid or a Fluorochrome die. In the Biology classroom, this basic process will be utilized to connect high school students to the modern uses of this biological engineering.

69. **Eric Dzienkowski**

A Step-Bot's Journey Towards Flat PVC Modules

Summer Advisor: Daniel Cronin-Hennessy
Department/Program Sponsor: Physics
Home Institution: Rensselaer Polytechnic Institute

Abstract:
The detectors for the NOvA experiment are made from PVC extrusions glued together to make a matrix to track particles' paths in space. When the extrusions are glued together to make modules, the result must be vertically offset by less than 9 mils. A robot was built to measure the vertical offset, or step height, of a module. The robot drives down a module, optically measures the step height, and wirelessly sends the data to a remote computer. A discussion of the robot operation, the accuracy of measurements, and current state of module production for a full scale prototype of a detector is included.

70. **Grace Elwell**
Clean Environment for Sensitive Detection Equipment
Summer Advisor: Vuk Mandic
Department/Program Sponsor: Physics REU
Home Institution:
Abstract:
A clean room environment was designed and constructed to provide a contamination-free location to work with and store detectors and other sensitive equipment for the Cryogenic Dark Matter Search experiment before they are installed in fridges. Initially the target environment was a class 10,000 room; but upon completion of construction, preliminary tests have shown that the original cleanliness goals may have been exceeded. However, this could be due to inaccurate testing equipment. Further tests are being run to confirm the cleanliness of the room. Current estimates for the level of cleanliness place the room between class 150 and class 300.

71. **Vanessa Engquist**
Study of Auroral Kilometric Radiation and the Interplanetary Magnetic Field
Summer Advisor: Dr. John Wygant
Department/Program Sponsor: UMN Physics
Home Institution: University of Nebraska at Kearney
Abstract:
Auroral Kilometric Radiation (AKR) is a powerful radio emission generated high above the Earth. A coronal mass ejection (CME) occurs when the sun expels enormous amounts of plasma, containing highly energized particles, into space. When CMEs hit the Earth, intense and increased auroral displays occur. It has previously been shown that when auroras occur, so does AKR. Further study into the relationship between the z-component (northward/southward direction) of the interplanetary magnetic field (IMF) and AKR is important because it applies, not only to our solar system, but also to planets outside our solar system.

72. **Lizbeth Esquivel**, Dr. Timothy Lodge, Dr. Luciana Meli, Dr. Lei Zhang
Studying the Formation of Diblock Copolymer Micelles in an Ionic Liquid Using Dynamic Light Scattering
Summer Advisor: Dr. Timothy Lodge
Department/Program Sponsor: MRSEC REU
Home Institution: Winston Salem State University
Abstract:
Block Copolymers are defined as 'a polymer composed of molecules in which two or more polymeric segments of different chemical compositions are attached end-to-end.' Block copolymers are used for drug delivery and commercial applications. Two types of block copolymers used in this experiment are poly-butadiene and poly-ethylene-oxide. Both of these block copolymers are observed and analyzed based on their behavior and interaction when mixed with ionic liquid and/or the cosolvent, dichloromethane. This process is also being analyzed in the formation of micelles. Micelles are described as an aggregate of surfactant molecules dispersed in a liquid colloid. Micelles are used in industry for detergency and solubilizing agents. A technique used to analyze this procedure is called dynamic light scattering. Dynamic light scattering is used to measure hydrodynamic radius of micelles as a cosolvent concentration to identify the formation of micelles. Through an interpretation of graph it is determined if micelles are formed and the size of the micelle using different cosolvent concentrations. This project will help in understanding the mechanism of formation of micelles.

73. **Aaron Feickert**
Effect of HCAL Segmentation on Signal Survival in CMS
Summer Advisor: Jeremiah Mans
Department/Program Sponsor: UMN Physics Department
Home Institution: North Dakota State University
Abstract:
The Compact Muon Solenoid is a general-purpose particle detector at the Large Hadron Collider. The detector currently performs a single readout of energy for each tower along the entire depth of its hadronic calorimeter. Future upgrades to the detector include the segmenting of layers of the hadronic calorimeter for the purpose of improving the purity of signal. In this study, we consider new algorithms for analyzing particles depositing energy into the electromagnetic and hadronic calorimeters. We examine the effects of various layer segmentations and energy deposition cutoffs to determine the optimal setup for maintaining the survival of signal. Preliminary results using a dielectron simulation indicate a marked increase in signal purity using layer segmentation. Further study is in progress to give more precise quantitative results.

74. **Kathleen Foote**
Investigating the Concept Test Gender Gap in Introductory Level Physics Courses
Summer Advisor: Dr. Kenneth Heller
Department/Program Sponsor: Physics REU
Home Institution: Providence College, RI
Abstract:
Gender differences in concept test scores and course performance are analyzed in introductory level calculus based physics courses, taught using Cooperative Group Problem Solving, for Scientist & Engineering majors at the University of Minnesota. The Force Concept Inventory (FCI), Conceptual Survey of Electricity and Magnetism (CSEM) and Brief Electricity and Magnetism Assessment (BEMA) diagnostic tests are used to quantify the concept test gender gaps in 1st semester Mechanics courses and 2nd semester Electricity and Magnetism courses. Males consistently score considerably higher than females on the FCI pre- and post- tests. A diminished gender gap remains in the Electricity and Magnetism course, starting small on both pretests but increases by post-test. Background variables and math skills are examined to attempt to account for this gap.

75. **Bonnie Gordon**, Greg McKusky, Tanner Schulz
Magnetic Domain Wall Resistance in Ni81Fe19 Permalloy Films
Summer Advisor: Dan Dahlberg
Department/Program Sponsor: MRSEC REU
Home Institution: Harvey Mudd College
Abstract:
A technique has been developed to measure magnetic domain wall resistance as a function of wall compression, in an attempt to observe giant magnetoresistance at the scale of individual neighboring electrons. The magnetization of one end of a 1000Å ferromagnetic Ni81Fe19 film was fixed by embedding it in a permanent NdFeB magnet. The domain wall was created by applying a magnetic field in the opposite direction of the permanent magnet using an electromagnet. We have measured the resistance across the domain wall as a function of the applied magnetic field. The measured field-dependent resistances may be dominated by anisotropic magnetoresistance and not giant magnetoresistance which was the focus of this project.

76. **Jon Graves**
Supernovae - Shockwave Propagation
Summer Advisor: Dr. Yong-Zhong Qian
Department/Program Sponsor: NSF
Home Institution: University of Nebraska at Omaha
Abstract:
Supernovae are known to explode with incredible forces. However, shortly after the core collapses to form a shockwave, gravity stalls it. That shock must be recharged with energy in some fashion in order to continue propagating. Though they emit enough visible light that they rival an entire galaxy in brightness, that energy is only about 1% of that which is required to recharge the shock. The required energy comes from nearly massless particles known as neutrinos, which pour forth from the newly made neutron star core in such copious quantities that they become very significant in recharging the shock and sending it on its way.

77. **Claire L. Hypolite**, Fadumo Abdullahi
Shrinky Dink Microfluidics In the High School Classroom
Summer Advisor: Kevin Dorfman
Department/Program Sponsor: MRSEC RET
Home Institution: Edison High School
Abstract:
Bringing microfluidics to the high school classroom has been helped by research showing that the children's toy, Shrinky Dinks, can be used to create inexpensive molds. This research uses the printed Shrinky Dink (SD) itself as the microfluidic device. Patterns of channels are created on the SD plastic using a laser printer. The channels are printed on the SD such that the ink forms the channel boundary. When heated, the plastic and the ink patterns shrink to about one-third their original length and width, while becoming up to nine times thicker. Printed and unprinted SD are shrunk together, sandwiching the ink between them, which channels forming in the un-inked areas. Fluid can then flow through the channels via capillary action.

78. **Cecily Keppel**, Chunyong He

Torque Magnetometry on $La_{0.70}Sr_{0.30}CoO_3$ Single Crystals

Summer Advisor: Chris Leighton

Department/Program Sponsor: MRSEC REU

Home Institution: Harvey Mudd College

Abstract:

Doped perovskites cobaltites are of considerable current interest as they display magnetic phase separation, and are suspected to have high magnetocrystalline anisotropy. We performed torque magnetometry on $La_{0.70}Sr_{0.30}CoO_3$ (LSCO) crystals in order to directly determine the magnetocrystalline anisotropy constants. Standard practice in such measurements is to acquire torque magnetometry curves in magnetic fields large enough to completely saturate the torque. Surprisingly, we observed clear non-saturation in the torque vs. field curves of LSCO, preventing simple analysis. In order to explain this anomalous behavior we hypothesize that small non-ferromagnetic (non-FM) regions (arising due to magnetic phase separation) contribute significantly to the torque, but little to the magnetization. We discuss a fitting method designed to separate FM and non-FM components, enabling determination of the intrinsic FM anisotropy.

79. **Wafa Koubaa**

Polymer Based Silica Coatings

Summer Advisor: Dr. Francis

Department/Program Sponsor: MRSEC REU

Home Institution: University of Pittsburgh

Abstract:

Coatings are usually made of a solution, water in most cases, and particles such as silica. When this coating dries and solution leaves, the particles left behind are compacted to the surface. Properties of the coating are thus directly related to how the particles are positioned and how they got there. The main regions or pathways that they take are evaporation, sedimentation, and diffusion. In this project, a new experiment is done where the coating is made of mostly a polymer solution, polyvinyl alcohol, rather than water. The polymer chains complicate the process because they do not leave like water does when the coating dries but rather are entangled with the particles in the dry coating. The project looks at how the polymer behaves in the above three pathways, how the particles interact with it, and the properties of this new polymer based coating. To begin, the polymer is made and tested for viscosity and the rheology properties. This s used to find important relationships like the Peckley and Sedimentation numbers. The logs of these numbers are used to determine the region on the drying map that the coating sample lies on. Experiments are run to see this in actuality at different stages in the drying of the coating through the different pathways and conditions. To do this, the sample can be frozen in time with liquid nitrogen and analyzed microscopically at the cross section with a Scanning Electron Microscope (SEM). The silica made was around 200 nm, 500 nm, and 1 um in diameter and the polymer will have a certain viscosity based on the concentration of the coating. Standards such as these are needed in order to have only the desired effect changing so that an accurate analysis can be made and the behavior predicted. Also with these standards it will be possible to see when samples move between the regions or pathways such as from evaporation to diffusion.

80. **Xingcheng Liu**

Differential Scanning Calorimetry and Rheology Studies on Poly(methyl methacrylate) and Ionic Liquid Mixtures

Summer Advisor: Prof. Timothy P. Lodge

Department/Program Sponsor: NSF/Lando, Chemistry Department

Home Institution: Wabash College

Abstract:

Homogeneous polymer containing poly(methyl methacrylate) (PMMA) with an ionic liquid 1-ethyl-3-methylimidazolium-bis(trifluoromethylsulfonyl)imide (EMI-TFSI) have been examined over the entire composition range via differential scanning calorimetry (DSC) and rheology to explore the presence of two glass transitions (Tg) and their viscoelastic properties. The samples with 35-55% PMMA showed two distinct glass transitions, and the glass transition width was broadening while their ratio was approaching 1:1. The composition dependence of Tg was different at high and low polymer concentrations. In addition, the depression of EMI-TFSI crystallization was observed. The rheological results of all samples were studied, based on time-temperature superposition (TTS), to generate a master curve at 140ºC with the entire composition range. The plateau modulus and viscosities of the mixtures were also reported.

81. **Alex Madsen**
pH-sensitive Polymersomes for Cancer Targeting
Summer Advisor: Professor Efie Kokkoli
Department/Program Sponsor: MRSEC REU
Home Institution: University of Minnesota, Morris
Abstract:
Fighting cancer is a fundamental issue, yet conventional chemotherapy often has major detrimental side effects to the patient. Self-assembled, nanoscale polymeric vesicles, also known as polymersomes, are drug delivery vehicles that can accumulate in tumors and release drugs in order to combat cancer cells. The use of specific targeting ligands promises to enhance the specificity and efficacy of this process. We are working on synthesizing diblock copolymers made of vinyl sulfone-terminated poly(ethylene oxide) and poly(ã-methyl-å-caprolactone) through multistep syntheses. These diblock copolymers will be dispersed to form degradable polymersomes capable of tethering a targeting ligand. The degradation of these polymersomes will later be studied at multiple values of pH to better predict degradation inside the acidic environment of a cancer cell.

82. **Jesse Olson**
Inquiry Using Dye Sensitized Solar Cells
Summer Advisor: Eray Aydil
Department/Program Sponsor: MRSEC RET
Home Institution: Anoka Hennepin ISD 11
Abstract:
I am designing curriculum based on scientific inquiry aimed at implementation within an alternative high school. The curriculum is focused on using the best practice of inquiry within the classroom. The poster will show several different ways in which teachers could use dye sensitized solar cells during an inquiry investigation.

83. **Tessie Panthani**, Ankur Khare
Synthesis of Cu2ZnSnS4 Nanoparticles for Solar Cell Applications
Summer Advisor: Eray Aydil, David Norris
Department/Program Sponsor: MRSEC REU
Home Institution: Case Western Reserve University
Abstract:
Excitonic solar cells made from nanocrystal quantum dots are being explored as an alternative to the currently used bulk or thin film solar cells due to a potential for increasing efficiency and lowering cost. However, most nanocrystal solar cells explored to date have been fabricated from materials containing lead or cadmium which being harmful to the environment limits the possibility of their commercial use. Cu2ZnSnS4 (CZTS) is being researched as an alternate to these materials. CZTS contains copper, zinc, tin and sulfur which are environmentally friendly, low-cost and abundant elements. Nanocrystal-based electronic devices require monodisperse nanocrystals for efficient operation. In order to synthesize size-selected, monodisperse single phase CZTS nanocrystals, diethlydithiocarbamate complexes of copper, zinc and tin were used as precursors in an air-free synthesis.

84. **Mark Pepin**
Seasons and Shadows: Soudan II Cosmic Ray Data
Summer Advisor: Dr. Marvin Marshak
Department/Program Sponsor: Physics REU
Home Institution: Creighton University
Abstract:
We analyze the cosmic ray data from the Soudan II Experiment with two objectives in mind. The first objective is to find the cosmic ray shadows made by the moon and sun. Both celestial bodies absorb incident cosmic rays and prevent the rays from reaching the Earth. Thus a deficit in the cosmic ray data in the direction of either body is expected. Secondly, a correlation between the cosmic ray rate and the atmospheric temperature is sought. As the atmosphere warms it also expands. This expansion causes more detectable particles to reach the underground detector. Hence a positive correlation is expected between the rate and temperature.

85.	**Christopher Pierse** ***Kinetics of Actin Polymerization and Gene Expression*** Summer Advisor: Vincent Noireaux Department/Program Sponsor: NSF, Physics REU Home Institution: Saint Louis University **Abstract:** When working in vitro with an artificial cell system, understanding the kinetics of processes such as gene expression and actin polymerization is essential. Using a heat sink and peltier scheme, we create several tools to analyze the temperature-dependent kinetics of both systems. Although each setup emulates the temperature gradients and oscillations desired, neither actin polymerization nor gene expression occurred in a sufficient quantity to make any significant conclusions.
86.	**Katherine Reeves** ***Photon Energy Resolution in the BES-III Electromagnetic Calorimeter*** Summer Advisor: Peter Zweber, Prof. Daniel Cronin-Hennessey Department/Program Sponsor: UMN Physics Home Institution: Univesity of Minnesota Twin Cities **Abstract:** A study of the Photon Energy Resolution in the BES-III Electromagnetic Calorimeter. Data samples and generic Monte Carlo simulations, of the Psi2S decay chain were studied because of its clear energy peaks. I applied cuts on the ranges of the data I sample to produce a clear sample. I also applied cuts on the cosine of the angle of the event as it left the detector to ensure that my events were in the correct region for most effectiveness. After applying these cuts I fit the peaks to a Bright-Wigner convoluted with a Crystal Ball equation and compared the fit of the data samples with the fit of the Monte Carlo samples, as well as the tabulated true literature values. We found that the Monte Carlo was near 70 percent of the data sample. The Monte Carlo simulates the Data to within 70 percent of its true magnitude.
87.	**Daniel Segura** ***Verification of GPU Based Lattice Boltzmann Fluid Flow Simulation Accuracy Using CUDA*** Summer Advisor: Prof. David Lilja Department/Program Sponsor: STEM Alliance Home Institution: University ofMinnesota, Twin Cities **Abstract:** Methods of verifying the integrity of solutions provided by a new implementation of the lattice Boltzmann method are investigated. This new implementation utilizes programs that harness nVidia graphics processing units to numerically approximate solutions to various fluid flow problems. These programs use 32 bit single and 64 bit double precision floating point variables are compared to analytical solutions to determine the error in the computation. Performance of the codes is also investigated to gauge the benefit brought buy this code in reference to standard central processing unit lattice Boltzmann method implementations. Unfortunately, due to several "road blocks" further investigation is necessary to assess the impact of single vs double precision as well as the possibility of developing a mixed precision code.

88. **Mei Sun**

Analysis of Glucose Mediated Crosslinking Mechanism in a 3-Methacrylamido Phenylboronic Acid-co-Acrylamide (MPBA-co-AAM) Hydrogel

Summer Advisor: Ron Siegel
Department/Program Sponsor: MRSEC REU
Home Institution: Macalester

Abstract:
Hydrogels are crosslinked polymer networks that are used in biomedical applications. Of specific interest are glucose-sensitive hydrogels based on poly(3-methacrylamideophenylboronic acid-co-acrylamide) (MPBA-co-AAm), which may be useful in glucose-sensing applications for treating diabetes mellitus. These hydrogels are prepared by redox copolymerization with different amounts of MPBA, and AAm, plus a crosslinker, methylenebisacrylamide (Bis). MPBA-co-AAm hydrogels undergo shrinking/swelling as a function of glucose concentration, due to the reversible formation/disruption of glucose mediated crosslinks between polymer chains, which coexist with the permanent crosslinks due to Bis. Thorough characterization of equilibria and dynamics of the glucose-mediated crosslinks will be needed in order to fully exploit the hydrogels for their intended purposes. Our experiment will consist of the following components: (1) Synthesis of MPBA from AAm and phenyboronic acid (2) Synthesis of MPBA-co-AAm copolymer hydrogels (3) Molding cylindrical disk hydrogels (4) Hydrogel Swelling (5) Compression test. We expect the force-time curve will reach a peak in the very beginning and decay as time goes by till it stays constant. The compression test will be used to mathematically formulate the relationship between the glucose concentration and the density of glucose crosslinks in the hydrogels.

89. **Bryce Williams**

Characterization of Gas Separation Polymer Membranes

Summer Advisor: Prof. Edward Cussler
Department/Program Sponsor: MRSEC REU
Home Institution: Iowa State University

Abstract:
Use of polymer membranes for gas separation processes has become quite popular. This work focuses on membranes used for natural gas purification. Raw natural gas must be processed to remove excess carbon dioxide before it is sold. This has proved problematic in the past, because carbon dioxide plasticizes membranes reducing their selectivity. A new membrane was created by cross-linking poly(norbornenylethylstyrene)-b-poly(N,N-dimethylaminoethyl methacrylate) (PNS-b-PDMAEMA) with cyclooctene (COE). The resulting membrane has a carbon dioxide permeable phase, the PDMAEMA block, while the rest of the membrane is essentially gas impermeable. The cross-linking provides a structure for the permeable phase. This reduces the plasticizing effect. At this point, research is focused on measuring the permeability and selectivity properties of the membrane.