

2008 Summer Symposium Schedule

Thursday, July 31 8:45 am – 12:30 pm

Oral Presentations: Festival Conference Center

8:45 Oral Session I: moderator with opening remarks

9:00 Paris Hamilton and Kevin Caran, "SYNTHESIS, STRUCTURAL, AND THERMOSTABILITY STUDIES OF LOW-MOLECULAR-WEIGHT ORGANOGELATORS"

9:15 Tatiana Niculescu, Dan Amon, and Brian Utter, "2D GRANULAR AVALANCHES WITH IMPOSED VIBRATIONS"

9:30 Christian R. Schwantes, Devon C. Flaherty, Kevin P. C. Minbiole and Reid N. Harris, "DEVELOPING A BACTERIAL TREATMENT USING *Janthinobacterium lividum* FOR AMPHIBIANS *Rana muscosa* AND *Plethodon cinereus* INFECTED WITH *Batrachochytrium dendrobatidis*"

9:45 Trevor Luks and Scott Paulson, "BRINGING NANOSCIENCE TO THE CLASSROOM"

10:00 Amanda Hoffman and Debra Mohler, "THE SYNTHESIS AND EFFECT OF ANCHORING GROUPS ON INTERFACIAL ELECTRON TRANSFER RATE"

10:15 Jonathan C. Axtell, M. Pash DeVore, Marita C. Lawler, Elisabeth A. Lehigh, and Kevin P. C. Minbiole, "CYCLOPROPANE FRAGMENTATION APPROACHES TO THE SYNTHESIS OF PIPERIDINES AND AZEPINES"

10:30 Break

Oral Session II: moderator

10:45 Dillon Trelawny and Ioana Niculescu, "PMT AND SCINTILLATOR TESTING FOR THE SUPER HIGH MOMENTUM SPECTROMETER AT JEFFERSON LAB"

11:00 Nicole Ando, Donna S. Amenta, and John W. Gilje, "RUTHENIUM COMPLEXES CONTAINING $\text{PPH}_2(\text{CH}_2)_N\text{P}(\text{O})\text{PH}_2$ LIGANDS"

11:15 Joe Hardcastle, Lok-kun Tsui and Scott Paulson, "FABRICATION OF MULIWALLED CARBON NANOTUBE OSCILLATORS"

11:30 Lok-kun Tsui, Joe Hardcastle and Scott Paulson, "APPLICATION OF AN EBL ALIGNMENT PROCEDURE TO THE STUDY OF CARBON NANOTUBES"

11:45 William R. Cannon and Gina MacDonald, "THE EFFECT OF HIGH CONCENTRATION SALT ON THE STRUCTURE, STABILITY, AND AGGREGATION OF RECA"

12:00 Stephanie L. Hall and Daniel M. Downey, "EPISODIC MONITORING PROJECT: PART I. THE ANALYSIS OF ORGANIC PESTICIDES IN THE SOUTH FORK SHENANDOAH RIVER AND CUB RUN IN STORM RUNOFF EVENTS"

12:30 – 1:30 Lunch "on your own"

Poster Presentations: Main Hallway - Physics and Chemistry Building

1:30-3:30 Poster Session –

List of Posters:

1. Alexandra Allen and Debra Mohler, "DNA CLEAVAGE BY HYDROLYSIS"
2. Nathalie Jaeger, John W. Gilje & Donna S. Amenta, "MONOHYDRIDE RUTHENIUM COMPLEXES OF BIS(DIPHENYLPHOSPHINO) ALKANE OXIDES"
3. Jennifer Pacchiana, Steven Kulsar and Brenda Seal, "DECODING NOVEL NUMBERS IN AMERICAN SIGN LANGUAGE"
4. Jon Willcox, W. Christopher Hughes and Brian Augustine, "FABRICATION OF MICROFLUIDIC PCR AND EOF DEVICES"
5. Brittany Branch-Smith and Gina MacDonald, "CIRCULAR DICHROISM AND FLUORESCENCE STUDIES OF SALT EFFECTS ON RECA-NUCLEOTIDE COMPLEXES"
6. Jonathan C. Axtell, M. Pash DeVore, Marita C. Lawler, Elisabeth A. Lehigh, and Kevin P. C. Minbiole, "CYCLOPROPANE FRAGMENTATION APPROACHES TO THE SYNTHESIS OF PIPERIDINES AND AZEPINES"
7. Samuel Ahlias Moore, Matthew Eddy, and Kathryn A. Layman, "ATR-FTIR INVESTIGATION OF *P*-CRESOL OXIDATION ON ALUMINA-SUPPORTED COBALT OXIDE CATALYSTS"
8. Nicholas M. Dugan, and Daniel M. Downey, "EPISODIC MONITORING PROJECT: PART II. FIELD MEASUREMENTS, INORGANIC IONS AND TRACE METAL CONCENTRATIONS"
9. Treise Lively, W. Chris Hughes and Brian Augustine, "FABRICATION OF EMBEDDED FLUORESCENT PROBES IN POLYMERIC MICROFLUIDIC SUBSTRATES"
10. Jacob W. Smith and Daniel M. Downey, "EPISODIC MONITORING PROJECT: PART III. QUANTITATIVE ANALYSIS OF GLYPHOSATE BY ION CHROMATOGRAPHY"
11. Jonathan Wyrick, Brian H. Augustine, W. Christopher Hughes and Scott Paulson, "NANO MANIPULATION IN A SUITCASE: USING A PORTABLE AFM COUPLED WITH 3D INTERACTIVE SOFTWARE TO DEMONSTRATE SUB-MICRON INTERACTIONS"
12. Christopher Sloan and Gina MacDonald, "USING INFRARED SPECTROSCOPY TO EXAMINE THE STABILITY AND STRUCTURE OF MYOGLOBIN"
13. Vanessa Shepperson, John W. Gilje & Donna S. Amenta, "PREPARATION AND SPECTRAL CHARACTERIZATION OF $\text{Ru}(\text{CO})_2(\text{PPh}_2\text{CH}_2\text{CH}_2\text{P}(\text{O})\text{Ph}_2)_3$ "
14. Glenn Young, Roddy Amenta, and Brian Utter, "AN APPARATUS FOR MODELING CONSTRICTIONS IN GRANULAR-FLUID FLOW"

15. Scott G. Polivka and Gina MacDonald, "PURIFICATION OF THE RECA PROTEIN"

Friday, August 1 9:00 am – 12:15 pm

Oral Presentations: Festival Conference Center

Oral Session III: moderator

9:00 Tracy Nichols and Scott B. Lewis, "THE SYNTHESIS OF 1,2-DISUBSTITUTED CYCLOBUTENES FOR STUDY WITH DIFLUOROCARBENE"

9:15 Matthew Bradley, Ashley J. Figueiredo, Brian Augustine and W. Chris Hughes. "MICROSCOPY ANALYSIS OF POSS-MA ON SiO₂ SURFACES"

9:30 Kristina Hamill, and Kevin Caran, "BISCATIONIC BICEPHALIC (DOUBLE HEADED) AMPHIPHILES"

9:45 Kevin Kindley, Hollee Kitts, Allyson Jones and Kathryn Layman, "CHARACTERIZATION OF MAGNETIC IRON OXIDE COMPOSITES"

10:00 Ralph Herman and Brian Utter, "SHEAR STRESSES IN A SATURATED TO NEAR-SATURATED WATER/SAND SYSTEM FLUIDIZED BY VERTICAL VIBRATION"

10:15 Seth K. Berkeley and Barbara A. Reisner, "IDENTIFICATION OF STUDENT MISCONCEPTIONS THROUGH CONCEPTIONS ANALYSIS"

10:30 Break

Oral Session IV: moderator

10:45 Adam Colbert, Gina MacDonald, "USING DIFFERENCE INFRARED SPECTROSCOPY TO INVESTIGATE THE EFFECTS OF pH ON PGK-SUBSTRATE COMPLEXES"

11:00 Courtney Braxton, Robert East, and Victoria Mariani, "CLONING AND EXPRESSION OF *N*-ACYLETHANOLAMINE-HYDROLYZING ACID AMIDASE AND ACID CERAMIDASE TOWARDS A BETTER UNDERSTANDING OF LYSOSOMAL AMIDOHYDROLASES"

11:15 Alan Mo, Brian Augustine and William Hughes, "IMPROVING THE ADHESION OF GOLD TO PMMA USING POSS-MA"

11:30 Curtis White and Tom DeVore. "CHARACTERIZING INTERMOLECULAR FORCES OF SIMPLE LIQUIDS BY VAPOR PHASE NMR"

11:45 Christopher Willis and Ioana Niculescu, "NEUTRON DETECTION EFFICIENCY STUDIES FOR THE CLAS DETECTOR AT JEFFERSON LAB"

12:00 Jennifer L. Bon and Scott B. Lewis, "THE SYNTHESIS OF BICYCLO[4.2.0]OCT-7-ENE AND OTHER SUBSTITUTED CYCLOBUTENES FOR REACTIONS WITH DIFLUOROCARBENE"

12:20 Group photographs in front of Physics / Chemistry Building followed by Luncheon at Dave's Downtown Taverna

Summer Research Symposium in Chemistry, Physics and Materials Science

16th Annual Summer Symposium

July 31 – August 1, 2008

Compiled Abstracts

For many of the student participants in JMU summer research, activities began in May. For others research projects began in the spring semester, or earlier. Either way the past ten weeks has been a time of intense activity in the laboratories of the Physics and Chemistry building. This symposium is the concluding activity for this summer and presents an opportunity for the student researchers to describe their work to a public audience. To arrive at this point, however, was an expensive and labor intensive undertaking and it must be remembered that projects have been supported primarily by grants and funds provided by external agencies and foundations. We appreciate this support and acknowledge the following sponsors. The keystone of chemical research at JMU during the summer has been the grant from the National Science Foundation Research Experiences for Undergraduates (NSF-REU) program chemistry division for many years. Other grants that support summer research in chemistry, physics and materials science include NSF Research in Undergraduate Institutions programs, other NSF grants, American Chemical Society Petroleum Research Fund, Camille and Henry Dreyfus Foundation, Tickle Bliss Foundation, Virginia Department of Environmental Quality, Virginia Department of Game and Inland Fisheries, USDA Forest Service, Jeffress Memorial Trust, James Madison University Departments of Chemistry & Biochemistry, Physics, Geology, Biology, Communication Sciences and Disorders, Center for Materials Science, Colleges of Science & Math and Integrated Science & Technology and James Madison University Internal Funds. We also acknowledge the faithful dedication shown by our students and students from other universities and colleges that have participated in the summer research program. We thank the Office of Sponsored Programs, Grants Accounting, Purchasing, other university and departmental staff and administrators who have provided incredible support both in the current summer and in past years. We acknowledge the housing support provided by JMU for many of the students. Finally, and perhaps most important, we thank the faculty for writing, achieving and administering the external funding that makes this program possible, and their willingness to spend the summer in the lab mentoring the students.

Alphabetized list of abstracts by first author:

DNA CLEAVAGE BY HYDROLYSIS

Alexandra Allen and **Debra Mohler**, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg VA 22807

The chemical reaction of $[\text{FeCp}(\text{CO})_2]_2$ and H_2O_2 has been shown to formally hydrolyze the sugar phosphate backbone of DNA without the presence of light. In this presentation, the mechanism of this reaction is explored. In particular, the pH dependence of the reaction is examined by treating plasmid DNA with $[\text{FeCp}(\text{CO})_2]_2$ and H_2O_2 and determining the amount of cleavage by agarose gel electrophoresis.

RUTHENIUM COMPLEXES CONTAINING $\text{PPh}_2(\text{CH}_2)_n\text{P}(\text{O})\text{Ph}_2$ LIGANDS

Nicole Ando, **Donna S. Amenta**, and **John W. Gilje**, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg, VA 22807

The reactions of $\text{Cl}_2\text{Ru}(\text{PPh}_3)_2$ with 1 equivalent $\text{PPh}_2\text{CH}_2\text{P}(\text{O})\text{Ph}_2$ and 1 or 2 equivalents of $\text{PPh}_2\text{C}_2\text{H}_4\text{P}(\text{O})\text{Ph}_2$ were run in toluene at room temperature. From the first reaction $\text{Cl}_2\text{Ru}(\text{PPh}_3)_2(\text{PPh}_2\text{CH}_2\text{P}(\text{O})\text{Ph}_2)$ was characterized by variable temperature ^{31}P NMR spectroscopy. The room temperature spectrum consists of broad, ill defined resonances that sharpen as the sample is cooled. From the 220K spectrum coupling constants and chemical shifts can be extracted and indicate that one PPh_3 is trans to the PPh_2 group of the $\text{PPh}_2\text{CH}_2\text{P}(\text{O})\text{Ph}_2$ ligand and that the second PPh_3 is cis to both of these. When the reaction is run in acetonitrile a complex that we postulate to be $\text{Cl}_2\text{Ru}(\text{PPh}_3)(\text{PPh}_2\text{CH}_2\text{P}(\text{O})\text{Ph}_2)$ is observed. The chemical shifts of the PPh_2 and $\text{P}(\text{O})$ moieties indicate that both the phosphino phosphorus and phosphoryl oxygen are bonded to the Ru. We postulate that the acetonitrile facilitates the dissociation of the second PPh_3 and that acetonitrile may be coordinated to the Ru in the final product. The ^{31}P NMR spectra of the products from the reactions between $\text{Cl}_2\text{Ru}(\text{PPh}_3)_2$ with either 1 or 2 equivalents of $\text{PPh}_2\text{C}_2\text{H}_4\text{P}(\text{O})\text{Ph}_2$ were not well defined at room temperature. Upon cooling the spectra underwent changes, but well defined peaks were not obtained.

CYCLOPROPANE FRAGMENTATION APPROACHES TO THE SYNTHESIS OF PIPERIDINES AND AZEPINES

Jonathan C. Axtell¹, **M. Pash DeVore**², **Marita C. Lawler**, **Elisabeth A. Lehigh** and **Kevin P. C. Minbiole**, Department of Chemistry and Biochemistry, MSC 4501, James Madison University, Harrisonburg, VA 22807

The ring expansion of hydroxycyclopropanes can be exploited for the stereocontrolled formation of oxygenated heterocycles such as oxepanes. Progress has been made toward the synthesis of nitrogenous heterocycles, particularly piperidines and azepines, via analogous fragmentation/recondensation strategies. This method condenses carbamate- or sulfonamide-substituted cyclopropanols with a carbonyl moiety, producing an amina. This amina either remains protected or can be deprotected with TMSOTf, and then under Lewis acid promotion the amina is expected to rearrange to form a piperidine or azepine. This rearrangement is still under investigation and different Lewis acids furnish different results. The use of various amine protecting groups, carbonyls, ring size, and Lewis acids will be discussed.

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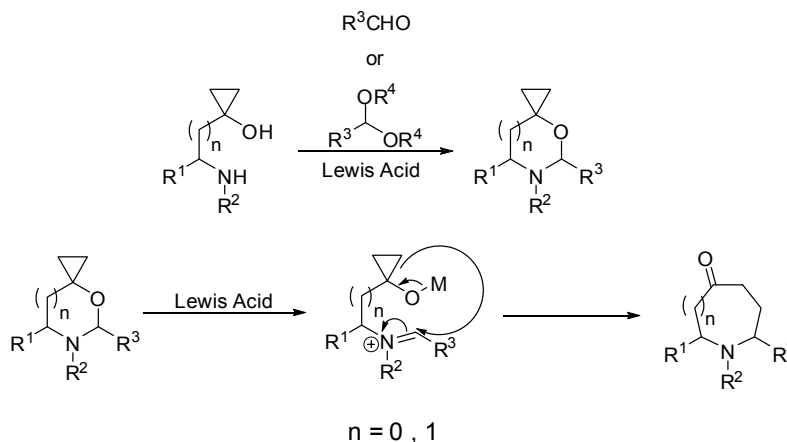


Figure 1. Reaction scheme for Axtell et al.

IDENTIFICATION OF STUDENT MISCONCEPTIONS THROUGH CONCEPTIONS ANALYSIS

Seth K. Berkeley and **Barbara A. Reisner**, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg VA 22807

New laboratory modules using the Model-Observe-Reflect-Explain (MORE) Thinking Frame have been developed for General Chemistry II Laboratory. The goals of MORE Thinking Frame, and the modules developed for it, are to increase student reflection, support scientific inquiry, and to encourage connections between macroscopic observations and molecular-level models. A conceptions analysis of student lab reports from part of a new module (Week 1: Spectroscopic Analysis of Food Dyes and Week 2: Quantitative Analysis of FD&C Red #3) has been performed. Students' conceptions about spectroscopy and solutions will be presented. Based on the conceptions analysis, the laboratory is being revised to help students improve their connections of macroscopic observations and calculations with molecular-level models.

THE SYNTHESIS OF BICYCLO[4.2.0]OCT-7-ENE AND OTHER SUBSTITUTED CYCLOBUTENES FOR REACTIONS WITH DIFLUOROCARBENE

Jennifer L. Bon and **Scott B. Lewis**, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg, Virginia 22807

This research concerns the synthesis of 3,4-disubstituted, 3-monosubstituted, and 1,2-disubstituted cyclobutenes for the purpose of reacting them with two equivalents of difluorocarbene. Bicyclo[4.2.0]-1-octene was synthesized by reacting cyclohexene with trichloroacetyl chloride to form 8,8-dichlorobicyclo[4.2.0]octa-7-one. The dichloroketone was then reduced using LAH to the corresponding mixture of diastereometric alcohols. This mixture was then mesylated using methanesulfonyl chloride and subsequently reduced by Na/NH_{3(l)} at reflux to yield bicyclo[4.2.0]oct-7-ene. The octene was then reacted with a source of two equivalents of difluorocarbene and the product characterized. The synthesis of other cyclobutenes including 3-hexylcyclobutene, 1-methyl-2-phenylcyclobutene and 1-isopropyl-2-methylcyclobutene has also been undertaken.

MICROSCOPY ANALYSIS OF POSS-MA ON SiO₂ SURFACES.

Matthew Bradley, Ashley J. Figueiredo, Brian Augustine, W. Chris Hughes, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg VA 22807

Poly(methacrylisobutyl POSS-co-methylmethacrylate) (POSS-MA) is a nanocomposite polymer that exhibits properties of both organic polymers and nanometer scale SiO₂ glass. POSS-MA is useful for adhering gold thin films to organic polymers as well as manipulating the hydrophilicity of a surface. POSS-MA was deposited onto thermally oxidized silicon wafers and then exposed to a 5%O₂/95%N₂ remote plasma. Samples were analyzed using static contact angle measurements as well as atomic force microscopy (AFM). It was determined that plasma exposure increases hydrophilicity of POSS-MA films, and 45% POSS-MA was the optimal mass ratio for surface modification. AFM analysis showed dendritic structures formed on the 45% POSS-MA thin films. These structures were also observed forming on 30% POSS-MA thin films approximately 10 hours after deposition at room temperature. Real time observations were made using AFM and will be discussed.

CIRCULAR DICHROISM AND FLUORESCENCE STUDIES OF SALT EFFECTS ON RECA-NUCLEOTIDE COMPLEXES

Brittany Branch-Smith³ and Gina MacDonald, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg VA 22807

The RecA protein is found in *Escherichia coli* (*E. coli*). RecA has two unique functions, homologous recombination and DNA repair that occur, during cell division. The secondary structures of the protein include α -helices and β -sheets. The RecA protein's function requires ATP. Circular Dichroism spectroscopy and fluorescence spectroscopy were utilized to study the effects of ATP/ADP nucleotide binding to RecA protein. We performed studies to see how binding ATP and ADP to RecA complexes effected RecA stability. In the results, the RecA protein control has a melting temperature around 65°C - 70°C. The melting point between 40°C - 48°C when RecA protein was bound to ADP or ATP nucleotide. When salt buffer solution was added to RecA-ADP/ATP complexes the melting temperature was around 60°C - 75°C showing increased protein stability in the presence of salt.

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CLONING AND EXPRESSION OF N-ACYLETHANOLAMINE-HYDROLYZING ACID AMIDASE AND ACID CERAMIDASE TOWARDS A BETTER UNDERSTANDING OF LYSOSOMAL AMIDOHYDROLASES

Courtney Braxton, Robert East, and Victoria Mariani, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg VA 22807

Fatty acid derivatives in which the carboxylate function is amidated by the primary amine of ethanolamine form a class of bioactive lipids referred to as *N*-acylethanolamines (NAEs). NAEs are hydrolyzed to their free fatty acids and ethanolamine by amidohydrolases. Two such lysosomal amidohydrolases, *N*-acylethanolamine hydrolyzing acid amidase (NAAA) and acid ceramidase (AC), have functional similarity catalyzing the hydrolysis of *N*-palmitoylethanolamine (PEA) and hydrolysis of ceramide to sphingosine respectively. PEA is a saturated NAE that exhibits anti-inflammatory, immunosuppressive, anti-nociceptive, antioxidant and neuroprotective effects. Ceramide and sphingosine have been identified as cell growth regulators. Both NAAA and AC have approximately 30% sequence homology and are both activated by self-processing. Expression of recombinant enzymes from rat species were attempted for means of characterization. A peptide mimicking the self-processing site of NAAA was designed as a means

to a functional assay for characterization towards inhibitor design. Specific inhibitors for each amidohydrolase can yield viable anti-inflammatory (NAAA) or anticancer agents (AC).

THE EFFECT OF HIGH CONCENTRATION SALT ON THE STRUCTURE, STABILITY, AND AGGREGATION OF RECA.

William R. Cannon and Gina MacDonald, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg VA 22807

The *Escherichia coli* RecA ATPase is critical for maintaining genetic integrity. RecA initiates the SOS response by cleaving *lexA* and also catalyzes DNA pairing and strand exchange. In normal, low salt conditions, RecA will hydrolyze ATP in the presence of DNA. Prior research demonstrated that high salt concentrations cause RecA to hydrolyze ATP at levels comparable to those obtained in the presence of DNA. Salts are known to affect protein stability and aggregation. We used circular dichroism and fluorescence to study the effect of salts on the structure, stability, and aggregation of RecA. We studied the melting temperature of RecA in the presence of various salts and found that NaCl, MgCl₂, and CaCl₂ stabilized RecA, while Na₂SO₄ and MgSO₄ destabilized RecA.

USING DIFFERENCE INFRARED SPECTROSCOPY TO INVESTIGATE THE EFFECTS OF pH ON PGK-SUBSTRATE COMPLEXES

Adam Colbert and Gina MacDonald, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg VA 22807

Yeast phosphoglycerate kinase catalyzes the reversible phosphate transfer in the reaction: ADP + 1,3-bis-phosphoglycerate \leftrightarrow ATP + 3-phosphoglycerate. Prior research indicates a hinge-bending mechanism occurs during catalysis to bring the substrates into closer proximity. Domain closure is only initiated in ternary complexes, in which both substrates are simultaneously bound to the enzyme. The activity and conformation of PGK is directly affected by substrate and salt concentrations as well as pH. PGK activity increases at higher pH (8.5) and is inhibited at low pH (6.5). To determine the effects of pH on the conformational changes of PGK, we used difference FT-IR in conjunction with caged nucleotides. Nucleotide (ATP or ADP) binding to PGK and PGK-3PG complexes was compared at pH 6.5 and pH 7.5 in order to isolate pH-dependent vibrations specific to each PGK complex. This technique allows for the identification of specific changes within amino acid side chains as well as protein secondary structures associated with nucleotide binding under varying pH conditions. Tentative assignments of those vibrations affected by pH will be further discussed.

EPISODIC MONITORING PROJECT: PART II. FIELD MEASUREMENTS, INORGANIC IONS AND TRACE METAL CONCENTRATIONS

Nicholas M. Dugan and Daniel M. Downey, Department of Chemistry and Biochemistry, James Madison University, Harrisonburg VA 22807

Since 2004 large numbers of fish have been reported dead with lesions on their bodies throughout the Shenandoah River and its major tributaries. The fish were mostly found following significant runoff events during the months of April and early May each year. In order to determine whether water chemistry was a contributing factor in these kills, concentrations of common inorganic ions (Na⁺, N-NH₄⁺, K⁺, Mg²⁺, Ca²⁺, Cl⁻, N-NO₃⁻ and SO₄²⁻) and selected trace elements (Be, Al, V, Cr, Mn, Co, Ni, Cu, Zn, As, Se, Mo, Cd, Sb, Tl, Pb, Th, and U) were determined in samples collected during Spring 2008 runoff events at a single location in the South Fork of the Shenandoah River (Island Ford) and a major tributary, Cub Run. Samples were taken at these locations before, during, and after several storms over a period of about six weeks. Major ions and trace elements were determined by ion chromatography and ICP-MS,

respectively. In addition to sample collection, measurements were made at the time of collection for pH, conductivity, water temperature, turbidity and discharge. It has been suggested that elevated ammonia concentrations from land application of fertilizer and animal waste could be a contributor to the fish mortality. No samples collected for this study contained N-NH_4^+ more than 22.1% of the VADEQ acute criterion amount. All of the other ions and trace metals were found at concentration values lower than their respective VADEQ criteria. However, turbidity and suspended sediment values were large and could be a stress factor contributing to the fish kills. At the Island Ford sampling location, a single storm at the end of April transported 3.66 metric tons (estimated) of suspended solids down the river during an eight day period.

EPISODIC MONITORING PROJECT: PART I. THE ANALYSIS OF ORGANIC PESTICIDES IN THE SOUTH FORK SHENANDOAH RIVER AND CUB RUN IN STORM RUNOFF EVENTS

Stephanie L. Hall and Daniel M. Downey, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg VA 22807

It has been suggested that pesticides in widespread use throughout the Shenandoah River watershed may be stressors contributing to the Shenandoah River Fish Kills that have occurred in recent years. Water samples were taken during April/May 2008 storm events at Island Ford on the South Fork of the Shenandoah River (SFSR) and Cub Run (SFSR tributary) as part of a study to evaluate possible chemical stressors during episodic events. A total of 166 storm associated water samples were collected, processed and analyzed for pesticides by standard methods (EPA 508.1; EPA 525.2). One liter of each water sample was first treated with 0.52 μg of 4,4'-dibromobiphenyl (surrogate standard) then extracted onto a solid C18 extraction disk. After desorption with ethyl acetate and concentration by evaporation, 0.57 μg pentachloronitrobenzene (internal standard) was added and the residual liquid transferred to a 2 mL GC injection vial. Organochlorine pesticides used for agriculture in the watershed, including some compounds that are produced by degradation of these pesticides, were determined in the water samples by gas chromatography - electron capture detection (GC-ECD). Pesticides that are not effectively determined by GC-ECD, such as the triazine group, were analyzed by gas chromatography - mass spectrometry (GC-MS). The organochlorine group included 35 compounds that we targeted for this study including heptachlor, chlorpyrifos, endosulfan sulfate, dieldrin, etc. The triazine group included 13 compounds including atrazine, simazine, etc. To date, two pesticides have been found greater than method detection limits: heptachlor exo-epoxide and alpha BHC. The concentration of heptachlor exo-epoxide was not more than 54.2% and 42.7% of the VADEQ acute criterion in the Shenandoah River and Cub Run, respectively. The concentrations of alpha BHC, etradiazole, chloroneb, hexachlorobenzene, pentachloroanisole, aldrin, dacthal, and methoxychlor found in some of the water samples were significantly below the VADEQ acute criteria. To date heptachlor exo-epoxide was the only contaminant that increased with stream discharge increase following a storm. The GC-MS analyses data for triazines have not yet been evaluated.

BISCATIONIC BICEPHALIC (DOUBLE HEADED) AMPHIPHILES

Kristina Hamill, and Kevin Caran, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg VA 22807

The synthesis of a family of novel amphiphiles with two cationic headgroups and a single hydrocarbon chain connected to a central benzene ring has been prepared. A series of surfactants were synthesized (in three steps each) with the two trimethylammonium headgroups in different positions relative to a tetradecyloxy chain. The headgroups are in the 2,3-, 2,4-, 2,5-, 2,6-, 3,4-, and 3,5- positions. Furthermore, the dependence of the colloidal properties on chain length was assessed by studying 2,5-derivatives with chain lengths ranging from 10-18 carbons. A monocationic derivative with the same aromatic ring and 14 carbon chain was also prepared for comparison. The Kraft temperatures (T_K) of the final products were determined using differential scanning calorimetry (DSC) and conductivity. The critical micelle concentrations (cmc) were

determined using conductivity and confirmed using ^1H NMR. Results show that the addition of a second headgroup increases the hydrophilicity of the surfactant and results in an increase in cmc and a decrease of T_K and ionization degree (α). The decrease in α is attributed to partial dehydration of the headgroups due to greater exposure of the hydrophobic arene to water than the arene of the single-headed derivative at the micelle surface.

SYNTHESIS, STRUCTURAL, AND THERMOSTABILITY STUDIES OF LOW-MOLECULAR-WEIGHT ORGANOGELATORS

Paris Hamilton and Kevin Caran, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg VA 22807

A family of multifunctional alcohols was synthesized and tested to determine their capacity to form gels in a variety of solvents. Each of these alcohols has a pentafluorophenyl ring and a second aromatic ring (phenyl, 1-naphthyl, 2-naphthyl, 9-anthracenyl, or tetrathiafulvalene) connected either directly or with an alkyne spacer, to the alcohol carbon. For those compounds that formed stable gels, concentration studies were performed to determine the lowest concentration necessary for gel formation. Furthermore, the thermostability of the gels was determined using the ball-drop method. To develop an aggregation model, ATR-IR was used to detect the presence of $\text{OH}\cdots\text{O}$ hydrogen bonding between molecules. Also, diffraction data from the gels were compared to simulated powder patterns of the analogous single crystal X-ray structures to determine whether the molecular organization in the gel was related to that of the solid state. The affects of chirality on the gel formation ability will also be discussed.

FABRICATION OF MULIWALLED CARBON NANOTUBE OSCILLATORS

Joe Hardcastle, Lok-kun Tsui and Scott Paulson, Department of Physics and Astronomy, James Madison University, MSC 4502, Harrisonburg, VA 22807

Friction is one of the least understood but most know concepts in physics. Our project uses multiwalled carbon nanotubes (MWNT) as a means for measuring and studying friction at the nanoscale. This is done by producing torsional or "paddle" oscillators on silicon nitride and using Atomic Force Microscopy (AFM) and Scanning electron microscopy (SEM) to measure the Quality factor of oscillating MWNT. The process for fabrication of these devices includes production of silicon nitride wafers with thin layered membranes using photolithography and plasma etching. Carbon nanotubes are then grown on the samples and imaged to confirm growth. After electron beam lithography and deposition of chrome and gold the membranes are etched using a chemical etching technique. The study of these torsional oscillators will give use further knowledge of fiction at the nanoscale.

SHEAR STRESSES IN A SATURATED TO NEAR-SATURATED WATER/SAND SYSTEM FLUIDIZED BY VERTICAL VIBRATION

Ralph Herman and Brian Utter, Department of Physics and Astronomy, James Madison University, MSC 4502, Harrisonburg VA 22807

Research into the behavior of three-dimensional granular systems has focused on dry systems, often using spherical particles, i.e. systems whose microscale physics can be modeled and described in a relatively straightforward manner, so that the complicated and non-linear behaviors that emerge on the macroscale can be more readily understood. However, many industrial and natural phenomena are based on the flow and failure of complex slurries and mixtures. We present data on the behavior of a "play sand" and water mixture under varying degrees of saturation. The granular material can be simultaneously "fluidized" by vertically vibrating the system. We find the addition of water tends to increase the shear stresses overall, though not in a linear fashion. Varying the intensity of vibration produces some interesting effects, such as our

finding that at around 70% saturation a peak of shear resistance is found at a vibration level of $\Gamma = 0.9g$, but at 100% saturation the peak moves to $\Gamma = 0.6g$.

THE SYNTHESIS AND EFFECT OF ANCHORING GROUPS ON INTERFACIAL ELECTRON TRANSFER RATE

Amanda Hoffman⁴ and Debra Mohler, Department of Chemistry and Biochemistry, James Madison University, MSC 4501, Harrisonburg VA 22807

Many advanced and modern technologies such as dye-sensitized solar cells, electron junctions, molecular electronics, photography, waste degradation, and H₂ production depend upon interfacial electron transfer processes. In order to optimize the rate at which electrons are transferred from adsorbates to solids, the Metal to Ligand Charge Transfer (MLCT) state of the dye can be altered to allow that greatest molecular overlap and contact between the solid and the adsorbate. This rate can be maximized by incorporating anchoring groups in the adsorbate that bind directly to the solid support overlap and provide a direct connection pathway. Therefore, the multi-step synthesis of target molecules 4,4'-diaminomethyl 2,2'-bipyridinerheniumtricarbonylchloride and 4,4'-diphosphonatemethyl 2,2'-bipyridinerheniumtricarbonylchloride will be discussed.

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MONOHYDRIDE RUTHENIUM COMPLEXES OF BIS(DIPHENYLPHOSPHINO) ALKANE OXIDES

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Transition metal complexes of bis-phosphinomonoxide ligands ($R_2P(CH_2)_nP(O)R_2$) have played important roles in catalytic reactions in the past decade. Because of their potential as hydrogenation catalysts, we are interested in synthesizing Ru (II) hydride complexes of $Ph_2P(CH_2)_nP(O)Ph_2$. The reaction of $RuHCl(CO)(PPh_3)_3$ with $Ph_2PCH_2P(O)Ph_2$ in methylene chloride produces $HCl(OC)Ru(PPh_3)_2(PPh_2CH_2P(O)Ph_2)$. This compound has been characterized by ¹H and ³¹P NMR and IR spectroscopy. The two PPh_3 ligands are trans and mutually cis to $Ph_2PCH_2P(O)Ph_2$, which is coordinated through the PPh_2 moiety and is trans to the hydride ligand. $HCl(OC)Ru(PPh_3)_2(PPh_2CH_2P(O)Ph_2)$ loses PPh_3 over about 30 minutes to form $HCl(OC)Ru(PPh_3)(PPh_2CH_2P(O)Ph_2)$. The $Ph_2PCH_2P(O)Ph_2$ chelates Ru with the ligand oxygen occupying the site vacated by the PPh_3 . Reaction of $RuHCl(CO)(PPh_3)_3$ with $Ph_2PCH_2CH_2P(O)Ph_2$ produces $HCl(OC)Ru(PPh_3)_2(PPh_2CH_2CH_2P(O)Ph_2)$, whose structure is analogous to $HCl(OC)Ru(PPh_3)_2(PPh_2CH_2P(O)Ph_2)$.

CHARACTERIZATION OF MAGNETIC IRON OXIDE COMPOSITES

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In order to remove metal cations from contaminated ground water, magnetic iron oxide composites are being investigated. These composites can be supported on various ratios of NaY zeolites, aluminum oxide, and silica. A previously published procedure to synthesize these composites was varied in order to create a more effective and practical adsorbent. The composites were then characterized using IR spectroscopy, the magnetic susceptibility balance, and the x-ray power diffractometer (XRD). In order to determine the amount of Cu^{2+} uptake by the composite, atomic absorption (AA) was used. Prior research has shown that 25°C is the optimal temperature for the synthesis of these composites. The amount of Cu^{2+} uptake and the magnetic susceptibility were influenced by six factors: 1) whether or not the support is added prior to the formation of the iron oxide particles; 2) the support to iron oxide mass ratio; 3) the type support

used; 4) the source of iron; 5) the stirring time; and 6) the amount of time it takes to add the NaOH. The type of support used determines the degree of correlation between the amount of Cu^{2+} uptake and the magnetic susceptibility. In the composite with the equal mass ratio of NaY zeolite to iron oxide, both the amount of Cu^{2+} uptake and the magnetic susceptibility peaked after being stirred for 10 minutes. XRD data shows that some supports are able to maintain their zeolite structure better than others depending on the $\text{SiO}_2:\text{Al}_2\text{O}_3$ ratio of the zeolite.

FABRICATION OF EMBEDDED FLUORESCENT PROBES IN POLYMERIC MICROFLUIDIC SUBSTRATES

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The purpose of this research is fabricating microfluidic devices. The generic term is 'lab-on-a-chip' (LOC). This is a relatively new and exciting side to material science. LOC refers to a device that integrates one or several laboratory functions on a single chip of only millimeters to a few square centimeters in size. LOC's offer potential advantages such as:

- Less waste, lower reagent costs and less required sample volumes.
- Faster analysis and response times, therefore better process control
- Lower fabrication costs, facilitating mass production and the potential for disposable chips.

Due to these characteristics, LOC technology may be the answer to improving health care throughout the world, especially in less developed countries. However a lot of research is still needed in this area. Imprinting channels onto a PMMA substrate can be carried out in a variety of ways. In this research two methods are used. The first method uses UV light to photo polymerize a solution; a process called micromoulding by photopolymerization in capillaries. Another method is hot embossing. This involves heat that is above the glass transition temperature (108°C) and pressure to mould the PMMA into a microfabricated master. The ultimate goal of this research is to monitor whether a PMMA base plate can have fluorescent dye cured into it using UV light with the μ -PIC process to create fluorescent features in the chip. Circular indentations were made in PMMA chips by hot embossing. These were filled by injecting into them 0.4 μl of a solution containing 20% PMMA pre polymer and an orange dye in ratios of 9:1, 4:1 and 1:1. The results are explored further at a later stage.

BRINGING NANOSCIENCE TO THE CLASSROOM

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Nanoscience is a relatively new field, but is growing rapidly along with our understanding of it. Because of the incredible small scale and the expensive equipment needed to research this field, there are little to no experiments and knowledge being brought to students on the high school level. Using an atomic force microscope (AFM) connected via the internet to a relatively portable Nanomanipulator, we developed a nanoscale friction experiment that can be brought to high schools and performed by high schoolers anywhere there is an internet connection. The experiment includes the tip of the AFM pressed down at different normal forces and dragged along a flat mica surface. This experiment is very similar to a classic friction experiment with a block on a table that many of these students have performed. The results of the frictional force are plotted versus the normal force and we observe the trend to see if and how and why it differs from what we would expect to see with our understanding of friction on a macroscopic scale.

IMPROVING THE ADHESION OF GOLD TO PMMA USING POSS-MA

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Gold has important applications because of its unique property as a metal that does not readily oxidize. It is this property of gold that limits the metal's ability to adhere to polymers. One particular polymer, poly(methyl methacrylate) (PMMA), is emerging as a useful material for microfluidic devices. PMMA requires less energy to be manufactured in comparison to silica-based glasses. Also, PMMA is moldable and more durable, in terms of force related stresses, than silica-based glasses. These properties of PMMA give the polymer the advantage over silica-based glasses when constructing "lab on a chip" devices. Yet one major drawback in using polymers is that gold does not adhere to them well. However, it was found that coating PMMA with 45% poly[(propylmethacryl-heptaisobutyl-polyhedral oligomeric silsequioxane)-co-(methylmethacrylate)] (POSS-MA) increased gold's adhesion to PMMA. This was quantified by capturing video through optical microscopy and analyzed by monitoring pixel value change. Acetone was the solvent used to degrade the bond between the metal and the polymer. Since POSS-MA exhibits both organic and inorganic properties, gold can bind to the silicon-oxygen cage of POSS-MA – with chromium as an adhesion layer – while PMMA can bind with the organic part of POSS-MA. When PMMA is coated with POSS-MA, gold adheres to the polymer at least twice as long as uncoated PMMA.

ATR-FTIR INVESTIGATION OF *p*-CRESOL OXIDATION ON ALUMINA-SUPPORTED COBALT OXIDE CATALYSTS

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p-Hydroxybenzaldehyde (PHBA) is an important intermediate in the synthesis of many pharmaceuticals, perfumes, flavoring agents, and agricultural chemicals. *p*-Cresol oxidation may reduce the cost, simplify synthesis, and decrease the environmental hazards encountered during the current industrial processes used to synthesize PHBA. Our work concerns the catalytic oxidation of *p*-Cresol by alumina-supported cobalt catalysts. Previous group research found that, among a group of similar metals calcined at varying temperatures and times, a 30% weight Co/Al₂O₃ catalyst calcined at 900 degrees Celsius for three hours yielded 95.7% *p*-cresol conversion and 92.4% selectivity to *p*-hydroxybenzaldehyde, which was most effective among those catalysts tested. Current efforts have focused on refinement and understanding of this reaction through Fourier Transform IR (FT-IR) analysis of catalysts after reflux and periodic High Performance Liquid Chromatography (HPLC) analysis of reaction conditions coinciding with this IR analysis. 5%, 10%, and 25% Co by weight Co/Al₂O₃ were each tested in range of temperatures from 400 to 900 degrees Celsius calcined for three hours. IR spectra of catalysts reclaimed from the reaction before and after washing indicate removal of hydrocarbons from the surface of the catalyst, suggesting that they are recyclable through simple washing with H₂O. HPLC analysis showed the greatest conversion in the 10% by weight Co/Al₂O₃ catalyst calcined at 600 degrees for three hours (97.0% conversion of *p*-cresol, 77.3% selectivity to *p*-hydroxybenzaldehyde) and greatest selectivity in the 5% by weight Co/Al₂O₃ catalyst calcined at 500 degrees for three hours (74.13% conversion of *p*-cresol, 83.8% selectivity to *p*-hydroxybenzaldehyde). In addition, we have also developed a set of liquid and solid phase KBr IR standards of reaction components to which our reaction spectra may be compared.

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THE SYNTHESIS OF 1,2-DISUBSTITUTED CYCLOBUTENES FOR STUDY WITH DIFLUOROCARBENE

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The synthesis of 1,2-disubstituted cyclobutenes was undertaken in order to study their chemistry with difluorocarbene. The compounds 1-methyl-2-pentylcyclobutene (1) and 1-hexylcyclobutene

(2) were prepared by using a modified version of the Negishi procedure. Scale-up of compounds 1 and 2 are currently in progress. Details of their synthesis as well as plans for future studies will be discussed.

2D GRANULAR AVALANCHES WITH IMPOSED VIBRATIONS

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We present work on a 2D granular flow system undergoing vertical vibration. The experiment consists of photoelastic grains enclosed in a 2D rotating drum either turning at a constant rate or oscillating back and forth. We measure the angle of the pile versus time and track the critical angle (the angle at which failure occurs) for each avalanche. We then proceed to isolate the angle of the first avalanche in one direction from those of subsequent avalanches in that same direction in order to determine the history dependence of the system. It appears that at little or no vibration, the first angle in each direction is less than the subsequent angles in that direction, reflecting an initial weakness of the pile before steady-state is reached. As the vibration increases, this history dependence is removed and the overall stability of the pile decreases.

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DECODING NOVEL NUMBERS IN AMERICAN SIGN LANGUAGE

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All spoken and signed languages rely on a number system for quantitative and qualitative values. Number literacy is important to educated societies and for tasks of daily living. Number literacy involves the ability to read, write, and use numbers (e.g. Roberts, 1995). Post-secondary students must demonstrate literacy through standardized test scores to be admitted to college and university programs. Students who attend Gallaudet University, the only liberal arts university in the world exclusively for deaf/Deaf students, must meet the same entrance and graduation requirements as hearing students in higher education, even if they rely on American Sign Language (ASL) and visual memory to read or decode and sign or encode their numbers. The purpose of this research is to determine if the position of a signed number affects the receiver's ability to read the number. Three participants were involved in this experiment in which a sign language interpreter with 10 years of interpreting experience and ASL as his native language presented 10 numbers in the carrying position with oral shadow, 10 in the carrying position with no oral shadow, 10 in the periphery with oral shadow, and 10 in the periphery with no oral shadow. Results of the videotaped test showed a range from 30%-70% accuracy with an overall average of 50%, and higher scores with 4 and 5 digit numbers than 7-9 digit numbers. The influence of position and oral shadow was observed to affect accuracy only in the 7-digit numbers.

PURIFICATION OF THE RECA PROTEIN

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RecA is found in *Escherichia coli* (*E. coli*) and has a molecular weight of 38 kDa. RecA functions using DNA strand exchange to perform homologous recombination and DNA repair. Growth of *E. coli* containing the plasmid pTXB-recA3 results in the overexpression of RecA attached to an intein tag. The *E. coli* cells were broken apart using a lysis buffer and sonication. RecA was then purified by running a chitin column and washing with multiple buffers. The purity of each step was checked by running SDS gels and performing ATPase activity assays. SDS gels and activity assays suggest the successful purification of RecA from *E. coli*.

DEVELOPING A BACTERIAL TREATMENT USING *Janthinobacterium lividum* FOR AMPHIBIANS *Rana muscosa* AND *Plethodon cinereus* INFECTED WITH *Batrachochytrium dendrobatidis*

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Chytridiomycosis, an amphibian disease caused by the fungus *Batrachochytrium dendrobatidis*, can be fought by metabolites produced by bacteria that live on amphibian skin. We have investigated a particular bacterium, *Janthinobacterium lividum*, and its ability to protect the mountain yellow-legged frog, *Rana muscosa*, and the red-backed salamander, *Plethodon cinereus* from *B. dendrobatidis*. Previous research has shown that *J. lividum* produces indole-3-carboxaldehyde and violacein, two antifungal compounds. Individuals received both the pathogen and the bacterium to determine if *J. lividum* is an adequate way of protecting the species. All frogs survived the experiment except for 60% of those given just *B. dendrobatidis*. Similar survival percentages were seen in the *P. cinereus* individuals, with 47% mortality in the group given only *B. dendrobatidis*. Violacein concentrations were measured by HPLC analysis of extractions off the individual's skin. Most individuals had violacein on their skin; however, in groups with *B. dendrobatidis* and *J. lividum*, the average concentration was higher than groups with just *B. dendrobatidis* or *J. lividum*, suggesting the bacterium is fighting the fungal infection. These results indicate that bioaugmentation with *J. lividum* may represent a protective strategy for amphibians that are susceptible to chytridiomycosis in captivity or even in the wild.

USING INFRARED SPECTROSCOPY TO EXAMINE THE STABILITY AND STRUCTURE OF MYOGLOBIN

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Myoglobin is a globular protein. Myoglobin stores and transports oxygen. Myoglobin binds oxygen molecules to its heme group. My project focuses on using infrared Spectroscopy (IR) to study myoglobin unfolding in the presence of salts. Infrared spectroscopy is used to monitor protein structure. Infrared peaks at 1648cm^{-1} (alpha helices) and 1622cm^{-1} (aggregated and unfolded structures) can be used to monitor unfolding and aggregation of myoglobin. I am using different salts and increasing the temperature of myoglobin to study and examine the stability and structures of myoglobin unfolding in the presence of salts. I am using IR spectra to see how protein structures change at increasing temperature. I am doing data analysis to determine how salt changes myoglobin stability. My results show that structure is a folded at 25°C to 55°C , partial unfolded and an aggregated at 65°C , and an unfolded and an aggregated at 75°C to 95°C .

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EPISODIC MONITORING PROJECT: PART III. QUANTITATIVE ANALYSIS OF GLYPHOSATE BY ION CHROMATOGRAPHY

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During the period 2004-2007, fish kills occurred in Virginia's Shenandoah River in April and early May. Although lesions and parasites were cited as the cause of the fish mortality, they were thought to be the result of elevated stress levels in the fish population. Previous studies of the Shenandoah River Fish Kills (SRFK) have focused on physical and environmental factors such as water temperature and discharge. Chemical contaminants may also be stress contributing factors. There is widespread use of conservation (no-till) farming in the Shenandoah Valley,

which employs various herbicides for weed removal before and after planting crops, rather than plowing. An herbicide commonly known as RoundUp™ which contains the active ingredient glyphosate (or one of its salts) is used extensively in the Shenandoah River watershed. Glyphosate has acid-base properties and cannot be extracted or concentrated by the same methods used for the analysis of other pesticides, nor can it be determined at low levels by GC-MS or GC-ECD, which are the main analysis methods used for other pesticides. We have developed an alternative method of analysis for that uses evaporation concentration followed by anion exchange ion chromatography. A strong anion eluant of pH 11.6 was employed to resolve the glyphosate anion ($R > 1.25$) from common anions present in the water samples (sulfate, nitrate, chloride). The detection limit for our method was 1.5 µg/L, which compared favorably to the LC-fluorescence detection limit. We have used this method to determine the concentrations of glyphosate in the Shenandoah River and Cub Run, a tributary, during April and May of 2008. To date the highest concentration of glyphosate found in any sample was 8.84 µg/L, which is 1.26% of the EPA maximum concentration level of 700 µg/L.

PREPARATION AND SPECTRAL CHARACTERIZATION OF $\text{Ru}(\text{CO})_2(\text{PPh}_2\text{CH}_2\text{CH}_2\text{P}(\text{O})\text{Ph}_2)_3$

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In solution Roper's Complexes, $\text{Ru}(\text{CO})_2(\text{PR}_3)_3$, readily dissociates a phosphine ligand to generate an unsaturated, reactive species that binds small molecules including alkynes, alkenes, and dihydrogen. Roper's Complexes have important uses in the catalysis of organic reactions, including the Murai olefin coupling reaction. We are interested in preparing analogs of the traditional Roper's Complexes that contain $\text{R}_2\text{P}(\text{CH}_2)_n\text{P}(\text{O})\text{R}_2$ ligands. These ligands can potentially coordinate through both the phosphino phosphorus and the phosphoryl oxygen atoms. Such chelate formation might stabilize the species that forms after ligand dissociation and allow new chemistry to be developed. Reaction of $\text{Cl}_2\text{Ru}(\text{CO})_3\text{thf}$ dissolved in acetonitrile at -5°C with one equivalent of methanolic NEt_4OH followed by the rapid, sequential addition of three equivalents of $\text{Ph}_2\text{P}(\text{CH}_2)_2\text{P}(\text{O})\text{Ph}_2$ in methylene chloride at -5°C and three equivalents of methanolic NEt_4OH yielded an orange solid. This solid showed IR bands at 1889 and 1834 cm^{-1} , which can be compared to 1898 and 1845 cm^{-1} in $\text{Ru}(\text{CO})_2(\text{PPh}_2\text{Me})_3$. Additionally, the ^{31}P NMR chemical shifts indicate that the PR_2 groups are coordinated to Ru, while the $\text{P}(\text{O})\text{Ph}_2$ moieties are not. The ^{31}P spectrum can be interpreted in terms of a second order $\text{AA}'\text{A}''\text{XX}'\text{X}''$ spin system with 60 Hz coupling between phosphorus atoms in the three PR_2 groups. This data is consistent with the complex being $\text{Ru}(\text{CO})_2(\text{PPh}_2\text{CH}_2\text{CH}_2\text{P}(\text{O})\text{Ph}_2)_3$.

PMT AND SCINTILLATOR TESTING FOR THE SUPER HIGH MOMENTUM SPECTROMETER AT JEFFERSON LAB

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The beam energy upgrade (from 6 to 12 GeV) of Jefferson Lab is one of the main priorities identified by NSF's Nuclear Science Advisory Committee in its 2007 report. This \$300M project will require the upgrade of the experimental equipment. In Hall C the existing High Momentum Spectrometer will be paired with a new Super High Momentum Spectrometer (SHMS). The JMU Particle and Nuclear Physics group is in charge of designing, building, and testing the scintillator hodoscope, an essential component of the SHMS. This presentation will show early results obtained using the scintillator and PMT test stand being developed at JMU.

APPLICATION OF AN EBL ALIGNMENT PROCEDURE TO THE STUDY OF CARBON NANOTUBES

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The study of Nanoscale Electromechanical Systems includes the challenge of measuring the mechanical properties of carbon nanotubes. The processes needed to build these devices require multiple microfabrication patterning steps conducted with submicron precision. We developed a method to use Electron Beam Lithography (EBL) with the scanning electron microscope (SEM) to write the patterns necessary to measure the nanotube properties. As references by which we can align ourselves with, we designed two sets of markers at 150 and 1000 micron scales and additional markers to indicate orientation. The lithography software ELPHY was then used to scan the alignment markers and make the coordinate adjustments appropriate to each sample. After initial tests showed the alignment procedure was accurate to under a micron, we used the atomic force microscope to measure the location of nanotubes relative to our pattern, and those measurements were used to craft a contact pattern to be written using the alignment procedure. We intend to soon show that this procedure successfully achieves the goal of placing our contact pattern in the correct locations over the nanotubes.

CHARACTERIZING INTERMOLECULAR FORCES OF SIMPLE LIQUIDS BY VAPOR PHASE NMR

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Vapor phase NMR has received little attention thus far in describing the intermolecular forces of simple molecules. Proton NMR was obtained for H₂O, methanol, ethanol, *tert*-butanol, acetone, acetic acid, toluene, cyclohexane, methylene chloride, and chloroform in the neat liquid and in the vapor phase. The heats of vaporization were determined for each sample from this data. The heats of vaporization found were similar to those reported in the literature. The chemical shifts for the vapor molecules were significantly different from those of the neat liquid. The temperature dependence of the chemical shifts was used to investigate the monomer and dimer equilibrium for vapor phase acetic acid.

FABRICATION OF MICROFLUIDIC PCR AND EOF DEVICES

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Microfluidic technology is used to manipulate fluids on a micrometer length scale. Our lab is working in collaboration with researchers at UVA to develop polymeric microfluidic polymerase chain reaction (PCR) devices for experimental analysis. To fabricate these devices we use hot embossing of poly(methyl methacrylate) (PMMA) films from a silicon master produced via conventional microfabrication techniques. We then bond the coverplate via solution and pressure bonding. Currently, we are attempting to measure the electro-osmotic flow (EOF) to determine the surface properties of the polymer microfluidic devices. We have developed devices that have two channels that form a cross structure. We have been manipulating a fluorescent dye through the channels in order to determine the EOF mobility (the velocity as a function of current), a key parameter in microfluidic device technology. Future work is to use this technique to modify the surface hydrophilicity of the structure so that water based solutions can be controlled within the device or make analytical separation possible.

NEUTRON DETECTION EFFICIENCY STUDIES FOR THE CLAS DETECTOR AT JEFFERSON LAB

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The CLAS detector installed in the experimental Hall B at Jefferson Lab is a hermetic spectrometer designed to detect charged particles produced in fixed – target nuclear physics

experiments. Additionally CLAS can detect neutral particles (neutrons and photons). This study aims at determining the neutron detection efficiency of the CLAS spectrometer as a function of momentum, as a preamble to an in depth investigation of processes involving neutrons in the final state, such as the electroproduction of the Σ^- hyperon.

NANO MANIPULATION IN A SUITCASE: USING A PORTABLE AFM COUPLED WITH 3D INTERACTIVE SOFTWARE TO DEMONSTRATE SUB-MICRON INTERACTIONS

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Atomic force microscopy has established itself as an integral part of nanoscience research and technology, yet access to this technology for educational purposes has remained limited due to high equipment costs and lack of portability. Recently, more affordable atomic force microscopes (AFMs) such as the Nanosurf easyScan 2 have become available and the opportunity has arisen to provide nanoscience education to a wider audience. Previously, we improved upon the educational uses of Nanosurf's AFM by coupling it with the virtual reality AFM control and data analysis tools provided by the 3rdTech NanoManipulator. The introduction of the NanoManipulator as the primary method of interaction between the user and the Nanosurf AFM allows for a more intuitive form of sensing and manipulating a sample: the NanoManipulator presents a scanned sample surface as a visible 3-Dimensional object that can be felt using haptic force feedback. In the current research project, we extended our implementation of the NanoManipulator / Nanosurf technology to include the NanoManipulator's functionality for sample modification. Additionally, we developed experiments involving the imaging and manipulation of nanospheres that demonstrate some of the interactions occurring during manipulations at the sub-micron scale.

AN APPARATUS FOR MODELING CONSTRICTIONS IN GRANULAR-FLUID FLOW

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The flow behavior of granular-fluid systems is of interest in many areas of science and engineering. The flow of solid particles in fluid through a constriction in a conduit may cause a phenomenon called jamming to occur so that the flow is completely blocked or the fluid permeates through the solids. We focused our work on the design and construction of an apparatus for modeling granular-fluid flow systems. Our apparatus consists of a rectangular system of PVC pipes, with a clear acrylic tube on one of the long sides, with a funnel in the clear tube to model a constriction. We used nylon spheres (spg ~ 1.14) to model neutrally buoyant particles in a fluid consisting of equal portions of water and glycerin. A pump designed as an Archimedes screw slowly propels the granular-fluid mixture. Future experimentation will replace the nylon spheres with smaller particles, to eliminate the scale effects caused by the wall of the pipes. Our model can be related to the rise of a magma-crystal mush column in a conduit beneath a volcano. Geologists observe that lavas rarely contain more than 50% early formed crystals, and theorize that jamming occurs in the column when crystals exceed 50%.