5th Annual
Graduate Research Colloquium
Michigan Technological University
February 21 - 22, 2013

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Department of Biological Sciences (*)
Department of Biomedical Engineering
Department of Chemistry
Department of Chemical Engineering
Department of Civil & Environmental Engineering
Department of Cognitive & Learning Sciences
Department of Computer Sciences
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Oral Presentations Day 1

Session 1: 11:00am - 12:20pm, *Room A*

1 A novel functionally based enzymatic hydrolysis model for lignocellulosic biomass considering structural morphology of cellulose and hemicellulose together

Yang Zhang[1], Wen Zhou[1]

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Lignocellulosic biomass has been recognized as an important carbohydrate source for human energy use because of its abundance and its potential to produce biofuels, which can reduce our dependence on traditional fossil fuels. For both economic and environmental reasons, intense research efforts have been directed at the conversion of lignocellulosic biomass to biofuels and biobased chemicals. In this work we develop a general modeling framework for the enzymatic hydrolysis of solid lignocellulosic biomass. This model, for the first time, takes into account the structural morphology of cellulose and hemicellulose together. It couples the enzymatic fragmentation kinetics of surface-exposed and enzyme-accessible main chains of lignocellulosic substrate, such as glucan chains and xylan chains, to the rate equations describing the time evolution of substrate morphology caused by the hydrolytic ablation of solid substrate surface. We propose a novel "$3n^2+2n+1+m$" site concentration formalism to keep track of concentration of different types of surface exposed bonds between monomer units in main chains, such as glycosidic bonds and xylosidic bonds. In addition, we consider the reactions involving beta-enzymes in solution and the competitive inhibition effects caused by different types of soluble oligomers by incorporating the enzyme adsorption and inhibition equilibrium. This general modeling framework has the numerical modeling capability to simulate the entire hydrolysis process of any type of lignocellulosic biomass.

2 Electrocatalytic Processing of Biomass-Derived Compounds: Efficient Prodution of Electricity, Valuable Chemicals and Hydrocarbon Fuels

Le Xin[1], Zhiyong Zhang[1], David J. Chadderdon[1], Ji Qi[1], Yang Qiu[1], Kai Sun[2], Wenzhen Li[1]

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Biomass is a renewable and carbon-neutral resource, and is expected to produce electricity, chemicals and fuels to alleviate the global reliance on the fossil fuels. Glycerol is mass-produced as a low-value by product (0.3 US\$$Kg^{-1}$) in the manufacturing of biodiesel. The partial oxidation of glycerol can lead to the formation of several higher-value oxygenated chemicals. Levulinic acid can be easily produced from lignocellulose ($<$ \$ 1.00 $gallon^{-1}$) using simple and robust hydrolysis processes at the low cost, and is considered a promising feedstock for the biofuel production. In this presentation, I will use a continuous flow electro-catalytic conversion system based on proton or anion exchange membrane fuel cell technology to selectively convert glycerol or levulinic acid into different chemicals and fuels. It is discovered that the working potential can significantly switch the product distribution. The electro-oxidation of glycerol on Au nanoparticles produces tartronic acid with a selectivity of $>$ 90% at the anode potential $<$ 0.4 V (vs. SHE); mesoxalic

acid with a selectivity of >50% in the 'sweet potential zone' of 0.5-0.6 V, and glycolic acid with a selectivity of 85% at applied anode potential >1.2 V. Multi-metallic nanocatalysts with controlled size, shape and structure can control over the selectivity to the target product: Pt favors the C-C bond breaking of C_3 glyceric acid to form glycolic acid, whereas PtNi/graphene structure facilitates the glyceric acid generation (>90% selectivity) by preventing the C-C bond cleavage. The electrocatalytic hydrogenation of levulinic acid on non-precious lead electrode leads to valeric acid (> 90% selectivity) at low pH electrolyte and gamma-valerolacetone (100% selectivity) at high pH electrolyte with very high yield, meanwhile, the renewable electricity gets stored in these high energy-density liquid fuels (68% electricity storage efficiency). Some fundamental understandings of reaction sequence and kinetics have also been studied.

3 Selective Mercury Sequestration from a Mercury/Silver Cyanide Solution using Sphalerite

Kristen Gabby[1], Timothy Eisele[1]

[1] *Department of Chemical Engineering, Michigan Technological University*

Silver and mercury are both dissolved in cyanide leaching and the mercury co-precipitates with silver during metal recovery. Mercury must then be removed from the silver/mercury amalgam by vaporizing the mercury in a retort, leading to environmental and health hazards. The need for retorting silver can be greatly reduced if mercury is selectively removed from leaching solutions. Mercury removal from silver in a pH 11 cyanide solution with sphalerite (naturally occurring zinc sulfide) as a selective precipitant was studied. Sphalerite was shown to be able to remove 99% of mercury from solution with negligible silver losses. Factors studied affecting selectivity and the reaction were: rate of reaction, particle size, reduction potential and necessity for oxygen. A counter current flow showed optimal results with negligible silver losses and complete mercury removal from a synthetic ore. The resulting solids of sphalerite coated in mercury sulfide were not shown to re-leach mercury during an environmental leaching test.

4 Life Cycle Assessment (LCA) of Ethanol and Potassium Acetate Produced from a Forest Product Waste Stream by an integrated biorefinery system

Jifei Liu[1], David R. Shonnard[2]

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Integrated technologies systems are designed based on the concept of "zero waste" to fully utilize natural resources by building industries next to each other when the waste of one is capable to fulfill the input requirement of another. Forest product waste stream is a typical industry waste stream with wood extractives suspended in it, thus lignocelluloses are the dominant components which meet the input requirement of a biorefinery facility. Biorefinery process produces biofuels as an alternative transportation fuel as well as a wide range of co-products like valuable chemicals and high temperature water. At the meantime the process could partially substitute original waste water treatment plants (WWTP). Life cycle environmental impact of fuel grade ethanol produced from an integrated biorefinery industry has been evaluated through greenhouse gas (GHG) emission to compare with gasoline. Three allocation methods, displacement, mass allocation, and market value allocation are applied in this study. Six scenarios are analyzed to evaluate the significance of each input and the GHG emission change when an alternative resource is used to substitute one. The LCA results show that ethanol produced from this biorefinery system is a sustainable liquid fuel compared to gasoline, and much of the credit comes from the reduction

of WWTP input, as well as saving of steam from hot water generated in biorefinery process. If natural gas or biomass is used to support the biorefinery process, the GHG emission of bioethanol product in life cycle would become much less. Uncertainty analysis including ethanol annual yield, potassium acetate yield, WWTP reduction and price fluctuation are conducted with plus/minus 10% to the GHG emissions.

Session 1: 11:00am - 12:20pm, *Room B*

1 Beech bark disease distribution and resistance in Michigan and fungal endophyte ecology of resistant and susceptible beech (*Fagus grandifolia* Ehrh.)

Rachel E. Griesmer[1], Andrew J. Storer[1], Dana L. Richter[1]

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Beech bark disease (BBD), a non-native association of the fungal pathogen *Neonectria faginata* (Castleburry & Rossman) and the wooly beech scale insect *Cryptococcus fagisuga* Lind., was introduced to North America in Nova Scotia around 1890. The disease has spread throughout the range of American beech (*Fagus grandifolia*) and is comprised of three stages: the advancing front, killing front and aftermath zone. Rapid mortality results when *Neonectria* enters through feeding wounds from trees heavily infested with beech scale. In order to monitor the spread and effects of BBD, the beech bark disease monitoring and impact assessment system (BBDMIAS) established a plot network throughout the range of American beech in Michigan in 2001. Forest health canopy assessments and basic forestry measurements including basal area were conducted on beech trees in the BBDMIAS plots in 2011 and 2012. Additionally surveys were conducted within and areas nearby monitoring plots for trees resistant to the disease identified by a lack of or marginal beech scale colonization. Where resistant trees were located, cambium tissue was sampled from both a resistant and susceptible tree within the same population. These data were used to test whether (i) forest health measurements show decline from initial observations in 2001; (ii) trees resistant to beech bark disease have different endophyte assemblages than susceptible trees and confer an additional resistance phenotype; and (iii) endophytes in resistant trees were antagonistic toward *Neonectria* in vivo. Several epicenters of disease have been identified in Wexford and Emmet counties where beech scale density is relatively high and Neonectria is present. All monitoring plots have been exposed to BBD, mainly pioneer populations of *C. fagisuga*. Preliminary results suggest that the initial area of introduction near Ludington, Michigan has progressed beyond the two beginning stages and can be categorized as the aftermath zone.

2 Association mapping of Single Nucleotide Polymorphisms (SNPs) in four poplar Lateral Boundary Domain genes

Roba Bdeir[1], Yordan Yordanov[1], Victor Busov[1], Oliver Gailing[1]

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Recent studies suggested that Lateral Boundary Domain (LBD) genes have an important role in wood formation, differentiation of phloem and xylem, and of ray cells. Gene expression studies indicated that LBD1 and LBD4 play a role in the regulation of secondary phloem development, while LBD15 and LBD18 are involved in the secondary xylem development. We plan to identify and associate polymorphisms in the four LBD genes under investigation in an association mapping population consisting of 1,100 Populus trichocarpa genotypes with traits related to wood growth, development and anatomical characteristics. Preliminary analyses indicate significant variation in many phenotypic parameters including diameter growth. Single - marker- based association

analyses will be applied to test for SNP-trait associations. All analyses will be conducted using the software TASSEL v. 3.0. The major aim of this study is to identify SNPs that can be used in marker-assisted breeding of poplars for enhanced wood productivity and quality.

3 Genetic differentiation between Quercus rubra provenances at gene-based and non-genic microsatellite markers

Sirikorn Khumwan[1], Oliver Gailing[1]

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Forests have a significant influence in our life. They are economically important and affect climate and global carbon cycle. Hence, sustainable management of the forest ecosystem is important. Studying the genetic control of key traits related to survival and growth under stresses can bring about the understanding of tree adaptation under changing environments. This knowledge is one factor leading to sustainable forest ecosystems stated above. Oaks are well-known commercial plants in the US (Burns and Honkala, 1990). One of the most important species is Northern red oak (*Quercus rubra* L.). Due to its wide geographic distribution growing under various climatic and edaphic conditions, we will use it as a model to study the adaptation of forest trees to changing environmental conditions. In this research, the key traits we focus on are drought tolerance and the timing of vegetative bud burst. Two provenance trials consisting of six provenances covering the species' distribution range in Michigan were established close to Michigan Technological University. A total of 1800 seedlings were planted in a completely randomized block design in spring 2011. To understand how oak trees adapt to changing environments and associated stresses, growth rate, the timing of vegetative bud burst and drought stress related characters such as water use efficiency will be assessed. DNA has been isolated from 50 randomly selected seedlings of each provenance (a total of 300 seedlings). Genetic variation patterns will be characterized at selectively neutral non-genic microsatellite markers and at microsatellite markers located in functional genes with a potential role in selective responses of trees to their environment. The long-term goal of this project is to associate genetic variation in candidate genes for vegetative bud burst and drought tolerance with phenotypic trait variation in an association mapping approach.

4 Evidence of divergent selection between *Quercus rubra* L. and *Q. ellipsoidalis* E. J. Hill populations using gene-based microsatellite markers

Jennifer F. Lind[1], Oliver Gailing[1]

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Oaks (*Quercus spp.*) provide a model system to study local adaptation due to their ability to maintain species identity despite their propensity for hybridization (reproduction between species). Whole genome scans between two interfertile European oak species have found a largely homogenous genome as the result of interspecific gene flow. However, a few genomic areas show high interspecific differentiation, known as outlier loci thought to be involved in the maintenance of species identity through divergent selection. *Q. rubra* and *Q. ellipsoidalis*, two interfertile North American oak species, exhibit different local adaptations to drought stress and flowering time. A set of 45 genic microsatellite markers or expressed sequence tag-simple sequence repeats (EST-SSRs) with putative functions in drought stress or flowering time were used to screen for candidate outlier loci between two sympatric population pairs of Q. rubra and Q. ellipsoidalis in the Baraga Plains near the Ford Forestry Center. Potential outliers were then characterized in two additional sympatric population pairs in northern Wisconsin to help distinguish between the effects geographical distance and adaptation. Within and between both sets of population pairs,

EST-SSR FIR013, consistently exhibited outlier status indicative of divergent selection. FIR013 has a putative function as constans-1, which plays a major role in flowering time in *Arabidopsis thaliana* and other plant species. This finding indicates that flowering time may play a role in the maintenance of species identity present between these interfertile species living in sympatry. This observation is consistent with a previous study of population structure that indicated very low gene flow between these populations and greenhouse observations of species differences in bud burst timing. Finally, three additional EST-SSRs with putative functions related to drought tolerance were also identified, but not in all population pair comparisions.

Session 2: 1:00pm - 2:40pm, *Room A*

1 Loss Estimation of Steel buildings to Mainshock-Aftershock Sequences

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During earthquake events, it is common to observe several aftershocks following a mainshock. Although the aftershocks are normally somewhat smaller in magnitude, their ground motion intensity may have a large value due to possible long duration and different energy content. Even intact buildings may be damaged as a result of the aftershocks. The mainshock-damaged buildings with deteriorated structural properties are more susceptible to damage. To effectively evaluate or retrofit a building, loss estimation from earthquake mainshock-aftershock sequences, in terms of transition cost and downtime cost, needs to be quantified. This paper proposes and demonstrates a methodology for loss estimation of steel structures subjected to mainshock-aftershock sequences. The analysis is based on a typical 4-story steel frame with a deterioration model. Mainshocks are modeled as a homogeneous Poisson process, while aftershocks are simulated as a non-homogeneous Poisson process with random magnitudes. The maximum interstory drift obtained in the nonlinear dynamic analysis is employed as the engineering demand parameter to determine the damage state. The proposed framework of seismic loss estimation is applied to examine the effects of aftershocks on seismic loss. Uncertainty of damage state in seismic loss estimation is also considered in the analysis. As the mean rate of aftershocks decreases with increasing elapsed time from the occurrence of the mainshock, seismic loss estimation due to one mainshock followed by multiple aftershocks at different time frames is compared. The expected losses under different seismic intensity levels, including the design basis earthquake and maximum credible earthquake, are presented. This methodology will contribute to mitigate seismic loss and improve the current building design.

2 The Impacts of Freeze-Thaw on Cliff Recession at the Calvert Cliffs in Maryland

Bonnie Zwissler[1]

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The Calvert Cliffs, which form much of the western coastline of the Chesapeake Bay in Calvert County, Maryland, are actively eroding and destabilizing. This instability is creating a critical condition for the many homes in close proximity to the slope's crest. In past studies, it has been identified that where waves directly interact with the toe of the slope, wave action controls recession; however, where waves do not regularly interact with the slope toe, freeze-thaw was identified as controlling recession rates. Sufficient work by others has been conducted that verifies the relationship between waves and cliff recession. The aim of this study was to determine if

there really is a relationship between freeze-thaw and cliff recession. This project analyzed the recession rate at five study sites along the Calvert Cliffs that are not directly affected by waves on a regular basis. While waves do have the role of removing failed material from the toe, in these regions freeze-thaw is believed to be the dominant factor driving cliff recession. Past recession rates were calculated for each study site using historical aerial photographs. These recession rates were analyzed together with historical temperature data and a variety of other site-specific cliff characteristics determined by field observation and laboratory testing (like slope height, slope angle, freeze-thaw susceptibility of the soil layers, etc.) to form a multivariate regression. The investigation found a meaningful relationship between cliff recession and freeze-thaw.

3 Free-Troposphere Ozone and Carbon Monoxide over the North Atlantic for 2001-2011

Aditya Kumar[1]

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Carbon Monoxide (CO) and Ozone (O_3) are considered to be one of the most important atmospheric pollutants in the troposphere with both having detrimental effects on human health. Both are included in the U.S. E.P.A list of criteria pollutants. CO is primarily emitted in the source region whereas O_3 can be formed near the source, during transport of the pollution plumes containing O_3 precursors or in a receptor region as the plumes subside. The long chemical lifetimes of both CO and O_3 enable them to be transported over long distances. This transport is important on continental scales as well, commonly referred to as inter-continental transport and affects the concentrations of both CO and O_3 in downwind receptor regions, thereby having significant implications for their air quality standards. Over the period 2001-2011, there have been decreases in the anthropogenic emissions of CO and NO_x in North America and Europe whereas the emissions over Asia have increased. How these emission trends have affected concentrations at remote sites located downwind of these continents is an important question. The PICO-NARE observatory located on the Pico Mountain in Azores, Portugal is frequently impacted by North American pollution outflow (both anthropogenic and biomass burning) and is a unique site to investigate long range transport from North America. This study uses in-situ observations of CO and O_3 for the period 2001-2011 at PICO-NARE coupled with output from GEOS-Chem, a global 3-D chemical transport model of atmospheric composition driven by meteorological input from the Goddard Earth Observing System (GEOS) of the NASA Global Modeling and Assimilation Office, to determine the trends in CO and O_3 concentrations over the past decade. These trends would be useful in ascertaining the impacts emission reductions in the United States have had over Pico and in general over the North Atlantic.

4 Structural Health Monitoring and Model Updating of Horizontal-Axis Wind Turbines using Wireless Sensors Technology

Antonio Velazquez[1], Andrew Swartz[1]

[1] *Department of Civil & Environmental Engineering, Michigan Technological University*

Wind energy has been one of the most growing sectors of the nation's renewable energy portfolio for the past decade, and the same tendency is being observed for the upcoming one; however safety and economical concerns have emerged as a result of the newly design tendencies for massive scale wind turbine structures presenting high slenderness ratios and complex shapes, typically located in remote areas (e.g. offshore wind farms). Safety operation requires not only real-time information regarding structural dynamic conditions under aerodynamic action, but also well

known environmental factors in which these multi-body rotating structures operate. Given the cyclo-stochastic patterns of the wind loading on a Horizontal-Axis Wind Turbine (HAWT), a probabilistic framework is appropriate to characterize the risk of failure, under resistance and serviceability conditions, at any given time. Furthermore, sources of uncertainty such as material imperfections, variable rotating speed, aeroelastic damping, damped gyroscopy, shadow effects, turbulence, vortex-shedding, flutter, buffeting, among others, have pleaded for the use of a more sophisticated mathematical framework that could properly handle all these sources of indetermination. Given the attainable modeling complexity that arises as a result of these characterizations, a need for a data-driven experimental validation methodology turns out imperative to validate the model, and is expected to be suitable for representing cyclo-stationary and cyclo-non stationary structural aerodynamics. For this aim, wireless sensors technology raises as the preferred choice for accomplishing the objective, given its flexibility, adaptability, and most importantly, its ability to execute rapid and inexpensive deployments in situ. These wireless sensors will accommodate a novel non-stationary and time-varying System Identification (SI) technique by means of the so called Subspace Realization Theory. The ultimate goal: a mechanical scheme to update the demand loads of a Structural Health Monitoring (SHM) system body designed specifically for model updating and tracking safe operation in real time.

Session 2: 1:00pm - 2:40pm, *Room B*

1 Model-Based Cycle-to-Cycle Control of Homogenous Charge Compression Ignition (HCCI) Engines

Mehran Bidarvatan[1], Mahdi Shahbakhti[1]

[1] *Department of Mechanical Engineering & Engineering Mechanics, Michigan Technological University*

Homogenous Charge Compression Ignition (HCCI) engines represent the next step in automotive engine technology; hold promise of high fuel efficiency and low emission levels than conventional Internal Combustion (IC) engines. Lack of a direct combustion trigger limits automotive industry to exploit HCCI benefits in mass production vehicles. Fast and robust control of combustion phasing and engine load over a wide operating range is critical to ensure reliable operation of HCCI engines in practice. On the other hand, blended fuel control of Low Temperature Combustion (LTC) has recently received a lot of attention in literature. This work presents the first physics-based dynamic Control Oriented Model (COM) to predict combustion phasing and Indicated Mean Effective Pressure (IMEP) (i.e., engine load) of a blended fuel HCCI engine. The model is validated for a wide operating range of steady state experimental data and also three experimental transient fueling conditions for a single cylinder Ricardo engine. Results show the COM has sufficient accuracy of less than 1.4 CAD and 0.2 bar for combustion phasing and load while it runs fast enough for real-time HCCI control.

A two-input two-output controller is designed to control combustion phasing and engine load by adjusting the ratio of two Primary Reference Fuels (PRFs) and manipulating the fuel equivalence ratio respectively. The designed controller consists of a Discrete Sliding Mode Controller (DSMC) and a feed-forward integral controller. Results of testing the controller on a more detailed physical model show promising tracking performance for both combustion phasing and IMEP. In addition, the designed controller is able to maintain a minimal disturbance to desired combustion phasing and IMPE when the engine speed and the intake manifold temperature vary. To the best of authors' knowledge, this is the first study undertaken for sliding mode control of HCCI engines in literature.

2 Effect of Gas Diffusion Layer Thickness on Liquid Water Transport in Polymer Electrolyte Fuel Cells

Mehdi Mortazavi[1], Kazuya Tajiri[1]

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Water transport mechanism in polymer electrolyte fuel cells is still uncovered for researchers. Liquid water produced during the operation of fuel cell can fill open pores of the gas diffusion layer (GDL) and block reactant flow. In this study, the effect of GDL thickness on liquid water transport within and on the surface of the GDL is studied. Taking an ex-situ approach, liquid water droplet emergence and detachment from GDL surfaces with four different thicknesses were captured using a high speed camera. It was observed that droplet emergence was less probable on the thinnest GDL while droplets easily formed and detached on thicker ones. Less frequent droplet emergence on the thinnest GDL may be justified by the smaller mean pore size as was reported by Lin et al [1]. Liquid water finds its path of least resistance through the GDL [2] and as the pore becomes smaller, the capillary pressure liquid water needs to exceed to be able to pass through the GDL increases. In this study, the surface morphology of the GDL samples will be examined by Scanning Electron Microscope to reveal the possible differences of the mean pore size of GDLs with different thicknesses.

3 Blend Ratio Optimization of Spark-Ignition Engine Fuels Containing Gasoline Blendstock, Ethanol, and Higher Alcohols (C3-C6)

Kristina Lawyer[1]

[1] *Department of Mechanical Engineering & Engineering Mechanics, Michigan Technological University*

The U.S. Renewable Fuel Standard (RFS2) requires an increase in the use of advanced biofuels in the transportation sector up to 36 billion gallons by 2022. Longer chain alcohols, in addition to cellulosic ethanol and synthetic biofuels, could be used to meet this demand while adhering to the RFS2 corn-based ethanol limitation. Higher carbon number alcohols can be utilized to improve the energy content, knock resistance, and/or petroleum displacement of gasoline-alcohol blends compared to traditional ethanol blends such as E10, while maintaining desired and regulated fuel properties. This study focuses on the development of three scenarios by which to compare higher alcohol fuel blends to traditional ethanol blends, the implementation of fuel property prediction methods adapted from literature, and the selection of multi-component gasoline-alcohol blends that can satisfy each scenario while adhering to transportation fuel regulations and consumer expectations. Ethanol, n-propanol, iso-propanol, n-butanol, iso-butanol, n-pentanol, iso-pentanol, and n-hexanol are considered in this study.

4 A Novel 3D Nanoscale Automation Analysis using Near-field Imaging Technique of TIRFM (Total Internal Reflection Fluorescence Microscopy)

Dong Hwan Shin[1], Mohammad Mamun[1]

[1] *Department of Mechanical Engineering & Engineering Mechanics, Michigan Technological University*

This study develops an automated analysis tool by combining one near-field imaging technique of TIRFM, an evanescent wave microscopic imaging technique, to capture time-sequential images and the corresponding image processing Matlab code to identify movement of single individual

particles. The developed code provides us to calculate Brownian mean square displacement (MSD) with respect to elevation, which leads to the best-fitted theoretical curve using a non-linear regression method. The known objectives and solution viscosity are used in experiment in order to confirm the analyzed data from code work. Examined particles are (505/515) yellow-green polystyrene fluorescent nanospheres whose diameters are 100, 200, and 500 nm. The different solutions are used for viscosity prediction such as de-ionized water, D-glucose, and glycerol with various weight fractions. The experimental MSD data to the solid surface was compared to the theory of hindered diffusion in the near-wall region within less than 1 μm from the surface. Results represent a good matching for MSDs between theoretical data and code predictions. Comparing the manufactured value, the particle size and viscosity of solutions are also well predicted by developed code. Eventually, it is able to calculate the particles size and the viscosity of the unknown solution where the nanoparticles are suspended using the developed code. This PTV (Particle Tracking Velocimetry) technique would be useful for biomedical applications such as tracking the drug delivery, target protein and diagnostics as well as measuring non-invasive viscometry.

5 On the Optimization of Earth-Moon Restricted Three-Body Trajectories: impulsive approach

Ehsan Taheri[1], Ossama Abdelkhalik[1]

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Optimal Earth-Moon two-dimensional trajectories using bi-impulsive maneuvers are addressed. Impulsive trajectory optimization is usually treated as a parameter optimization problem. In the approach presented in this presentation, the transfer trajectory is not necessarily tangent to the initial or final orbits. Initially, the Earth-Moon trajectory optimization is carried out based on the Patched-Conic approximation to find the optimal patch point. The domain around the patch point is then used in the planar circular restricted three-body system to search for the optimal Bi-impulsive trajectories. An evolutionary algorithm is implemented for optimization. The total impulsive cost is minimized; for a given maximum transfer time. The results obtained in this note show that this approach can find trajectories with lower cost, and yet satisfies the constraint on the flight time, as compared to the solutions presented in literature. In addition, the numerical results show that the transfer trajectory is close to being tangent to both the initial and final orbits.

Session 3: 3:00pm - 4:00pm, *Room A*

1 Use of an Option Generation Paradigm to Investigate Situation Assessment and Response Selection in Law Enforcement

Joel Suss[1], Paul Ward[1]

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When individuals make decisions in the natural ecology, generation and selection of a course of action is informed by their assessment of the situation. Previous option generation research—largely using complex but static tasks—has examined, separately, the decision strategies employed during the situation assessment and response phases of decision making. This research found that decision makers generate a small number of options, and their first option is generally a good one. In dynamic tasks, however, skilled performance involves not only comprehension of the current

situation, but the ability to predict impending events. The goal of this study is to test existing claims about the option generation strategies employed during the situation assessment and response phases of decision making, in the context of a dynamic task. Objectives: To examine the direction of the relationship between the number of options generated and the quality of the "final" (i.e., selected) option, in order to test predictions made by two theories: Take the First heuristic and Long Term Working Memory theory. Methods: Skilled and less-skilled police officers interacted with 20 temporally-occluded video scenarios of law enforcement incidents. At the point of occlusion, participants generated situational and response options and rated the likelihood and quality of each option. A subject matter expert rated each of generated options as relevant/irrelevant and then determined the criterion response option for each scenario. Results: Although skilled and less-skilled participants anticipated the situational outcome of scenarios equally well, skilled officers generated significantly more criterion response options across the scenarios. Contrary to Take The First heuristic, which hypothesized a negative relationship between the total number of response options generated and decision quality, we found—consistent with Long Term Working Memory theory—a positive correlation between the number of task-relevant response options generated and the number of criterion response options.

2 Predicting risky decision making among highly educated professionals: Advances in adaptive numeracy assessment technology

Saima Ghazal[1], Edward T. Cokely[1]

[1] *Department of Cognitive and Learning Sciences, Michigan Technological University*

Individual differences in numeracy (i.e., practical mathematical competence) predict superior decision making across many financial, health, and legal domains (e.g., interpreting political claims; managing chronic illness). Unfortunately, the assessment technologies used in the decision sciences are psychometrically poor (e.g., negative skew; limited construct validity). Moreover, relatively little is known about the underlying cognitive mechanisms that give rise to the relationship between numeracy and superior decision making. In 2012, we introduced the Berlin Numeracy Test—an adaptive technology for the assessment of numeracy and the prediction of risk literacy (http://riskliteracy.org). The test has been shown to be psychometrically robust when used with diverse samples of educated individuals from 30 industrialized countries. In this paper we, we continue to address and refine our understanding of this numeracy testing technology. First, we examine the extent to which the The Berlin Numeracy Test can predict a wider range of risky medical and financial decisions in samples of highly numerate working professionals, including those in medicine and management. Secondly, we examine some of the cognitive mechanisms that mediate the relationship between numeracy and superior decision making (e.g., examining decision latencies and metacognitive calibration). Results are based on two large studies conducted in Holland (n=5408). Study one was an interactive journalism project conducted with a Dutch newspaper De-Volkskrant. Study two examined a sample of respondents who took part in the Dutch Grand National Survey of Mathematical Ability. Results reveal that even amongst highly numerate people the predictive power of the Berlin Numeracy Test is robust. The adaptive testing technology predicted risky financial and medical decision making. Results also indicated that our new test doubled the predictive power of other standard non-computerized measures of numeracy (i.e., Schwartz et al., 1997). Implications for cognitive theory and the design of decision support systems and training technology will be discussed.

3 An Investigation of Crossword Expertise

Kejkaew Thanasuan[1], Shane T. Mueller[1]

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The crossword puzzle was first introduced over a hundred years ago. Today it remains well-loved mental activity for millions of people, from casual players who play crosswords occasionally, to serious players who solve several every day. There have been a number of psychological studies examining crossword expertise by using related lexical tasks such as word generation or word completion. However, these studies have not examined expert's performance with real experts as they solve real puzzles. In this study, we will examine and compare the performance of expert and novice players, showing how they solve the puzzles differently and how experts manage to solve each clue, helping understand the superior performance of crossword expertise.

Session 3: 3:00pm - 4:00pm, *Room B*

1 Pre-vascularized Cell Sheets for Potential Treatment of Myocardial Infarction

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Myocardial infarction (MI), more commonly known as heart attack, can induce severe loss of function within the heart. The heart has limited regenerative capacity, which can lead to loss of contractile mass, scar formation, and eventually heart failure. Current cell therapy approaches involve direct injection of autologous stem cells or progenitor cells. These approaches have only marginal success, due mainly to the lack of incorporation into the injured host tissue. Recent progress has been made in the development of cardiac patches. Such patches can replace scar tissue and improve cardiac remodeling, leading to improvements in function. Natural heart tissue is highly vascularized. However, most of cardiac patches being developed are not pre-vascularized, increasing the risk of necrosis after implantation. The objective of this project is to develop a completely biological, pre-vascularized cell sheet that can be layered in cardiac patches by using human mesenchymal stem cells (hMSCs) and endothelial cells. hMSCs are attractive candidates in this application due to their multilineage differenation, immunosuppressivity, and angiogenic properties. Most importantly, hMSCs can act as pericytes and provide trophic support to endothelial cells as they form vasculature. To develop a pre-vascularized cell sheet, hMSCs are pre-conditioned under physiologically low oxygen concentration to stimulate their trophic factor secretion and then co-cultured with endothelial cells, resulting in vasculature formation *in vitro*. Currently, the degree of vasculature formation, as well as molecular mechanisms, is being examined. Future work includes *in vivo* studies to observe anastomoses with host vasculature, biocompatibility, and immunocompatibilty. Also, co-culture with cell types relevant to the heart, including cardiac myocytes and cardiac fibroblasts, will be used for pre-vascularized cardiac patch fabrication.

2 Nanoparticle Incorporated Dopamine-Modified Poly(Ethylene Glycol) Hydrogels with Enhanced Mechanical and Adhesive Properties

Yuan Liu[1], Hao Zhan[1], Bruce P. Lee[1]

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Rapid and effective wound closure remains an important goal of virtually all modern endoscopic and conventional surgical procedures. Additionally, surgical reconnection of injured tissues is essential for restoration of their structure and function. Tissue adhesives can simplify complex procedures, reduce surgery time, and minimize trauma typically associated with mechanical perforating devices (e.g., sutures, staples). Due to stringent design requirements such as water-resistant adhesion, biocompatibility, and biodegradability, successful tissue adhesives have been difficult to engineer. In developing new and improved tissue adhesive, we combined a 4-arm poly(ethylene glycol) end-capped with dopamine (PEG-D4) and a biocompatible nano-silicate, Laponite, in creating a nanocomposite hydrogel with improved mechanical and adhesive properties. Dopamine, mimics adhesive moiety found in mussel adhesive proteins, is capable of forming strong cohesive and interfacial bonds under wet, saline environments. We hypothesized that strong interfacial bonds formed between dopamine and Laponite will enhance the cohesive and adhesive properties of the nanocomposite hydrogel. Up to 2 wt% Laponite was incorporated into PEG-D4 hydrogel and the effect of Laponite content on gelation time, equilibrium water content, mechanical and adhesive properties of the nanocomposite hydrogel was determined. Increasing Laponite content reduced gelation time as dopamine-Laponite bond reduced the required number of covalent bonds needed for network formation. Incorporation of 1 wt% Laponite greatly enhanced the maximum compressive strength (932±120 kPa), a 50% increase over Laponite-free gels. Similarly, adhesives with 2wt% Laponite demonstrated elevated lap shear adhesive strength and work of adhesion (3.0 and 1.8 times increase, respectively) using wetted pericardium tissue. Increased adhesive properties was presumably due to enhanced bulk cohesive properties of the material. Slightly reduced water content (from 92.60±0.24 to 90.3±0.24) confirms a denser crosslinked network due to incorporation of Laponite. Future work will determine the effect of Laponite content on viscoelastic property, biocompatibility, and degradation rate of the nanocomposite adhesive hydrogel.

3 Framing "risk" in National fish consumption advisories and the Ojibwa tribal fish harvest: Real or imagined public health protection?

Valoree S. Gagnon[1]

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In the U.S. since the early 1970s, environmental policy regulating the harmful effects of toxic chemicals has relied heavily on risk communication through prescriptive fish consumption advisories (FCAs). Teaching the public how to avoid risk exposure—limiting and/or eliminating fish consumption—is a normalized, legalized, and accepted policy instrument utilized in national public health protection. Constructing advisories requires expert calculations of 'risk', real risk, while simultaneously overcoming public risk perceptions, imagined risk. Experts believe that a knowledgeable public will avoid real risk while putting their imagined perceptions to rest. But FCAs are criticized for multiple shortcomings, primarily because they lead to disparate risk exposure, concentrating risk within multiple sensitive populations, populations immune to risk prescriptions. This ethnographic study of the tribal fish harvest in one Ojibwa nation, the Keweenaw Bay Indian Community in the Upper Peninsula of Michigan, discovered the incompatibility of the FCA and Ojibwa risk framework: conflicting histories, ideologies, and synergies of risk. As a sovereign nation with a continued, substantial reliance on fishing, studying through advisories

expose environmental injustices posed by federally-mandated, state-implemented FCAs and the multiple toxics they intend to 'regulate'. Exploring the larger story of Ojibwa harvesting continuity and its cultural meanings, reveals that limiting or eliminating fish consumption is viewed as a risk to Ojibwa culture; but sustaining the harvest increases Ojibwa health risk exposure. Policies designed to minimize harmful exposure must be re-evaluated and reformulated in the effort to protect human health beyond risk communication, beyond the real and imagined risk debate, focusing on sensitive populations with different experiences of risk.

Session 4: 4:20pm - 5:00pm, *Room A*

1 Mitochondria-Targeted Fluorescent Probes for Detection of Mitochondrial Oxidative Stress

Nazmiye B. Yapici[1], Yansu Guo[2], Steffen Jockusch[3], Srinivas Mandalapu[1], Chunyan Li[2], Nicholas Turro[3], Lanrong Bi[1]

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Mitochondrial oxidative stress is implicated in aging and many disorders including neurodegenerative diseases, diabetes, stroke, ischemia/reperfusion injury, age-related macular degeneration (AMD) and cancer. Recently, we have developed two new mitochondria-targeting fluorescent probes, MitoProbes I/II, which can specifically localize in mitochondria and can be used for in vivo and in vitro mitochondrial oxidative stress detection. In this presentation, we will report the design and synthesis of MitoProbes, as well as demonstrate their application for the detection of mitochondrial oxidative stress in living human retinal pigment epithelial cells, in breast/colon cancer patients and in ischemia/reperfusion (I/R) injured rats. Through the use of MitoProbes, imaging mitochondrial redox status can be clinically implemented utilizing cryogenic biopsy specimens and will be proven useful for drug development and for clinical diagnosis of oxidative stress-mediated diseases.

2 Sources, Sinks and Cycling of Acetyl Radicals in Tobacco Smoke: A Model for Biomass Burning Chemistry

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Smoke near the source of biomass burning contains high concentrations of reactive compounds, with NO and CH_3CHO concentrations four to six orders of magnitude higher than those in the ambient atmosphere. Tobacco smoke represents a special case of biomass burning that is quite reproducible in the lab and may elucidate early processes in smoke from other sources. The origins, identities, and reactions of radical species in tobacco smoke are not well understood, despite decades of study on the concentrations and toxicities of the relatively stable compounds in smoke. We propose that reactions of NO_2 and aldehydes are a primary source for transient free radicals in tobacco smoke, which contrasts with the long-surmised mechanism of reaction between NO_2 and dienes. The objective of this study was to investigate the sources, sinks and cycling of acetyl radical in tobacco smoke. The production of acetyl radical was demonstrated both in tobacco smoke and a simplified mixture of air combined with NO and acetaldehyde, both of which are significant smoke components. Acetyl radicals were trapped from the gas phase using 3-amino-2, 2, 5, 5-tetramethyl-proxyl (3AP) to form stable 3AP adducts for later

analysis by high performance liquid chromatography (HPLC), mass spectrometry/tandem mass spectrometry (MS-MS/MS) and liquid chromatography–mass spectrometry (LC-MS). 2.15×10^{13}-3.18×10^{14} molecules/cm^3 of acetyl radicals were measured from different cigarette samples and smoking conditions. Matlab was employed to simulate reactions of NO, NO_2, O_2, and a simplified set of organic compounds known to be present in smoke, with a special emphasis on acetaldehyde and the acetyl radical. The NO^2/acetaldehyde mechanism initiates a cascade of chain reactions, which accounts for the most prevalent known carbon-centered radicals found in tobacco smoke, and pathways for formation of OH and peroxyl species. Tobacco smoke provides a new perspective of radical generation in a relatively well-defined biomass burning process.

Session 4: 4:20pm - 5:00pm, *Room B*

1 Autonomous Navigation in an Unknown Environment with a Mobile Robot

Dereck A. Wonnacott[1]

[1] *Department of Electrical and Computer Engineering, Michigan Technological University*

A mobile robot must minimally accomplish three key tasks to perform any useful work in an unknown environment; First, the robot must generate a map of it's environment using only on-board sensors. Second, the robot must maintain an accurate estimate of it's current location in that map. Finally, the robot must be able to plan navigation paths through environment based on known obstacles and avoid new obstacles as they are detected. The goal of this research project was to implement such a platform using mobile robots available on the Michigan Tech campus and enable future research in mobile robotic systems. Robot Operating System (ROS) is an open source software library for building advanced robotic applications and is used by many robotics researchers around the world. It incorporates many rigorously tested and peer reviewed algorithms capable of performing these three key tasks and provides a well defined benchmark for future research. A mobile robot has been configured with an ROS interface and an easy to use application has been developed which allows and untrained user to easily explore and navigate an unknown environment from a remote location. This work lays the foundation and provides a valuable benchmark for future research in mobile robotics at Michigan Tech.

2 Phase Measurement Unit analysis and its application on wide area protection

Yawei Wei[1]

[1] *Department of Electrical and Computer Engineering, Michigan Technological University*

With the Smart Grid plan's development, the new wide area protection method and phase measurement unit equipment aiming to handle the much more complex super grid are catching more attentions. Our research wants to make a clear and careful analysis about the recent develop PMU equipment, like testing their accuracy and their robust about different grid situations and also their install location selecting method. We try to combine the right now in using grid protection device, like relaying, with this new equipment to build a beginner set for future wide area system and their protection networks. We are using EMTP ,ASPEN and MATLAB to do the modeling and simulating work. With all of these work, we are trying to draw a brief map of PMU applications on power system. And based on our forecasting and analysis about this method

development, we are going to follow path to promote this field growth.

Poster Presentations Day 1

Session 1: 10:00am - 12:00pm

1 Modeling Human Performance in Simulated Unmanned Aerial Search

Brandon S. Perelman[1], Shane T. Mueller[1]

[1] *Department of Cognitive and Learning Sciences, Michigan Technological University*

In the present study, we modeled participants' behavior during two types of simulated aerial search tasks, a multiple target search task and a probability density preference task, using a neurocomputational model of the hippocampus. To examine behavior during these search tasks, we created a synthetic task environment to represent the cognitive task requirements of unmanned aerial vehicle operators in wilderness search and rescue. In the first task, participants searched a map of probable target locations for targets represented as lost boy scouts. After the search, participants were tested for their memory of the locations of found targets and asked to reconstruct the path flown during the trial. Participants exhibited widely varying degrees of aptitude in completing this task. A number of observed behavioral phenomena are discussed. In the second task, participants used the environment to search preferentially a long linear probability distribution (e.g., a road) or a circular high density probability distribution (e.g., an oasis). In this task, participants showed a high preference for the high density probability distribution even in cases where searching the linear region first was advantageous. Participants' decision making behavior during both tasks was modeled via basic hill climbing toward neural activation of perceived reward associated with each region.

2 Exploring Affective Effects on Driving Performance and Workload

Wei Zhang[1], Myounghoon Jeon[1]

[1] *Department of Cognitive and Learning Sciences, Michigan Technological University*

Typically, affect detection research has depended on a valence dimension (positive or negative). However, recent research proposes that different affective states, even if they are in the same valence dimension, may cause specific cognitive processing and then lead to different behaviors. For example, an angry driver tends to be aggressive and causes road rage, whereas an excited driver tends to miss critical elements of the situation, such as pedestrians crossing the road or speed limit signs, which could yield a fatal accident. The present study is to investigate specific effects of different negative emotions – anger and sadness – on driving performance and perceived workload.

24 undergraduates participated in a simulated driving task under three different road scenarios: highway (easy), foggy/snowy/tunnel (medium), and rolling rocks (difficult), with either induced anger or sadness. Driving performance was measured using four categories: lane deviation, aggressive driving (pressure on the pedal and speed violation), violation of traffic rules (stop signs, red lights, and turn signals), and collisions. Participants also reported subjective assessment of driving confidence and risk perception in addition to perceived workload using NASA-TLX.

The intended affective states significantly increased after induction procedure and decreased after the experiment, which indicates successful manipulation. Participants with induced sadness showed numerically more errors than those with anger, but this result did not reach the conven-

tional statistical level. However, both of them led to more errors compared to ones in the neutral condition in the previous studies. Besides, the participants with induced anger reported greater workload than those with induced sadness, which goes beyond the simple valence approach, but might be explained with the cognitive appraisal mechanism. The current study is expected to contribute to constructing a comprehensive driving behavior model by including emotions and affect and to designing an in-vehicle interactive discourse system for affect detection and intervention.

3 Communicating the conditional risk of HIV to Low Risk Individuals: Assessing US Hotline Practices and the benefits of Natural Frequencies

Katrina M. Ellis[1], Gary L. Brase[2]

[1] *Department of Cognitive and Learning Sciences, Michigan Technological University*
[2] *Psychology Department, Kansas State University*

CDC recommendations suggest HIV testing of all individuals, although low-risk patients are more likely to receive false positives than high-risk individuals. We evaluated current counseling of low-risk test recipients via a sample of 29 HIV hotline counselors from state and national hotlines. 100% of counselors interviewed failed to provide an accurate conditional HIV risk for low-risk women. A second study including idealized counselor transcripts using a natural frequency format offered a small but significant improvement in conditional reasoning (among undergraduates), consistent with frequentist theories. Discussion will include additional findings (e.g., the influence of numeracy) and implications for theory and practice.

4 Neural and Muscular Alterations in Healthy and Obese During Intermittent Static Exertions

Ashley E. Shortz[1]

[1] *Department of Cognitive and Learning Sciences, Michigan Technological University*

The aim of this study is to explore obesity-related neural and muscular changes during intermittent upper extremity exertions. A total of fifteen participants (7 obese and 8 healthy) performed intermittent elbow and grip exertions (30s cycle, 15s of work/15s of rest) at 30% of maximum voluntary contraction (MVC). Cerebral oxygenation, perceived exertion (Borg ratings), and force fluctuations were recorded throughout the entire duration. It is hypothesized that obesity-related differences in neural, perceptions of exertion, and muscular will be observed. Results indicated that the obese group was significantly different compared to the healthy group when performing the grip task at 30% MVC but the healthy group had significantly more force fluctuations when performing the elbow exertion at 30% MVC as time progressed. There was no significant difference in oxygenated hemoglobin in the prefrontal cortex observed for the healthy group. The obese group displayed significantly greater oxygenated hemoglobin in the elbow exertion versus the grip exertion. Results indicate that there was no observed significant difference in the obese group for perceived exertion. Perceived exertion was significantly greater for the elbow when compared to the grip in the healthy group. Females had higher perceived exertion than male participants. The results suggest that there are neural and muscular differences between obese and healthy individuals. The increased neural activation in the obese group could be due to additional resources needed to complete the task, meaning that to complete the same task the obese group was in need to more oxygen supply to the prefrontal cortex. This suggests there could be possible difference in the way obese individuals use their oxygen supply to complete a physical task. Difference in force fluctuations could be attributed to different muscle fiber types in the obese and healthy groups.

5 The Role of Toolkit Genes in the Evolution of Complex Wing, Thorax, and Abdominal Color Patterns in *Drosophila guttifera*

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Animal color patterns such as zebra stripes, leopard spots, and the myriad variants of butterfly wing color patterns are known to play important ecological and physiological roles in the life of animals and are crucial for the survival of species. Scientists first tried to solve the secret of animal patterns with mathematical approaches to find models that could explain how these patterns developed. In 1952, Turing proposed the famous reaction – diffusion model in which a short-range acting activator molecule diffuses from a source to stimulate color production, while a long-range acting inhibitor molecule prevents pigmentation. Using the spectacularly ornamented fruit fly *Drosophila guttifera*, we developed a transgenic protocol to study the development and evolution of color patterns. We identified that the Wingless morphogen had evolved a new function in the *D.guttifera* lineage by activating the yellow gene on pre-existing structural landmarks on the wing, causing black melanin spots around sensory organs, tips of the veins, and crossveins. We are currently expanding this work by investigating if the melanin patterns on different body parts of *D.guttifera* evolved by the same mechanisms involving Wingless, or if they are a product of convergent evolution. We optimized an in situ hybridization technique for the developing thorax and abdomen and showed that the yellow gene is expressed in a pattern precisely foreshadowing the four longitudinal melanin stripes on the thorax, and six rows of abdominal spots that decorate the body of the adult *D.guttifera* fly. We will use the in situ hybridization technique to identify candidate regulators that govern the complex yellow expression pattern.

6 Sympathoexcitation Induced by SK Channel Blockade in PVN Requires Activation of NMDA Receptors

Robert A. Larson[1], Andrew D. Chapp[1], Mingjun Gu[1], Qing-Hui Chen[1]

[1] *Department of Kinesiology and Integrative Physiology, Michigan Technological University*

Small conductance calcium activated potassium channels (SK) are abundantly expressed in the paraventricular nucleus (PVN). SK channel blockade in the PVN augments sympathetic nerve activity (SNA), yet the mechanism remains unclear. We hypothesized that the increased SNA evoked by SK channel blockade in PVN requires local activation of glutamate receptors. In anesthetized rats, bilateral PVN microinjection of SK channel blocker Apamin (25 pmol, 50 nl) significantly (n=5; $p<0.01$) increased splanchnic SNA (SSNA) (304±60%) and mean arterial pressure (MAP) (33±6mmHg). Pre-treatment with PVN injection of KYN (7.2 nmol), a non-selective glutamate receptor blocker, significantly attenuated (n=4) the elevated SSNA (137±31%; $p<0.05$ vs vehicle control) response to Apamin. Similarly, pre-treatment with AP5 (6.0 nmol), a NMDA receptor blocker, also attenuated (n=4) the SSNA (155±17%; $p<0.05$ vs vehicle control) response to Apamin. Pre-treatment with KYN (n=4) and AP5 (n=4) obviously attenuated MAP responses to Apamin (17±6mmHg, p=0.08 for KYN; 14±11mmHg, p=0.06 for AP5) but didn't reach statistical significance. Immunohistochemistry studies demonstrated SK channel expression in PVN neurons with projections to the RVLM. This data indicates that the sympathoexcitatory response elicited by SK channel blockade in PVN, at least partly, requires local activation of NMDA receptors. Support: AHA2640130 (QHC).

7 Sympathetic and Cardiovagal Baroreflex Sensitivity in Humans: Comparison of Valsalva's Maneuver and Spontaneous Methodologies

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Valsalva's maneuver (VM) and spontaneous techniques have been used to assess sympathetic (sBRS) and cardiovagal (cBRS) baroreflex sensitivity, but the intra-individual reliability between these methodologies has not been examined. We hypothesized that spontaneous BRS would be positively correlated to VM BRS. Heart rate (HR), blood pressure (BP), and muscle sympathetic nerve activity (MSNA) were measured in 28 healthy subjects (age, 23±1 yr; 14 men and 14 women) during 10min supine rest and 3 VM at 40mmHg expiratory pressure (15s, 1min recovery). For spontaneous BRS, relations between diastolic BP and MSNA were used to determine sBRS, while relations between systolic BP and RR interval were used to determine cBRS. During VM, sBRS was the ratio of MSNA and the maximum diastolic BP reduction during early phase II, and cBRS was derived from linear relations between systolic BP and RR interval during early phase II (i.e. hypotensive stimulus) and phase IV (i.e. hypertensive stimulus). Spontaneous sBRS was significantly correlated to VM sBRS (r=0.516, p=0.036). Spontaneous cBRS (up-up sequence) was correlated to VM phase IV cBRS (r=0.356, p=0.048). In contrast, spontaneous cBRS (down-down sequence) was not correlated to VM phase II cBRS (r=0.128, p=0.295). In conclusion, our findings demonstrate low- moderate associations between spontaneous and VM estimates of assessing sBRS and cBRS. Supported by NIH (HL-098676).

8 Quantification of Bioenergetic Rates in Lake Superior *Diporeia*

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Predicting population dynamics of the amphipod *Diporeia*, a prominent prey item for fish in Lake Superior, requires information on the physiological effects of changes to its environment. The primary objective of this study is to obtain quantitative data for rates of production, respiration and consumption that can be incorporated into a bioenergetics model for Lake Superior *Diporeia*. This model will be used to further the understanding of the role that this abundant macrobentho plays in ecosystem function. Benthic communities in Lake Superior were sampled bimonthly from April to September during 2011 and 2012 to investigate spatial and temporal trends of *Diporeia* abundances as well as age and sex structures of the population. Additional samples of *Diporeia* were collected and kept alive in natural sediment for laboratory experiments. I measured respiration rates for three different size classes of *Diporeia* by monitoring dissolved oxygen levels in microcosoms using microelectrodes. Additionally, a series of experiments to estimate consumption and assimilation rates based on food availability using 14C-labeled algae (Selenastrum capricornutum) were conducted. Amphipod population densities are highest along the slope (30-110 m) compared to the shelf (0-30 m) or profundal (¿110m) regions in Lake Superior. This heterogeneous distribution of *Diporeia* in Lake Superior is an important component of quantifying lake-wide biomass. Rates of oxygen consumption by *Diporeia* ranged from 34.49-65.27 mg O_2 g^{-1} DW d^{-1}, and tended to decrease with body size per individual. My current work is focused on varying the specific activity of ^{14}C-labeled algae so that carbon assimilation can be accurately measured. Data on *Diporeia* production and bioenergetics found in this study can be incorporated to a model used to estimate the viability of this population under potential future environmental stressors.

9 Metabolite Profiling of Vetiver Grass (*Chrysopogon Zizanioides*) Under Lead stress

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Lead (Pb) contamination in residential soils and public places due to its prior use in paints and various other household materials is a serious concern in the United States. Children are more prone to Pb toxicity due to ingestion and inhalation. Lead affects nervous and renal systems and also causes behavioral and developmental problems. Phytoremediation is an effective, economically feasible green technology for Pb remediation. Vetiver (*Chrysopogon Zizanioides*) is a hyperaccumulator of Pb. Characteristics such as high biomass, an extensive root system and non-invasive nature make vetiver a suitable choice for Pb remediation. Metal stress induces various physiological and biochemical changes in the plant systems. Metabolomic tools can provide an insight into some of these changes, which would lead to a better understanding of the process of metal tolerance and accumulation by hyperaccumulators. Our goal was to identify the global metabolomic changes in the vetiver plants under lead stress. Plants were subjected to various concentrations (0, 400, 800, 1200 mg/L) of lead for different time periods (0, 10 and 20 days) in a hydroponic set up. Root and shoot samples from all the treatments were analyzed for metabolite changes using Gas chromatography- Mass spectrometry (GC-MS). Metabolites were extracted in methanol: chloroform: water, then polar and non polar components were separated and derivatized. Raw GC-MS data was deconvulted by Automated Mass Spectral Deconvolution and Identification System (AMDIS) and metabolites were identified using mass Spectral Library - NIST98. Metabolites with significant changes were identified and metabolomic pathway analysis was performed. Salient features of the data obtained show that the major upregulated pathways were tRNA biosynthesis in both root and shoot, amino acid metabolism including glycine, serine, threonine, valine, leucine, isoleucine, arginine and proline in root. The significance of the metabolomic changes in vetiver plant from lead stress will be discussed.

10 Evaluation of larval lake sturgeon production near an artificial spawning reef (Fighting Island reef) in the Detroit River

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In 2008, an artificial spawning reef was constructed near Fighting Island in the Detroit River to enhance spawning habitat for native fishes including lake sturgeon (Acipenser fulvescens). In this system, much of the natural lake sturgeon spawning habitat has been degraded or eliminated as a result of channelization, dredging, and substrate removal. The Fighting Island reef consists of 12 experimental reef beds containing four different substrate treatments. In 2012, reef beds composed of different substrates were sampled for fish larvae in order to evaluate the effectiveness of this artificial reef project. We detected the presence of lake sturgeon eggs on all substrate types on 9 May, and began larval lake sturgeon sampling using D-Frame drift nets on 15 May. We focused larval sampling efforts on the four reefs closest to Fighting Island where we found the highest egg densities. Night sampling (20:00-06:00 hrs) was conducted biweekly until 5 June. In total, 30 lake sturgeon larvae were collected directly downstream of the four reef beds and 3larvae

were collected upstream in control sites. Approximately 45.5% of the larvae were collected on the 15 May, and zero larvae were collected on 5 June. A repeated measures ANOVA found no significant difference in average CPUEs (larval sturgeon/hr/night) between sampling sites located directly downstream of the four reef bed treatments. Our results indicate that the Fighting Island reef is producing viable lake sturgeon larvae. While our sampling effort in such a large system is small, larval drift downstream of each substrate type was documented.

11 Genetic Variation at Non-Genic and Gene-Based Microsatellite Markers (EST-SSRs) in Four North American Oak Species (Section Lobatae)

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Oaks are economically and ecologically important species in the Northern hemisphere and have become model taxa for the study of ecological speciation due to their high tendency to hybridize while maintaining their species identity. Eight non-genic nuclear microsatellites (nSSRs) and 20 gene-based microsatellites (EST-SSRs) were characterized in natural populations of four Lobatae Loudon section species, *Q. ellipsoidalis* E.J. Hill, *Q. coccinea* Münchh., *Q. rubra* L. and *Q. velutina* Lam. These oak species are similar morphologically and at amplified fragment length polymorphism (AFLP) genetic markers, suggesting the possibility of gene flow between some of these species. Cross-species transferability of nSSR and EST-SSR markers make them cost-effective and advantageous as tools for identification of genetic variation. The study aimed at assigning individual samples to putative species and estimating past gene flow between the Lobatae species at the microsatellite markers. Another objective was to elucidate species identities and taxonomic relationships between the four species with specific focus on the closely related species *Q. ellipsoidalis* and *Q. velutina*. The present study is based on two hypotheses: (1) There will be evidence of past gene flow between *Q. ellipsoidalis*, *Q. velutina*, *Q. rubra* and *Q. coccinea* at the microsatellite markers with the highest level of gene flow between *Q. ellipsoidalis* and *Q. velutina* as shown by the largest number of interspecific hybrids; (2) Similar patterns of interspecific differentiation will be observed at microsatellite markers and at AFLP markers. Results based on the 28 highly variable microsatellite markers showed a clustering of the *Q. ellipsoidalis* and *Q. velutina* populations with the highest number of hybrids and introgressive forms between them, and a clear separation from *Q. rubra* and *Q. coccinea*. The combined analysis of genetic characters (microsatellites and AFLPs) will allow a better characterization of taxonomic relationships in this taxonomically "difficult" group of red oak species.

12 Candidate genes for speciation and local genetic adaptation in oaks (*Quercus spp.*)

Alexis R. Sullian[1], Sandra A. Owusu[1], Oliver Gailing[1]

[1] *School of Forest Resources and Environmental Science, Michigan Technological University*

Multispecies oak (Fagaceae: *Quercus*) communities are model systems for the study speciation and genetic adaptation because they defy traditional explanations of species diversity. Hybridization is common among oaks, and species boundaries in the North American red oaks (*Quercus* section *Lobatae*) are notoriously weak. Contrary to the modern evolutionary synthesis, recurrent gene-flow among these species has not led to a loss of genetic cohesiveness or adaptive distinctness. Given an apparent of lack barriers to gene-flow, natural selection imposed by competition and site characteristics appears to be an important factor in species development and maintenance. To determine which genes may be important in oak speciation, we screened sympatric populations

of interfertile species *Q. velutina*, *Q. coccinea*, *Q. rubra*, and *Q. ellipsoidalis* for loci bearing the signature of divergent selection. Among a total of 22 gene-linked microsatellites (EST-SSR), four loci, all involved in stress responses or photosynthetic efficiency, were identified as potentially under selection. In order to identify nucleotide variation associated with interspecific differences, the coding and regulatory regions of these genes will be sequenced in a representative sample of each species. First results indicate that sequence similarity of these genes among *Quercus* species reflect ecological specializations rather than phylogenic relationships.

13 Characterization of the Lateral Organ Boundaries Domain Genes *PtdLBD1*, *PtdLBD4*, *PtdLBD15* and *PtdLBD18* in a *Populus trichocarpa* x *Populus deltoides* cross

Faten Dhawi[1,2], Oliver Gailing[1]

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Wood cells are the key to solve ecological problems associated with pollution, producing high quality biofuel and reducing global warming. Formation, development and differentiation of wood vascular tissue are regulated by the interaction between ecological and molecular factors. The molecular factors which we are interested in the current study are Lateral Organ Boundaries Domain (LBD) transcription factors. The Lateral Organ Boundaries Domain (LBD) family of transcription factors is involved in secondary woody growth. As mapping pedigree a F2 full-sib family (family 52-124, *Populus trichocarpa* clone 93-968 x *P. deltoides* clone ILL-101 crossed with the male *P. deltoides* clone D14) was used to characterize the LBD genes *PtaLBD1*, *PtaLBD4*, *PtaLBD15* and *PtaLBD18*. Gene and regulatory regions (7000 bp per gene) were sequenced in the *P. trichocarpa* x *P. deltoides* seed parent in order to characterize Single Nucleotide Polymorphisms (SNPs) for genetic mapping. Using a Quantitative Trait Locus (QTL) mapping approach, SNP variation will be associated with height and diameter growth and with wood anatomy. Primers were developed to sequence the coding regions for the four genes *PtaLBD1*, *PtaLBD4*, *PtaLBD15* and *PtaLBD18* based on sequence information from Populus trichocarpa. DNA was extracted and amplified using 5 to 7 primers pairs per gene in order to sequence DNA fragments with overlapping sequences. SNPs were confirmed for *LBD15*, *LBD18*, *LBD4*. SNPs for *LBD1* are currently validated. Identified SNPs in *LBD15*, *LBD18* and *LBD4* genes were mapped in a *Populus trichocarpa* x *Populus deltoides* full-sib family using PCR- RFLP.

14 Characterization of highly variable genetic markers in sugar maple (*Acer saccharum* Marsh.) for genetic variation studies

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An understanding of the principles and consequences of the spatial and temporal dynamics of population genetic structure is the requirement for development of strategies to conserve genetic resources. Different silvicultural treatments including regulation of stand structure, harvesting operations and promotion of natural regeneration are expected to have considerable effects on the reproduction system of trees. These changes are reflected in changes of fine scale genetic structure of the progeny generation within populations. The development and application of highly polymorphic genetic markers will greatly enhance research on the dynamics of the genetic structure and help understanding the effect of forest management on genetic variation and productivity in *Acer saccharum* stands. The objective of our project is to develop and characterize polymorphic

nuclear microsatellite markers (nuclear Simple Sequence Repeats or nSSRs) for sugar maple to assess genetic variation. The first markers have been tested in a small number of samples and showed successful amplification. Additionally, our investigation will focus on highly variable nuclear microsatellites originally developed for *Acer pseudoplatanus*. The usefulness of microsatellites is due to the fact that the number of sequence repeats at a given locus varies within species or/and populations. Microsatellites have proved to be highly polymorphic and suitable for investigations of gene flow and mating system for many plant species.

15 Habitat Selection Cartograms at both Regional and Local Scales for an Endangered Lepidopteran Specialist in Wisconsin, USA

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Visualizing the habitat selection dynamics of a species is difficult but necessary for successful conservation and restoration. This occurs at both the regional and local scale when selecting appropriate geographical areas to establish or promote species presence. Multi-Criteria Risk Models are capable of considering multiple variables at one time while generating cartograms across the landscape. Generating these outputs requires an in-depth understanding of how a species selects habitat and how specific geographic characteristics will affect species presence, density and movement. Habitat selection cartograms were produced for an endangered Lepidopteran specialist, *Lycaeides melissa samuelis* Nabokov (the Karner blue butterfly) across eight Wisconsin state properties (116,000 acres) and 31 field sites (800 acres) in four distinct ecological regions at 1m resolution. Regression models isolating influential habitat characteristics were compared to models based on literature review. Ground-data collected in 2010 and L. melissa populations from 2011-2012 were used to train and test models. Regional cartograms were generated utilizing existing remote sensing and GIS layers. Local cartograms were generated utilizing on-site ground-measurements including focal nectar plants species, ground cover, and host plant distribution. Models performed well across the entire selected landscape of Wisconsin at both the landscape and local scale. These models highlight potential habitat areas and visually illustrate how a specialist Lepidopteran utilizes habitat structure and composition. These cartograms will focus management and monitoring efforts and can be adjusted for associated species, contributing to the overall restoration of this species and its ecological community.

16 Availability of aspen and northern hardwood forests as feedstock resources for Kinross biofuel production plant: in the Upper Michigan: Analysis of changes between circa 1800 and now

Sara Alian[1], Ann Maclean[1]

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Biofuels are viewed by many as a viable renewable energy source, which can be used as an alternative to fossil fuels in the primary energy mix, particularly in the transportation and electricity sectors. Two key factors constraining the use of biomass for energy production are resource availability and choice of energy crops. In the United States, comprehensive plans are being developed to investigate appropriate biofuel-based energy sources which will make the nation less dependent on importing fossil fuel products. Michigan is one of the states that have abundant forests and farmlands. As a result, the commercial cellulosic ethanol plant in Kinross Township located in Chippewa County in the eastern Upper Peninsula (UP) of Michigan has been proposed. It is estimated that sufficient woody feedstock resources exist within the 150-mile radius of the plant.

The area covers 33 counties in southern and eastern UP and northern and central Lower Peninsula of the Michigan. The spatial distribution of the aspen and northern hardwood needs to be investigated to inventory the available feedstock resources. As a first step, the vegetation map of circa 1800, Pre- European vegetation, to extract the availability of aspen and northern hardwood in the area. Then, the land use/ land cover 2001 maps will be used to investigate the current availability of aspen and northern hardwood. Finally, the amount of changes and the location of the changes will be calculated.

17 Interactive controls of water table position and vegetation type on biogeochemical processes in a northern bog ecosystem: PEATcosm experiment

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Northern wetlands, peatlands in particular, have been shown to store around 30% of the world's soil carbon and thus play a significant role in the carbon cycle of our planet. Carbon accumulation in peatlands is the result of retarded decomposition due to low oxygen availability in these waterlogged environments. Changes in our planet's climate cycles are altering peatland hydrology and vegetation communities, resulting in changes in their ability to sequester carbon through increases in peat carbon oxidation and mineralization. To date, consequences of altered hydrology and changes in vegetation communities, and their interactive effects on carbon storage, are not well understood. We have initiated a research plan that assesses the varying roles that water table variation and vegetation communities have on extracellular enzyme activity and labile carbon availability in porewater from an ombrotrophic bog. Specifically, we measured dissolved organic carbon (DOC), total dissolved nitrogen (TDN), enzyme activity, anions and cations, spectral indexes of aromaticity, and phenolic content in testing our hypotheses of responses to climate change drivers. We hypothesized that oxygen availability will strongly influence decomposition in these systems but that this response will largely be mediated by changes in plant community types. To date, our data confirm interactive vegetation and water table related patterns. Cation concentrations in sedge-dominated communities dropped significantly with depth and drainage (relative to control and ericaceous treatments), likely reflecting changes in redox potential owing to physiological differences in sedges and a reduction in the products of anaerobic metabolism. DOC increased in the lowered water table treatments in all vegetation community types, hinting at inhibitory mechanisms to DOC degradation. Hydrolase enzymatic activities showed seasonal responses and potential vegetation inhibition. Through this research, we are hoping to advance our knowledge of the drivers behind peatland biogeochemistry and how ombrotrophic peat systems may respond to climate change influences.

18 Pattern identification in volcanic activity signals obtained through satellite remote sensing

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The dynamics of volcanic eruptions are intricate and varied with many factors attributing to the levels of activity identified in different locations. The prediction of eruptions can be complicated by a variety of factors including external forcing, geophysical dynamics within the conduit system and geochemistry of the magma source. These features vary depending upon the location with

particular emphasis upon geologic setting of volcano. Satellite remote sensing using ultraviolet (UV) and thermal infrared (TIR) radiation wavelengths can be used to facilitate monitoring of ongoing activity through the identification of sulfur dioxide (SO2) and surface radiative heat fluxes respectively. The aim of this work is to identify if patterns are present in the volcanic signals, produced through monitoring with the aforementioned techniques, with particular focus upon the variations of these patterns throughout the eruptive cycle of a volcano. Assessment will be completed through the utilization of a Welch filter, producing periodigrams indicating the presence and significance of cyclical patterns within the data. This research will incorporate analyses of volcanoes displaying varied activity types including Soufriere Hills (Montserrat), Kilauea (Hawaii), Ambrym (Vanuatu) and Piton De La Fournaise (Reunion). Measurements of SO_2 will be obtain using the operational Ozone Monitoring Instrument (OMI) located onboard NASA's Aura satellite whilst TIR data will be retrieved from MODVOLC, a dataset derived from surface 'hot spots' indentified by the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard NASA's Aqua satellite platform. The utilization of multiple sensors will facilitate the identification of different forms of activity at each location allowing production of a more comprehensive analysis and potentially allowing the cross correlation between activity types.

19 Probabilistic modeling of rainfall induced landslide hazard assessment in San Juan La Laguna, Sololá, Guatemala

Patrice Cobin[1]

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The municipality of San Juan La Laguna, home to approximately 5,200 people, sits on the western side of the caldera lake, Lake Atitlán. Surrounding the town are the steep slopes of the ancient caldera rim. To the southeast of the town, on the southern side of the lake, are three volcanoes, volcanoes San Pedro, Tolíman and Atitlán. The whole watershed of Lake Atitlán experiences a myriad of natural hazards, but most predictably are the landslides that occur annually with each rainy season. Hurricane Stan passed through in October 2006, and the resulting flooding and landslides devastated the Atitlán region. Utilizing various primary and secondary features, geology, geomorphology, distance to faults and streams, land use, slope, aspect, curvature and topographic wetness index, this study makes use of statistical modeling to predict landslide susceptibility in the San Juan area. The landslide observations for the statistical modeling were obtained from the field and ortho-photos following Hurricane Stan. The model was validated using the landslides observed after Hurricane Agatha in 2010. The ultimate aim of this study is to produce a probabilistic landslide susceptibility map for the area surrounding San Juan and to share the results with the municipality, using contacts developed during the author's time as a United States Peace Corps volunteer, allowing for more effective future hazard mitigation.

20 Numerical Modeling of Magmatic Intrusions and Their Effects on Volcanic Stability at Pacaya Volcano, Guatemala

Lauren N. Schaefer[1]

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Instability factors in volcanic settings can act in combined processes, making it difficult to understand the trigger of a given slope failure. Often, failures occur in association with magmatic eruptions, but the complexity of magmatic systems makes it difficult to understand the risk of

magma pressure provoking collapse. This study aims to improve our understanding of the interplay between magma intrusion, magma system geometries, and collapse features using numerical modeling. The active Pacaya Volcano in Guatemala is an ideal study site for this type of analysis given its continual eruptive activity, history of a large ancestral collapse, and more recent smaller collapses in 1962 and 2010. Results of a stability analysis with the Limit Equilibrium and Finite Element Method using the physical-mechanical material properties of Pacaya's intact rocks and rock mass characteristics show that the edifice remains stable under gravity. This implies that the mechanical properties are not enough to induce failure as a single mechanism and that they are likely related to changes in the magmatic system. Coincident summit Strombolian eruptions and flank lava eruptions during these events also indicates the possibility of magma reservoirs high in the cone. To better constrain the causes of the recent failures, different magma pressures and magma system geometries were considered in numerical modeling. Additionally, alignment of collapse features with vents and regional deformation patterns suggests tectonic controls on dike intrusions. These structural surface features at Pacaya were compared to existing analog models to provide a clearer understanding of the internal mechanisms controlling deformation at Pacaya. Understanding these factors will provide a more comprehensive platform for hazard analysis and risk reduction.

21 Source Processes Revealed at Two Guatemalan Volcanoes: Insights from Multidisciplinary Observations of Harmonic Tremor and Numerical Modeling

Kyle A. Brill[1], Gregory P. Waite[1]

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Tremor signals at volcanoes have typically been attributed to fluid movement within the system. Characteristics of harmonic tremor (i.e. duration, frequency content, polarization) can convey detailed information about source processes from which they emanate, but decoding these signals poses great challenges due to the complexity of volcanic environments. We recorded instances of harmonic tremor at both Santiaguito and Fuego volcanoes located in the Guatemalan section of the Central American Volcanic Belt. The instances of harmonic tremor occur both independent from and contemporaneous with explosions, and last anywhere from 30 seconds to tens of minutes. The signals have their fundamental frequencies between 0.3 and 2.5 Hz, with as many as 20 overtones, and exhibit spectral gliding of up to 0.75 Hz over the course of an event, changing as quickly as 0.1 Hz/second. Using field observations; video recordings; and time-lapse, ultraviolet, and thermal imagery; collected simultaneously with acoustic and seismic recordings, we are able to constrain source locations and processes beyond what would otherwise be possible with the acoustic and seismic recordings alone. We propose that the harmonic tremor signals are generated by the nonlinear excitation of fracture walls as gas vents out of the systems. Additionally, we investigate the complex wavefield generated by harmonic tremor and the heterogeneous volcanic media. Particle motions at both volcanoes are typically elliptical, but vary dramatically over time as the fundamental frequency glides up and down (see figure). In addition, the particle motions of harmonics often have different polarities from each other and the fundamental frequency. Through finite difference modeling, we isolate the effects of near-field terms, topography, and source mechanism to explore each of these factors' contribution to the unexpected behavior.

22 Analogy: Energy/Thermo/Fluids in Everyday Life

Aneet D Narendranath[1], Jess Kane[2]

[1] *Department of Mechanical Engineering & Engineering Mechanics, Michigan Technological University*
[2] *Visual and Performing Arts, Michigan Technological University*

The poster depicts through a diurnal activity how basic fluid mechanics and/or thermodynamics affect or appear in our life. Several concepts in the area of Energy/Thermo/Fluids are reinforced only by rote. This poster attempts to depict a light hearted situation through a cartoon/caricaturized version of a day-to-day activity that, in it's essence, could help reinforce and augment our understanding of the fluid physics subsumed in the seemingly complicated equations that describe it.

23 A Lab-on-a-chip Microfluidic Device for miRNA Isolation from Body Fluids

Radheshyam Tewari[1,2], Craig Friedrich[1,2]

[1] *Department of Mechanical Engineering & Engineering Mechanics, Michigan Technological University*
[2] *Multi Scale Technologies Institute (MuSTI), Michigan Technological University*

Micro-ribonucleic acids (miRNAs) are increasingly recognized as potential biomarkers for early detection of diseases. A significant amount and number of miRNAs manifest themselves in the extracellular media of several body fluids where they are believed to primarily remain bound to Argonaute2 (Ago2) protein. As a viable method for isolating miRNAs from body fluids, Ago2 has been immunoprecipitated using anti-Ago2 antibody. However, to our knowledge, a lab-on-a-chip type microfluidic device that facilitates immunoprecipitation of Ago2 from very small volumes of unprocessed body fluids has not yet been reported. This project is developing a microfluidic device which will isolate and detect target miRNAs from different body fluids as a sub-system toward a silicon nanowire based integrated biosensor. Work has started to proof and simplify the steps of the immunoprecipitation process this device will employ. Work has also started to explore different substrate options which will both support protein functionalization and be amenable to mechanical or semiconductor fabrication methods toward building the device. We will report up to date progress on the development of our microfluidic device.

24 Simultaneous Opto-Electric Examination of Non-Adherent Cell Growth and Settling

Jen-Yung Chang[1], Bryan Plunger[1,2], Chang-Kyoung Choi[1,2]

[1] *Department of Mechanical Engineering & Engineering Mechanics, Michigan Technological University*
[2] *Micro Electrical and Optical Sensing (μ-EOS) lab, Michigan Technological University*

Electrical impedance sensing has been used to qualitatively and quantitatively examine numerous cellular traits including cell proliferation, cell membrane properties, cell type, and stem cell differentiation. However, the most pronounced aspects of a cell's impedance signature are dependent on its adherence to the measuring electrode's surface. This means that impedance for a non-adherent cell line is a more sensitive function of their spatial distribution in 3D, including the number of cells settled but not adhering to the electrode surface. This study uses a combined electrical impedance and optical imaging approach to correlate the impedance measurements taken

with the spatial distribution of cells at the electrode surface, where the greatest impact on the overall impedance reading is made. Traditional impedance measurement utilizes non-transparent gold electrodes, limiting optical techniques and fidelity. Improvement in opto-electrical sensing is possible by virtue of the optical and electrical properties of an Indium Tin Oxide (ITO) electrode, which is both conductive and transparent. The ITO electrode therefore allows for simultaneous impedance sensing and microscopic imaging to take place. This is critical for interpretation of the impedance results. Sampling with the ITO electrode is carried out in an automated fashion using software, while imaging is done manually at intervals to maximize clarity. This study will use impedance to track in real-time the relative cell density in a sample while controlling for the highly significant effect of cells that settle and cluster on, or very near to, the electrode surface. This combination of techniques allows for a more comprehensive opto-electrical evaluation of the state of the culture sample and therefore more reliable results.

25 A Hybrid Electrokinetic Pump for a Lab-on-a-chip Microfluidic Device

Jen-Yung Chang[1], Radheshyam Tewari[1,2], Chang-Kyoung Choi[1,2], Craig Friedrich[1,2]

[1] *Department of Mechanical Engineering & Engineering Mechanics, Michigan Technological University*

[2] *Multi-Scale Technologies Institute, Michigan Technological University*

This research explores alternating-current (AC) and direct-current (DC) based electrokinetic (EK) pumping strategies for a lab-on-chip microfluidic device for on-chip isolation and sensing of micro-RNAs from whole blood by immunoprecipitation (IP). A conventional DC-EK pump is better used for shorter operating times, localized fluid movements, open-channel systems, and low flow rates. For high flow rate requirements and for relatively longer operating times however, it results bubble formation, heat generation, and electrolysis. On the other hand, AC-EK pumps provide high flow rates and are suitable for longer operating times. But, at low frequencies, an AC-EK pump acts like a DC-EK pump and at high frequencies the flow rate decays considerably. To combine the benefits of both AC and DC pumping strategies, we have microfabricated a hybrid EK pump in a single device that utilizes interdigitated electrodes for AC-EK based pumping and diodes for DC-EK based pumping respectively. Due to diode's characteristic of rectification, both pumps are sufficiently operable using one AC external source. This allows operating the diode pump at relatively higher frequencies which minimize the electrolysis related issues common with conventional DC-EK pumps. In addition, the device design allows remotely placing the diodes away from the fluid channel providing more flexibility and the ability to externally change the flow direction. Along with device design and fabrication details, we will also report the range of flow velocities possible with this pumping strategy when different biosensing system compatible working fluids are used.

26 Using Molecular Dynamics to Predict Mechanical Properties of New Aerospace Materials

Benjamin D. Jensen[1]

[1] *Department of Mechanical Engineering & Engineering Mechanics, Michigan Technological University*

Carbon-based materials are ideal for aerospace structural components because of their high specific strength and high specific stiffness relative to traditional metallic aerospace materials. New carbon-based nanostructured materials contain constituents such as carbon nanotubes, tetrahedral amorphous carbon (ta-C), nanodiamond, graphite, and graphene. Development of new carbon-based materials that maximize the desirable properties of their nano-constituents can be

time consuming and expensive. Molecular Dynamics (MD) simulations can be used to accelerate the design and development of carbon-based materials. Molecular models give detailed atomic information not easily obtained from physical samples, and they provide precise control over environmental variables in the simulation. Since bond dissociation and formation are critical in determining properties of materials such as ultimate strength and for generating amorphous covalently bonded structures such as ta-C, a new generation of force fields, such as the recently developed Reax Force Field (ReaxFF), are required to simulate these material systems. In this study MD and ReaxFF methods are employed to create an atomic model of a carbon nanotube composite with ta-C used as the matrix material. Covalent bonds are added between the amorphous carbon matrix and the nanotubes in order to determine their influence on load transfer between constituents. This study predicts that this material can have an ultimate strength of 55 GPa and 30 GPa in the axial and transverse directions respectively. A Young's modulus of 500 GPa in the axial direction and 250 GPa in the transverse direction is predicted. Failure in the axial direction is indicated to initially occur with the nanotubes and the ta-C bears the remaining load until complete failure of the material, indicating good load transfer between the matrix and nanotubes. These results indicate that MD with the ReaxFF can be an effective tool in development and prediction of new carbon-based materials.

27 Testbed for Collaborative Control in High-risk Environments

Byrel Mitchell[1]

[1] *Department of Mechanical Engineering & Engineering Mechanics, Michigan Technological University*

Typical control models for underwater navigation ignore ambient currents, or treat them as completely uniform. Demanding missions in high-risk environments require high-fidelity, robust environmental estimation and control. To develop these multi-vehicle coordination algorithms, an inexpensive testbed is required. Current off-the-shelf underwater gliders are expensive ($65,000 and above), large (1-2 m long), and heavy (50 kg and above), which decreases their utility for cooperative control testing. The GALUR (Glider for Autonomous Lake Underwater Research) developed in the Nonlinear Autonomous Systems lab has a much lower cost, size and greater flexibility, permitting free testing in hazardous environments.

Oral Presentations Day 2

Session 1: 11:00am - 12:00pm, *Room A*

1 Time-Lapse Seismic Observations of Regional Gas Blowdown at Teal South

Nayyer Islam[1,2], Wayne D. Pennington[1], Mohamed A. Ezawi[1]

[1] *Department of Geological & Mining Engineering & Sciences, Michigan Technological University*

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Tremor signals at volcanoes have typically been attributed to fluid movement within the system. Characteristics of harmonic tremor (i.e. duration, frequency content, polarization) can convey detailed information about source processes from which they emanate, but decoding these signals poses great challenges due to the complexity of volcanic environments. We recorded instances of harmonic tremor at both Santiaguito and Fuego volcanoes located in the Guatemalan section of

the Central American Volcanic Belt. The instances of harmonic tremor occur both independent from and contemporaneous with explosions, and last anywhere from 30 seconds to tens of minutes. The signals have their fundamental frequencies between 0.3 and 2.5 Hz, with as many as 20 overtones, and exhibit spectral gliding of up to 0.75 Hz over the course of an event, changing as quickly as 0.1 Hz/second. Using field observations; video recordings; and time-lapse, ultraviolet, and thermal imagery; collected simultaneously with acoustic and seismic recordings, we are able to constrain source locations and processes beyond what would otherwise be possible with the acoustic and seismic recordings alone. We propose that the harmonic tremor signals are generated by the nonlinear excitation of fracture walls as gas vents out of the systems. Additionally, we investigate the complex wavefield generated by harmonic tremor and the heterogeneous volcanic media. Particle motions at both volcanoes are typically elliptical, but vary dramatically over time as the fundamental frequency glides up and down (see figure). In addition, the particle motions of harmonics often have different polarities from each other and the fundamental frequency. Through finite difference modeling, we isolate the effects of near-field terms, topography, and source mechanism to explore each of these factors' contribution to the unexpected behavior.

2 From Analog to Digital Modeling of Volcanoes: the Kinect Sensor Capabilities

Riccardo Tortini[1], Simon A. Carn[1]

[1] *Department of Geological & Mining Engineering & Sciences, Michigan Technological University*

The Kinect is a motion capture device designed for the Microsoft XBOX system. The device comprises a visible (RGB) camera and an infrared (IR) camera, refractor and light emitter emitting a known structured light pattern at a near-infrared wavelength of 830 nm, plus a three-axis accelerometer and four microphones. Moreover, by combining the signal from the IR camera and the light emitter it is possible to produce a distance image (depth). Thanks to the efforts of the free and open source software community, although originally intended to be used for videogames, the Kinect can be exploited as a short range, low-cost camera-type laser scanner by scientists in various fields. The main limitation of the Kinect is its limited field-of-view and working distance, which ranges from 0.5 to 10-15 m with a distance sensitivity of 1 mm at 0.5 m and 8 cm at 5 m (Tortini and Carn, 2012). However we envisage several possible applications of the small-scale, precise topographic data acquired by the Kinect in volcanology, and solicit other ideas from the community. We will present the calibration process for the RGB and depth images to the color spectrum and analogue modeling materials. Possible applications could include mapping inactive lava tubes, capturing topographic data on the outcrop scale, mapping surface roughness variations on volcanic mass flow deposits, or visualizing analog volcano models in the lab. As a demonstration, we will present an application of the Kinect as a tool for 2D quantitative analysis and 3D visualization of lab models of volcanoes. Data will be collected with free and open source software, demonstrating the cost-effectiveness of the Kinect, particularly where conditions may be unsuitable for the deployment of more costly instruments.

3 Effect of stratospheric ozone recovery on tropospheric chemistry

Huanxin Zhang[1]

[1] *Department of Geological & Mining Engineering & Sciences, Michigan Technological University*

The stratospheric ozone has decreased greatly since 1980 due to ozone depleting substances (ODSs). As a result of the implementation of the Montreal Protocol and its Amendments and

Adjustments, stratospheric ozone has been predicted to recover towards its pre-1980 level in the coming decades. We examined the consequences of stratospheric ozone changes for the tropospheric chemistry and surface ozone air quality with a global chemical transport model (GEOS-Chem). Significant decreases in surface ozone photolysis rates due to stratospheric ozone recovery were observed. The global average OH decreases by 1.74% and the global burden of tropospheric ozone increased by 0.78%. The change of global average surface ozone shows a strong seasonal variation.

Session 1: 11:00am - 12:00pm, *Room B*

1 Translocation and Telemetry of Pre-Spawning Lake Sturgeon in an Upper Reach of the Menominee River

Jeremy G. Olach[1]

[1] *Department of Biological Sciences, Michigan Technological University*

In spring of 2012, twelve pre[U+2010]spawning sturgeon were tagged and translocated from one impounded each on the Menominee River to another impounded reach upstream. The sturgeon were implanted with Vemco transmitters and then tracked with both stationary and mobile receivers to determine whether they would travel upstream to use the historic spawning site at the top of the study reach. Within 8 days of translocation, seven of the twelve sturgeon were detected at the top of the 39 rkm study reach, where spawning activity was also observed. The study supports the idea that the impounded population of sturgeon dwelling downstream would utilize a historical spawning site after having no access to the site for over 60 years.

2 Meta analysis of microarray studies identifies distinct molecular profiles of abiotic and biotic stress responses in plants

Rafi Shaik[1], Mychal W. Ivancich[1], Wusirika Ramakrishna[1]

[1] *Department of Biological Sciences, Michigan Technological University*

Plant stress response is a complex trait involving multiple genes that are regulated in several layers involving epigenomic, transcriptomic, proteomic and metabolomic factors. Further, more often than not plants are simultaneously exposed to multiple stresses resulting in enormous changes in the molecular landscape within the cell. Currently multiple transcriptomic studies identifying these changes exist for the same or related stress conditions. So far only a few meta-analyses based on plant stress microarray studies are reported. Here, we performed meta-analysis of drought and salinity (abiotic), bacterial and fungal (biotic) stress microarray studies in rice and Arabidopsis to identify the differentially expressed genes (DEGs) in each of the stresses. We analyzed a total of 386 and 482 microarray samples belonging to 20 and 25 microarray studies in rice and Arabidopsis, respectively. The microarray CEL files of each stress were normalized together using Robust Multichip Average (RMA), quality checked with arrayQualityMetrics package in R and differentially expressed genes (DEGs) were identified using RankProduct method. The identified DEGs were exhaustively characterized for enrichment of a number of molecular features, compared to DEGs reported by other studies and orthologous genes between rice and Arabidopsis were also identified. An all vs all comparison of DEG lists was performed to identify the common and unique genes and molecular features of each stress type. Weighted Gene Co-expression Network Analysis (WGCNA) was performed to break-down the lists into small modules with genes showing similar expression patterns and high co-expression and identified stress specific hub genes showing high connectivity.

3 Embeddedness: A Context Dependent Driver of Fish Habitat Preference

Anthony D. Matthys[1], Casey J. F. Huckins[1]

[1] *Department of Biological Sciences, Michigan Technological University*

We measured movement parameters of juvenile coaster brook trout (Salvelinus fontinalis), sculpin (Cottus spp.), and coho salmon (Oncorhynchus kisutch) to evaluate the hypothesis that local habitat sections (10m reaches) containing patches of exposed larger substrates (e.g., boulders, cobbles, gravel) would be more preferred over local habitat sections fully embedded with fine sediments. We tested this hypothesis at two sites: one heavily affected by fine sediments (mean sediment depth .265m) and one site which has been less impacted (mean sand depth 0.04m).We used the dynamic turnover model developed in Belanger and Rodriguez (2002) to estimate immigration rates in local habitat sections and infer habitat preferences of stream fishes. We found that in reaches heavily impacted by fine sediments embeddedness seems to be an important determinate of immigration rate (i.e. habitat preference) for brook trout (Mantel's r=0.98, p=0.04) and sculpin (Mantel's r=0.89, p=0.04), although these correlations are not significant at Bonferoni corrected levels. However, for brook trout embeddedness and the indirect effects of the physical habitat and local habitat position, predicted immigration rate well (Mantel's r 0.99, p=0.0001). Interestingly, we did not detect a significant response of immigration to embeddedness at the less sediment impacted site. This suggests to us that the importance of exposed cobbles appears to be context dependent. When cobbles are exposed in sandy reaches, they form very attractive habitats but when the prevalence of cobble increases, the relative importance of cobble to habitat selection appears to decrease. This research suggests that patches of exposed cobbles are preferred habitats in fine sediment impacted reaches and should be focal points to conservation and restoration efforts of affected rivers.

Session 2: 1:00pm - 2:00pm, *Room A*

1 Fast Imaging of Freezing Drops: Studies of Contact Nucleation

Colin Gurganus[1,2]

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[2] *Department of Atmospheric Sciences, Michigan Technological University*

Understanding microphysical cloud processes is essential for improving the efficacy of weather and climate forecasting to better predict variability in the atmosphere. Decades of satellite remote sensing observations aid in the development of parameterizations, yet despite this wealth of data a poor understanding of microphysical cloud processes limits the fidelity of current models. Our efforts are aimed at better understanding the phase transitions of supercooled cloud droplets, which can initiate precipitation processes and drive cloud turbulent mixing. Tropospheric nucleation is dominated by the heterogeneous mode due to an abundance of natural and anthropogenic aerosol catalyst particles. Disentangling complex droplet-aerosol interactions in the laboratory is important for correct parameterization in cloud microphysical models.
Heterogeneous nucleation remains enigmatic and our approach utilizes simple experiments to disentangle several competing hypothesizes. Previous laboratory experiments have noted a preference for nucleation by a catalyst in "contact" with a droplet, with freezing temperatures 2-5K warmer than similar immersed catalyst. To study this difference between these interactions, we employ high speed imaging of supercooled water drops to determine nucleation site spatial statistics for a droplet-catalyst system. These experiments utilize droplets resting on homogeneous and atomically smooth silicon substrates. Radial distributions of the nucleation sites in these slowly

cooled systems reveal no preference for nucleation at the three phase contact site, a surprising null result.
One hypothesis for this conflicting observation is the presence of a thermal gradient within droplets experiencing differential cooling. Here we report on the modification of our experiment to examine these parameters in more detail. Initial results agree with our previous observations suggesting that the lower energy barrier to nucleation in some contact studies may result from a nanometer scale "point-like" interaction. It remains unclear to what extent morphology, texture and size influence the nucleation rate in other non-idealized systems.

2 Why does it rain? New insight into an old question using in-situ holographic measurements

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How do clouds produce rain? This seems like a fairly simplistic question, yet it remains one of the largest and most debated mysteries of our age. A current, and somewhat controversial, theory involves inhomogenous mixing of cloud air with subsaturated environmental air, which reduces the number of drops in the system without reducing the size of the survivors. These surviving drops have less competition for vapor and are thus able to grow much larger. The presence of a shell of saturated, subsiding air surrounding the cloud could also produce a similar scenario by allowing for dilution with minimal evaporation. Unfortunately, the current suite of aircraft based, cloud instruments are unable to accurately measure cloud drop spectra at scales small enough to capture the dynamics of mixing and dilution.
Digital holography represents a major paradigm shift for in-situ cloud measurements, providing the ability to resolve cloud volumes at scales relevant to mixing processes for the first time. Each hologram from the Holographic Detector for Clouds II (HOLODEC II) records an instantaneous "snapshot" of all particles located within the 20 cm3 sample volume. In addition to capturing the micro-scale droplet size spectra, the 3D position data allows for the visualization of the actual mixing process. Digital holograms recorded by the Holodec II during transects of a cumulus cloud are analyzed to search for the signature of inhomogeneous mixing. By utilizing natural, ambient chemical tracers and other atmospheric state measurements, three transects at different altitudes through the cumulus cloud are compared with holographic data to investigate the effect of mixing and entrainment on the enhancement of condensational growth.

3 Using Artificial Intelligence in Predicting First Interaction Length of An Extensive Air Shower observed by the Pierre Auger Observatory

Tolga Yapici[1], Brian Fick[1], David Nitz[1]

[1] *Department of Physics, Michigan Technological University*

For the particle accelerators to retrieve the hadronic interaction parameters (cross-section, inelasticity and multiplicity) at high energies (E>10^{18} eV) at the current technology level is impossible. The lack of experimental information about the hadronic interactions at these energies results in uncertainties in extensive air shower (EAS) simulations and the interpretation of observed EAS. The important information about the parameters can be probed using the EAS data from Pierre Auger Observatory which observes cosmic rays at these high energies. In this work, we focused on the cross-section, which manifests itself as the first interaction length. It was determined that a simple relation between EAS and first interaction length is hardly possible. Thus, a sophisticated

model, an Artificial Neural Network model, that predicts cross-sections for the hadronic interactions in EASs was developed. The results have demonstrated that the method can be used for identifying the composition for the cosmic rays.

Session 2: 1:00pm - 2:00pm, *Room B*

1 Exploring Zinc as a Bioabsorbable Material

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Metallic stents are commonly used in conjunction with balloon angioplasty to promote revascularization and retard possible restenosis of damaged arteries. To mitigate the long-term side effects associated with conventional cardiac stents, a new generation of so-called "bioabsorbable" metal stents is currently being developed. Research spanning the last decade has focused on iron- and magnesium-based cardiac stent materials with little success. It was found that biocorrosion of iron produced a harmful corrosion product, whereas magnesium and its alloys proved to corrode too rapidly to be acceptable.
The authors have recently proposed a novel concept: the development of zinc-based bioabsorbable stents. Early indications from *in vivo* murine (rodent) experiments are that pure zinc exhibits ideal biocorrosion behavior for an absorbable material. Cross sectional analysis has enabled both quantitative corrosion rate measurements and elemental analyses. The mechanical properties of many zinc alloys meet or exceed general criteria for this application, especially regarding elongation to failure. Several commercial and experimental zinc alloys have been identified that merit further investigation, and *in vitro* (non-animal) methods are currently being developed to do so.

2 Electrolyte-induced Precipitation of Graphene Oxide in Its Aqueous Solution

Hui Wang[1], Yun Hang Hu[1]

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Graphene oxide (GO) can easily dissolve in water to form a stable homogeneous solution due to its hydrophilic property and ionization of functional groups. However, in this paper, it is reported that a strong electrolyte (HCl, LiOH, or LiCl) can destabilize the GO solution, causing the GO precipitation. This indicates that the electrostatic repulsion plays a critical role in stabilizing aqueous GO solution. The electrolyte-induced precipitates were characterized by transmission electron microscopy (TEM), Raman spectroscopy, and Fourier transform infrared spectroscopy (FTIR). The oxygen-containing functional groups of GO sheets, which are carboxyl, epoxy, and hydroxyl groups, remained unchanged during HCl and LiCl-induced precipitations. In contrast, during the GO precipitation induced by LiOH, the carboxyl group of GO sheets disappeared with a remarkable increase in hydroxyl group and aromatic C=C bonds. This indicates that the LiOH-induced GO precipitation resulted in the partial reduction of GO sheets. Furthermore, it was demonstrated that the HCl-induced GO precipitation is a feasible approach to deposit GO on a substrate as a Pt-free counter electrode for a dye-sensitized solar cell (DSSC), which exhibited 1.65% power conversion efficiency.

3 Effect of Solute Additions on Grain Size Stability of Aluminum Alloys

Andrew H. Baker[1], Stephen L. Kampe[1]

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Methods to enhance the thermal stability of nano-sized grains in Al are of interest in order to maintain various properties when exposed to elevated temperatures during solid state consolidation of Al alloys in the powder or ribbon form. In this research, various metallic solute additions were incorporated into solid solution with Al through melt-spinning. The effect of the solute additions on the thermal stability of grain-size and other microstructural changes were determined using x-ray diffraction and metallographic measurements after aging under controlled annealing temperatures and times. A comparison of the experimental results with current predictive thermodynamic models of the effect of solute addition on grain growth is also presented.

Session 3: 2:20pm - 4:00pm, *Room A*

1 Functionalized Boron Nitride Nanotubes for Quantum Devices

Boyi Hao[1]

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Boron nitride nanotubes (BNNTs) are wide band gap nanomaterials with extraordinary mechanical and chemical stability. Unlike carbon nanotubes (CNTs), the band gap of BNNTs is merely uniform, not sensitive to the change of chirality, diameter, and number of nanotubular walls. Furthermore, BNNTs are of advantageous to nanowires as they are ideally free of dangling bonds at their surfaces. Thus BNNTs are promising nanostructures for nanoscale electronic and photonic devices. Theoretical calculations show wide band gap of BNNTs is tunable by various methods, such as giant stark effect, doping and etc. However, there is no experimental evidence showing that BNNTs can be used for electronic and photonic devices. Here we show two novel approaches for the functionalization of BNNTs with quantum dots (QDs) and CNTs, which enable the applications of BNNTs in tunneling electronic and plasmonic devices.

2 Modeling of Charge Transport in a One Dimensional Chain of Metallic Nano-islands on an Insulating Wire: The Effect of Chain-length and Temperature on Device Characteristics

Madhusudan A. Savaikar[1], Douglas Banyai[1], Yoke Khin Yap[1], Paul L. Bergstrom[2], John A. Jaszczak[1]

[1] *Department of Physics, Michigan Technological University*

[2] *Department of Electrical and Computer Engineering, Michigan Technological University*

Although devices have been fabricated displaying interesting single-electron transport characteristics, there has not been much progress in the development of simulation tools that can simulate such devices based on their physical geometry. In this work, we present the development of a simulator – SIMASET based on a physical model that can simulate quantum transport devices. After describing the physical model and simulation techniques, the capabilities of SIMASET are demonstrated by modeling experimental devices described in the literature. Next we present a series of studies of charge transport through a long one-dimensional (1D) chain of gold nano-islands on an insulating substrate. Results are presented of the current-voltage (IV) characteristics as a function of the overall chain-length and temperature (T). Under large biases the IV characteristics are non-Ohmic and follow a power law behavior without showing any Coulomb staircase (CS)

structures. Conversely, at small biases they show clear CS structures that are more pronounced for larger chain-lengths. The Coulomb blockade (CB) and the threshold voltage (V_{th}) required for device switching increase linearly with increasing chain-length. While with increasing temperature, blockade effects are diminished as the sharp increase in current at V_{th} is smoothed out and V_{th} decreases. Results show that beyond V_{th}, at small biases, devices with larger chain length are able to retain their CS structures even at higher temperatures. For a given chain length, V_{th} -T variation may not follow a linear behavior but its slope depends on the temperature. At zero V_{th}, any further increase in temperature increases the zero-bias conductance of the device that is characterized by an Arrhenius behavior. At large biases, temperature has no appreciable effect on the device current which is indicative of quantum tunneling through the nano-islands. The likely presence of defects (missing islands) in an experimentally fabricated device increases the blockade and V_{th} substantially.

3 Parameterized maximum-principle-satisfying flux limiters for high order finite difference WENO scheme for solving convection-diffusion equations

Yi Jiang[1]

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A class of parameterized flux limiters has been developed by Xu (XU, 2012) to preserve strict maximum principle for high order numerical schemes solving hyperbolic conservation laws. In this research, we generalize the maximum principle preserving flux limiting technique to the high order finite difference weighted essentially non-oscillatory (WENO) scheme for the convection-diffusion equations. By applying the limiters only at the final stage of the explicit Runge-Kutta time discretization, we obtain both high order accuracy and maximum principle with regular CFL number. We show that the method can be applied to the high order schemes solving two-dimensional incompressible Navier-Stokes equations with designed accuracy and satisfies the maximum principle. Numerical experiments for fifth-order finite difference WENO scheme with both third and fourth RK temporal integration are reported. Preliminary analysis is also presented to demonstrate why the scheme works with regular CFL number.

4 The Effects of Minification on Aperture Width Judgments

James Walker[1], Anthony Nordman[1], Scott A. Kuhl[1]

[1] *Department of Computer Science, Michigan Technological University*

Studies have consistently shown that people underestimate distances in virtual environments as compared to the real world. Previous studies by our research group have shown that minification, a graphical manipulation that widens the field of view being rendered, can cause users' reports of their distance judgments in virtual environments to be very similar to their real-world judgments. However, potential side effects of minification on other spatial judgments are not well understood. This research investigates what effect expanding the graphical field of view has on users' judgments of aperture widths and gap affordances. Two studies were conducted, both of which presented users with two vertical poles in a sparse virtual room at varying egocentric and exocentric distances. In the first study, users reported whether they believed they could walk between the poles without turning their shoulders. In the second study, users indicated the perceived width of the poles by spreading their hands. In the first study, users' aperture width judgments were unaffected compared to their real-world counterparts, while in the second study, their judgments were affected by minification. This may suggest that minification is not affecting users' verbal reports of aperture widths, but is affecting their action-based responses, which is

consistent with the results from previous minification studies.

5 A Phenomenological Approach to Teaching Engineering Ethics

Valorie E. Troesch[1]

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The ethical reasoning skills of undergraduate engineering students at Michigan Tech, as measured by the Defining Issues Test 2 (DIT-2), are lower than their peers at other universities. Despite this, however, the way we teach engineering ethics remains substantially unchanged. Engineering ethics pedagogy traditionally uses real or hypothetical case studies to examine professional engineering conduct against three standards: the rules-based National Society of Professional Engineers code of ethics, a values-based approach that considers the values of engineers, and a formulaic utilitarian approach that seeks the greatest good for the greatest number. For this research, I hypothesized that a phenomenological method of inquiry could improve students' ethical reasoning skills. Phenomenology is a philosophical and research method that investigates and describes phenomena as they are consciously experienced. By "bracketing out" causes or other preconceptions, phenomenology allows us to focus on the things themselves. In the redesigned Enterprise Ethics in Engineering Design course, the single point of inquiry for students was: what is it to be an ethical engineer? Through a series of readings about ethical engineers, studies of exemplary engineers and other persons of high ethical integrity, personal interviews with engineers, and their own self-examination of what it is to be an ethical engineer and of their own character and values, students began to reflect upon the "essence" of an ethical engineer. They were asked to experience, as much as possible in a classroom setting, the phenomenon of being an ethical engineer. The new course was piloted in the Fall 2011 semester. Direct measures included (1) student pre-tests (week 1) and post-tests (week 14) using the DIT-2 and (2) assessment of student work product. DIT-2 scores improved by 23% (N2 scale) and by 18.8% (P scale). Future work includes broadening the participant pool, adding control group classes, and introducing additional ethical measurements.

Session 3: 2:20pm - 4:00pm, *Room B*

1 Diffuse interface field approach to modeling and simulation of arbitrarily shaped particles packing with friction

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Particle packing problems are relevant to a variety of areas of science and engineering such as ceramics, metallurgy, pharmacy, biology, transportation, agricultural and communication industries. This ancient problem, which was first studied by Johannes Kepler back in the 16th century, turned out to be easy to ask, but difficult to solve rigorously. The purpose of this study is to develop an effective model of dynamic random packing of arbitrarily shaped particles based on the diffuse interface field approach (DIFA). As a dynamic model, also known as sequential procedure, the proposed model was designed to capture the physical packing process and generate the packing configuration. It automatically simulates the translation and rotation of arbitrarily shaped particles without explicitly tracking their surfaces, facilitating the implementation of the model in high computational efficiency. The approach is also able to account for the friction between particles, which helps us to better understand the packing process of granular materials. Being capable of investigating several important process variables, the DIFA model will find its

application in many material processes, including the storage and flow of granular materials in hoppers or tubes, powder compaction process, etc.

2 Combined Computational-Experimental Study of Templated Grain Growth and Uniaxial Texture Development in Ferroelectric Polycrystalline Ceramics

Jie Zhou[1], Yongke Yan[2], Shashank Priya[2], Yu Wang[1]

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Templated grain growth process and texture development in ferroelectric polycrystalline ceramics are studied by complementary computational and experimental methods. Phase field modeling is employed to perform computer simulation of polycrystalline grain structure evolution during template grain growth. X-ray diffraction peak intensities of the simulated polycrystals are computed during grain structure evolution. Texture development is characterized by the evolution of Lotgering factor. The effects of template seed volume fraction and sizes on the final grain structure and texture are investigated. It is found that, while the degree of texture increases with increasing template volume fraction until approaching perfect uniaxial texture (i.e., Lotgering factor approaching 1), the average template seed distance also plays an important role, thus reducing the template size and shortening seed distance is an effective way to achieve higher texture at lower template volume fraction, which is desired for enhancing piezoelectric properties. Experimental measurements are performed to characterize the grain structures, textures and properties at selected stages of sintered ceramics, and are compared with the computational results in good agreements.

3 Friction Stir Fabrication of New Al-Sc-Zr Alloys Using Supersaturated Feedstock

Kyle Deane[1]

[1] *Department of Materials Science & Engineering, Michigan Technological University*

Al-Sc-Zr alloys are promising precipitation hardening alloys due to the formation of coherent L12 $Al_3Sc_{1-x}Zr_x$ precipitates. The most appealing aspect of these alloys is that the precipitates are stable at the aging temperatures of other precipitation hardening alloys, such as Al-Cu, allowing them to keep their strength over a larger temperature range. This temperature stability is due to an internal segregation of the precipitates, with fast-diffusing Sc at the center and slow-diffusing Zr at the surface creating a "shell" that limits coarsening. However, Sc and Zr are only soluble in Al at concentrations around 0.1%, limiting the amount of precipitates, and in turn strengthening, that can be achieved. In an attempt to create an Al-Sc-Zr alloy with a greater potential for precipitation hardening, supersaturated alloys have been created through the rapid solidification process known as melt spinning, which creates thin ribbons solidified between 105 and 107 °C/s. In order to apply this supersaturated ribbon to other material shapes, the ribbon was powdered, pressed into loose bar form, and friction stir welded into the surface of pure Al plates. Cross sections of friction stir processed plates show a composition gradient, which can be used to observe the properties of multiple alloys at once. Hurdles faced and knowledge gained in the endeavor to achieve said supersturation will be discussed, as well as the findings associated with the resultant Al-Sc-Zr plates. This work was sponsored by the Office of Naval Research, grant No. N00014-11-10876, and all friction stir processing is being done by Aeroprobe Corporation.

4 Interdiffusion Coefficients of Scandium and Zirconium in Aluminum

Marcel A. Kerkove[1], Paul G. Sanders[1], Douglas J. Swenson[1], Thomas D. Wood[1]

[1] *Department of Materials Science & Engineering, Michigan Technological University*

Understanding the kinetics of the Aluminum-Scandium-Zirconium (Al-Sc-Zr) system is important, as it shows promise as a high temperature precipitation hardened alloy. Motivation for this study is that currently available diffusion coefficients between 475-625°C are insufficient for alloy design. Diffusion couples of pure Al with Al-Sc and Al-Zr master alloys have been heat treated at temperatures from 475 to 625 °C. Analysis of the Al-Sc diffusion couples using wavelength dispersive x-ray spectroscopy provided concentration profiles which allowed for determination of interdiffusion coefficients of Sc in Al within the temperature range of interest. The diffusion coefficients of Sc and Zr in Al will be important in future work related to the interaction between Sc and Zr, which has been observed to result in a reduced rate of coarsening. This work was sponsored by the Office of Naval Research, grant No. N00014-11-10876.

5 Formation of Copper Gasars

Helen J. Ranck[1]

[1] *Department of Materials Science & Engineering, Michigan Technological University*

Gasars are directionally porous structures formed by the solidification of a gas-saturated melt. Porosity and morphology is controlled by the variation of processing parameters including solidification rate, soluble gas partial pressure and solidification pressure. Many metal-gas systems have been found to form gasars including copper-hydrogen, iron-nitrogen and magnesium-hydrogen. Typical processing requires the use of high hydrogen and total gas pressures in the range of 10 to 20 atmospheres. Processing with pressurized hydrogen presents difficulties for large scale manufacturing from a logistics and safety prospective. For this reason the study of low pressure formation of gasars in the copper-hydrogen system is of interest. A designed experiment comparing the effects of solidification rate, soluble gas partial pressure and solidification pressure is under way. No studies of gasar formation have occurred in which the number of samples reflect the complexity of foam formation. This research should be useful for comparison with existing models based on the formation of gasars at positive pressures. It will also allow for the quantification of the significance of the various processing parameters on the formation of copper gasars.

Poster Presentations Day 2

Session 1: 10:00am - 12:00pm

1 High performance direct crude glycerol fuel cell with surface dealloyed PtCo nanoparticles supported on carbon nanotube as anode catalyst

Ji Qi[1]

[1] *Department of Chemical Engineering, Michigan Technological University*

Due to the fast growth of global energy needs and quickly diminishing of fossil fuel resources, people are forced to seek reliable, high performance, cost-effective and environmentally-beneficial renewable energy sources. Anion exchange membrane based direct alcohol fuel cells have recently attract enormous attention as a potential solution to alleviate the current energy issues. Exploring crude glycerol as fuel for direct alcohol fuel cells not only provides a promising solution to using

excessive biodiesel byproduct, but also opens a new avenue towards development of low-cost alcohol fuel cells. In the present study, surface dealloyed PtCo nanoparticles supported on carbon nanotube (SD-PtCo/CNT) were prepared by *ex situ* method and used for crude glycerol oxidation for the first time. SD-PtCo/CNT anode catalyst based AEMFC with a 0.5 mgPt cm^{-2} achieved peak power densities of 268.5 mW cm^{-2} (crude glycerol/O_2) and 284.6 mW cm^{-2} (high purity glycerol/O_2) at 80 oC and ambient pressure, which are close to the published result of direct high purity glycerol solid oxide fuel cell operated at high temperature of 800 °C (327 mW cm^{-2}), and are higher than all other published performances of direct high purity glycerol microbial fuel cell and anion exchange membrane fuel cell. This work successfully developed a high output power direct alcohol fuel cells with biorenewable, environmentally-friendly fuel and dealloy technique prepared catalyst, which will substantially impact future catalyst design and fuel cell development.

2 Electrophysiological Effect of Salicylic Acid on Erythrocytes in a 3D graphene electrode dielectrophoretic device

Hongyu Xie[1], Adrienne Minerick[1]

[1] *Department of Chemical Engineering, Michigan Technological University*

We present a laminated three-dimensional graphene electrode microdevice to characterize the effects of salicylic acid on red blood cells. Salicylic acid and its derivatives are a class of drugs that can penetrate the cell membrane and therefore change the dielectric properties of the red blood cells; this prototypical cellular system can provide insights into drug mediated plasma bilayer effects on dielectrophoretic measurements. Graphene is a monolayer of carbon atoms packed two-dimensionally, which gives it exceptionally high crystal and electronic quality [1]. Graphene paper is relatively inexpensive, relatively easy to handle, and amenable to layering with polydimethylsiloxane (PDMS) in order to achieve 3D electric field gradients for dielectrophoretic characterizations. Red blood cell movements before and after Salicylic Acid treatment are tracked in the dielectrophoretic field via light microscopy intensity changes. Cell behaviors are measured over a period of time at various frequencies and the dielectric properties of the cells are determined using an ellipsoidal multi-shell model. Numerical simulations demonstrate the 3D graphene electrode geometry permits optimal field gradients and higher sample through-put than traditional 2D devices. It was found that typical force exerted by the electric field on RBCs was $\sim$50 pN and the average time it takes for the cell to travel from the center of the well to the edge was 3.1 s for a 300μm well and 10.1 s for a 500 μm well.

3 Guanosine Prodrug Incorporated Polymeric Nanocarriers for Suicide Gene Therapy

Alicia J. Sawdon[1], Ching-An Peng[1]

[1] *Department of Chemical Engineering, Michigan Technological University*

The most prominent suicide gene therapy is the use of herpes simplex virus thymidine kinase (HSV*tk*) in conjunction with a variety of guanosine-based prodrugs (ganciclovir and acyclovir). Currently, introduction of the gene for a foreign enzyme and the prodrugs are administered in a two-step process. First, the foreign gene is delivered into the targeted cancer cells, expressed and released into the cytoplasm. Then the prodrug is administered and activated to its cytotoxic form by the gene-expressed exogenous enzyme. Many gene delivery systems have been proposed for suicide gene therapy most focusing on the use of viral vectors to deliver the prodrug activation gene. In this study, a one-step approach was harnessed to deliver gene and prodrug through polymeric nanocarriers.

Guanosine-based GCV and ACV were used as the initiators in ring-opening polymerization of ϵ-caprolactone to form hydrophobic GCV-PCL and ACV-PCL, which were then grafted to hydrophilic chitosan to form amphiphilic copolymers for the preparation of stable micellar nanoparticles. The synthesized amphiphilic copolymers were validated by ^{1}H NMR and FTIR. Self-assembly behavior of micellar nanoparticles was determined by TEM, particle size and charge and critical micelle concentration (CMC). Polymeric nanocarriers complexed with HSVtk plasmids were cultured with colorectal HT-29 cancer cells and toxicity measured. 1H NMR analysis shows successful synthesis of guanosine-based prodrugs to PCL. FTIR spectra reveal characteristic absorption peaks associated with chitosan and PCL are simultaneously present in amphiphilic copolymers - GCV-PCL-Chitosan and ACV-PCL-Chitosan. CMC of ACV-PCL-Chitosan copolymer was measured to be 0.0056 mg/ml, while size measured by dynamic light scattering was detected to be 150-220 nm, with a zeta potential of +20.14 mV. Toxicity results demonstrate that GCV-PCL-Chitosan/HSVtk and ACV-PCL-Chitosan/HSV$_{tk}$ nanocarriers are a feasible approach to kill HT-29 cells.

4 Induction of Microalgal Lipids for Biodiesel Production

Wilbel Brewer[1]

[1] *Department of Chemical Engineering, Michigan Technological University*

In recent years, use of microalgae as an alternative biodiesel feedstock has gained huge interest. One reason for this renewed interest derives from it promising growth in global transport fuel demand constrain by limited energy supplies along with increasingly efficient algae production without compromising global food supply. With new energy independence policy and legislation in place, biodiesel production from microalgae has shown increase trend to meet global demand due to its harvesting technique in a more renewable and stainable fashion.
In this study, green microalgae Chlorella protothecoides was cultivated to produce high-yield biomass with high lipid content which could be converted to biodiesel by transesterification. Different operating parameters (light intensity and CO2 concentration) were investigated to optimize the lipid induction process. At room temperature, Chlorella protothecoides was inoculated with 1x105 cells/ml in 250-ml Erlenmeyer flasks and exposed with various combinations of light intensities and CO2 concentrations. Our results showed that stressful culture conditions of 15% CO_2 concentration and high light intensity up to 210 μE/m^{2}s induced high microalgae lipid contents determined by Nile red dye.

5 Life Cycle Assessment Methods of Algae Biofuels Production Pathway

Rui Shi[1]

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The production of biofuels gained a lot of interests in recent years. This is because compared to petroleum fuels, biofuels are more economically-viable, renewable, and have less greenhouse gas emissions. Interest in algae is high because algae may address some of the concerns related to plant-based biofuels. Life-cycle analysis (LCA) has become an integral part of assessing the energy and environmental effects of algae products. In this study, a LCA have been performed for algae-based biofuel pathways. The greenhouse gas emission has been assess for all the algae life cycle. This study took GREET Model inputs of chemicals and energy of algae pathways for producing biofuels and use identical inputs in a SimaPro model to simulate the algae fuels life cycle. Greenhouse gas emissions and fossil energy demand of each stage during algae production are calculated within SimaPro 7.2 LCA software on the basis of per kg of final algae fuel, biodiesel

in this case. Results indicated the greenhouse gas emission of algae-base biofuels from cradle to grave.

6 Mathematical modeling of growth and inhibition of microbial biofilms

Xiaotong Han[1], Wen Zhou[1]

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Biofilms are microbial communities encased in a layer of extracellular polymeric substances (EPS), adhered to biotic or abiotic surfaces. Biofilms enhance the virulence of the pathogens and hold their potential roles in various infections. In this research, a two-dimensional mathematical model concerning hydrodynamic environment, nutrient, EPS, quorum sensing signal molecule, quorum sensing control ingredients will be developed in this reaction diffusion bacterial Pseudomonas aeruginosa (PA) system. The main goal is to improve existing models from literature simulating biofilm growth, and anti-quorum sensing treatment. The components will be expressed in partial differential equations and these PDEs will finally be solved in COMSOL Multiphysics 4.3. In this research, we will develop a rigorous dynamic computer simulation of the PA biofilm at the stage of maturation. This model better represents experimental data of biofilm height with the change of time by considering the diffusion coefficient for all components as a function of density. Moreover, three kinds of quorum sensing controllers depending on treatment type provided successful treatment. This approach provides a more accurate and user-friendly graphical interface system allowing researchers to quickly change any system variables. In addition, the resulting predictive capability can be used to test the system under a wide range of conditions which may not be readily accessible to experimentalists.

7 Estimation of CO_2 Emissions from Direct Land Use Change (dLUC) of Rapeseed Biofuel Crop Using RSB Methodology

Suchada Ukaew[1], David R. Shonnard[1]

[1] *Department of Chemical Engineering, Michigan Technological University*

Land use activities from the agricultural sector are one of the main sources of greenhouse gas (GHG) emissions. Transformation of land use from one type of land use to another can emit GHG emissions (CO_2, CH_4, and N_2O). Changes in carbon dynamics from cropland results from changes in tillage practice, crop type, and nutrient input to soils. In this work, total CO_2 emissions from direct land use change (dLUC) from wheat crop to rapeseed crop biofuels are estimated in different states (MT, ND, OR, WA, and OK) using the Roundtable on Sustainable Biofuels (RSB) methodology. The tillage management practice and nutrient inputs of wheat crop at the beginning of land use are assumed to be full tillage and medium inputs. At the last land use, the management practices of rapeseed are assumed to be full tillage, reduce tillage and zero tillage, combined with have low, medium, high without manure and high with manure inputs for each case. The results show that different tillage practices and amount of nutrient input in rapeseed cropland can have significant impacts on CO_2 emissions or removal. Full tillage with low input can release CO_2 emissions higher than other cases due to loss of carbon stocks in soil. On the other hand, reduce tillage and no tillage show a positive impact to the environment by removing CO_2 from the atmosphere and depositing carbon to the soil.

8 Use of a Carbon Budget Model to Calculate Land Use Change Greenhouse Gas Emissions Associated With Forest-based Biofuels Production in Michigan

Jiqing Fan[1,3], David R. Shonnard[1,3], Robert E. Froese[2], Robert Handler[3]

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[3] *Sustainable Futures Institute, Michigan Technological University*

Michigan is heavily forested with 19.4 million acres of timberland, and the large volume of timber resources are potential feedstocks for biofuel and bioenergy production. To truly understand the environmental impacts of biofuels production in Michigan, it is essential to evaluate the land use change (LUC) impacts associated with the biomass production practices in this area, namely sustainable harvesting from natural regeneration forest land, and short rotation forestry (SRF) plantation. These two practices are not likely to cause indirect land use change (iLUC) emissions because forest products are not used in the food market. However, the impacts of direct LUC (dLUC) should be examined. The Carbon Budget Model of Canadian Forest Sector (CBM-CFS3) is applied in this study to estimate the dLUC impact associated with the biomass production in Michigan. The CO_2 flux between the atmosphere and soils due to dLUC are quantified and incorporated into the LCA study of the biofuels. We consider two cases for this model; 1. Business as usual (BAU) 2. Increased harvesting above the BAU level to satisfy a certain level of biofuel production. The BAU harvesting scenario is first established based on the current harvesting acreage and intensity, a case in which MI forests continue to accrue carbon as forests recover from historic harvest practices. Because the carbon budget model simulates over a several decade time period, we will also include estimates of changes in fossil greenhouse gas emissions due to changes in extraction practices, for example by relying in inputs from high greenhouse gas intensity crude oils, such as tar sands, using literature values. Finally, we include these landscape level carbon dynamics into life cycle assessments of biofuels that can be produced from forest feedstocks, for example cellulosic ethanol, to understand the potential impacts on product-based LCA results.

9 Micron-scale Ion Concentration Gradients in Nonuniform AC Electric Fields

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Erythrocytes were observed to deform and shrink over time from high electric field density toward low field density in phosphate buffer saline in a two dimensional nonuniform AC dielectrophoretic microdevice. We hypothesized that this cell behavior was due to changing osmotic pressure between the cell and the local medium as an ion concentration gradient develops and propagates through the electric field area. Cells are known to respond rapidly to the surrounding media tonicity; isotonic media yields an erythrocyte's typical biconcave shape, while hypotonic media will cause erythrocytes to swell and hypertonic media causes cells to shrink. Experiments were conducted and cell size quantified in initially isotonic buffer composition under nonuniform AC DEP field strength and frequency. Results indicate that cell shrinkage can be observed beginning at 120 seconds after 12.5 to 20 Vpp and 0.25 to 1 MHz field application. Cells begin to shrink close to the higher field density region and over the next 240 seconds, shrinkage propagates toward the lower field density region. Cell area decreases with increasing applied signal frequency (up to 1MHz) and increases with increasing peak-to-peak potential. These results have important implications in dielectrophoretic manipulations. Research in this field has, until now, assumed polarization of dielectrics in dielectrophoretic fields occurs in relatively constant medium conditions with polarizations confined to the Debye layer, which comprises tens to hundreds of nanometers

from the particle or electrode surface. Our work elucidates the formation and transportation of ions tens to hundred of microns from the electrode surfaces in non-uniform AC electric fields. Further, corresponding experimental results suggest complex interaction between the dynamic ion distribution in the medium and the particle's induced dipole response.

10 Is reduction of disulfide bond key to protein aggregation?

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Hallmark of several neurodegenerative diseases is observation of aggregated proteins at the end stage of the disease but the link between protein aggregates and cellular toxicity is not clearly understood. How do cellular stresses play a role in protein misfolding and aggregation has been the focus of health science researchers for a long time. The cellular environment is highly reducing and combined with other destabilizing influences can break the disulfide bonds of proteins making them unstable and prone to misfolding and aggregation. In this study, we tested effect of a disulfide reducing agent dithiothreithol (DTT) on chicken egg white lysozyme and bovine serum albumin (BSA) at physiological pH and monitored their disulfide reduction, misfolding, and aggregation by electrophoretic and spectroscopic techniques. Disulfide bond reduced proteins formed visible aggregates starting at 2 hours that grew in size as a function of time. Extrinsic fluorophores such as 1,8-anilinonaphthalene sulfonic acid (ANS), Bis-ANS, and Thioflavin T (ThT) were used to monitor proteins hydrophobicity and aggregation of BSA and lysozyme that showed different response to the fluorescent probes. In addition, lysozyme and BSA showed different structural morphologies for the aggregated proteins under scanning electron microscope (SEM). These results suggests that proteins can proceed through different misfolding and aggregation pathways even when similar cellular stress is applied and the subtle changes in their biochemical and biophysical properties as indicated by fluorescence studies and SEM maybe key to their toxicity.

11 Reduction of disulfide bond: key to insulin aggregation at physiological pH

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Protein misfolding and aggregation have been linked to many human diseases; and with increasing applications of proteins in therapy it has caught the attention of pharmaceutical and biotechnology industry as well. Many cellular proteins go through a disulfide bond maturation process that is essential for correct protein folding and cellular functions. In addition, disulfide bonds have been shown to be critical for providing extreme stability to proteins. However, the cellular reducing environment combined with other stresses can reduce the disulfide bonds and destabilize the proteins affecting their overall stability. In this study we explored the aggregation propensity of insulin, an important metabolic enzyme, at physiological pH and cellular reducing environment. Even though, insulin is a well-studied small protein its aggregation at physiological pH still remains an open question. We measured the aggregation kinetics of reduced-insulin (in presence of dithiothreitol (DTT)) and compared it to the oxidized protein at pH 7.2. All studies were carried out at 37°C and protein misfolding and aggregation was monitored by UV-visible spectroscopy and fluorescence spectroscopy. Proteins unfolding and aggregation was monitored by intrinsic fluorescence and also by extrinsic fluorophores such as 1-anilinonapthalene-8-sulfonic acid (ANS) and Bis-ANS that binds to proteins hydrophobic pockets. These insulin aggregates were further characterized by thioflavin T fluorescence and scanning electron microscopy. Disulfide reduced

insulin was found to aggregate rapidly compared to the oxidized insulin and formed amorphous aggregates.

12 Comparing the Effect of Chemically Modified Rice Husk Reinforcement on Properties of UF Composites

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Rice husk (RH) is an abundant and inexpensive agricultural residue in most parts of the world where wood resources are limited. The purpose of this study was to investigate the moisture resistance and mechanical properties of the inexpensive, but brittle, urea-formaldehyde (UF) thermoset resin reinforced with unmodified and chemically modified RH. Chemical modifications were designed to modify the interface properties and to determine how thick an interface is required to modify the interface to enhance moisture resistance and toughness. In order to answer these questions we used a type of "controlled radical polymerization" (Atom transfer radical polymerization, ATRP) that allowed us to test the effect of using a hydrophobic interface for moisture resistance "topped" by a polar monomer to adhere to the UF resin. The RH was modified by polymerizing specific numbers of Methyl Methacrylate monomers (giving PMMA), and Acrylonitrile monomers (giving PAN), for the following grafted RH modifications: RH-g-PMMA (for moisture only) and RH-g-PMMA-g-PAN (for moisture and toughness). The interface modifications were analyzed by Fourier transform infrared spectroscopy (FTIR), X-ray photon spectroscopy (XPS), and Scanning electron microscopy (SEM). UF-grafted RH composites were prepared with (giving %) UF and (giving %) RH, and mechanical and moisture properties were measured.

13 Mapping the proteins aberrantly exposed hydrophobic surface using a novel fluorescent probe

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There are several proteins that misfold and aggregate and can lead to cellular toxicity by their ability to interact through aberrantly exposed hydrophobic surface. Even though, the need for identifying the hydrophobic surface of such proteins is well recognized in the medical and scientific community, not much progress has been made till date due to lack of suitable fluorescent probes that can effectively label the partially exposed sticky protein surface. To address this issue we have designed and synthesized a functionalized hydrophobic probe by modifying 1, 8-anilinonaphthalene sulfonic acid (ANS) that has the ability to cross-link with proteins through NHS ester near proteins hydrophobic surface. To evaluate the functionality of this modified novel fluorescent probe for its ability to label proteins hydrophobic surface we tested several well studied proteins (Human Insulin, Chicken egg white Lysozyme and Bovine Serum Albumin (BSA)). Dye modified proteins were separated on sodium dodecyl sulfate polyacrylamide gel by electrophoresis (SDS PAGE) and identified by UV imaging and also by change in molecular weight as detected by mass spectrometry. UV images of the proteins on SDS-PAGE show significant signal for labeled proteins with very little signal for control (unlabeled) proteins. Mass spectra results show varying degrees of labeling for proteins with Insulin and BSA showing 1 – 2 dye units added per protein molecule and Lysozyme showing 1 - 4 possible dye units added. Further work is in progress to identify the modified amino acid residues on these proteins using proteomic approach. Identifying

the surface exposed amino acid residues will provide novel targets for developing new drugs by rational drug design using combinatorial chemistry.

14 More Convenient and Less Expensive Non-Chromatographic Method of DNA Drug Purification

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Synthetic oligodeoxynucleotide (ODN) is expected to find wide applications as therapeutics to cure human diseases. This requires large quantities of pure ODN. The automated solid phase synthesizer can synthesize large quantities of ODN. However, the ODN from the synthesizer generates impurities. Most of the impurities comprise failure sequences and they are difficult to remove. Current methods for ODN purification have limitations. They are expensive and are not practical for large scale purification. Recently, we developed a new technique of non-chromatographic ODN purification, which could solve this problem. In this method, failure sequences during automated synthesis were capped with a polymerizable phosphoramidites. After synthesis, they were simply removed by polymerization. The method does not need chromatography and expensive reagents and purification is achieved by simple operations such as stirring and extraction. Therefore, it is suitable for large scale purification.

15 Quantitative Analysis of Bromodomain-Histone Binding Interactions by Isothermal Titration Calorimetry

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Histone proteins are important sites for epigenetic modifications because they are in direct contact with >90% of DNA at any given time. These epigenetic modifications can significantly alter protein-DNA interactions. Four histone proteins, H2A, H2B, H3, and H4, form the histone core, a key component for the compaction of DNA into chromatin. Acetylation of lysine residues on the N-terminals of histone proteins causes a decrease in the electrostatic interactions between DNA and the histone core, thus allowing DNA to become accessible for transcription, replication, and DNA repair. A class of protein domains known as bromodomains 'read' the acetylation patterns on histone proteins and are primarily found in proteins associated with transcriptional initiation. Consequently, these domains, and the presence of the acetylated histones that act as binding targets, are strongly linked to the initiation of DNA transcription. Here, we explore the binding interactions between acetylated histone proteins and bromodomain-containing proteins. To conduct this study, the first 25 amino acids of acetylated histone protein H3, which composes the bromodomain binding interface, was synthesized using an AAPTEC Endeavor, this allowed for precise placement of the acetylation sites. Recombinant bromodomain proteins were produced using a Rosetta *E.Coli* expression system. Both protein products were confirmed via MALDI-TOF mass spectrometric analysis. The binding interactions between the bromodomains and acetylated histone protein H3 were quantified using isothermal titration calorimetry to determine specific binding affinity and the number of binding sites. Understanding the binding features of this process could be potentially useful for those designing bromodomain inhibitors as a way to inhibit aberrant or deregulated transcription (e.g. in instances such as cancer).

16 Diblock Copolymers for Drug Delivery

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Thermoresponsive polymers undergo coil-to-globule transitions at lower critical solution temperatures (LCSTs), which are tuned by changing the ratio of hydrophilic to hydrophobic monomers or end groups. We studied the effects of amphiphilic end group placement on the LCST of diblock copolymers (i.e. End1-BlockA-BlockB-End2, End1-BlockB-BlockA-End2) prepared by living radical polymerization to allow block length and end group placement to be controlled. End group and structure effects were also studied on a symmetrical tri-block copolymer (i.e. End2-A-B-A-End2) and a three-arm star diblock copolymer (End2-A-B)3-Core. Two diblock copolymers, each with an LCST between 50-60°C were selected for additional study of their controlled release capabilities with a hydrophobic model drug, ibuprofen.

17 Targeted Delivery of Doxorubicin to Renal Carcinoma Cells via Peptide-Based Bionanoconjugates

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In this study, short peptide sequences are used in conjunction with gold nanoparticles to improve both the specific delivery and controlled release of small molecules into clear cell renal cell carcinoma (ccRCC) cells. The bionanoconjugates described here are defined by the synergy between metal nanoparticles, targeting biomolecules, and self-assembling biomaterials. We wanted to examine the ability of short peptide sequences to deliver small molecules to specific tissues, while at the same time overcoming the limitations often discussed in the literature. This was accomplished by building both structural and functional features into the peptide sequence, including; [1] selective targeting, [2] cellular uptake and [3] controlled drug release. Targeting peptides derived from phage display specific to the Caki-2 ccRCC cell line, self-assembling peptides, and bovine serum albumin fragments were conjugated to gold nanoparticles to form the complete bionanoconjugate . The chemotherapy agent doxorubicin was incubated with the bionanoconjugate to allow for embedding into the self-assembled peptide layer. Cytotoxicity assays were performed on both Caki-2 and Primary Renal Mixed Epithelial Cells with drug-loaded and non-loaded bionanoconjugates to determine if a) the delivery vehicle itself is cytotoxic and b) if increased cell death is seen in cancerous cells compared to normal cells. Examination of these features will permit us to enhance our understanding of peptide-based bionanoconjugates and facilitate the convergence of these technologies on directed therapeutics.

18 Theoretical Investigation of Lithium Monoxide Anion Acidity

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The most popular computational methods have been utilized to determine the dependency of the acidity trend of the first-row hydrides and their lithiated analogs on the choice of basis set. Tian and coworkers were able to produce the gas phase lithium monoxide anion (LiO-) which was found to be a weaker acid than methyl anion (CH3-), known as the strongest base for about three decades before this discovery [PNAS, 105, 7647, (2008)]. Furthermore, the authors confirmed their experimental results by employing the CAS-AQCC within the aug-cc-pVQZ basis set. However,

this method is highly demanding in terms of the computational effort as well as a level of expertise needed. We have shown that the proper acidity trend, i.e., ΔHacid°(CH_4) < ΔHacid°(LiOH), can be obtained with less expensive "black box" type methods if only the basis set is properly chosen. Our results prove that the augmented basis sets are necessary for appropriate predictions of acidities. For all of our calculations the correct order of ΔHacid° was achieved by augmenting cc-pVXZ (X=D,T) basis sets, except for results produced by the B3LYP functional. Proper predictions for this Density Functional Theory (DFT) functional can be only obtained when more diffuse basis functions are added. Moreover, a similar effect is observed for the family of Pople's basis sets. In addition to DFT methods we have also employed coupled cluster approach, CCSD(T), as an example of a highly accurate "black box" method, that can be applied for this problem by non-experts and which leads to equally accurate results within aug-cc-pVDZ basis set. Our estimation for the acidity with CCSD(T)/aug-cc-pVDZ is ΔHacid°(LiOH) = 425.4 kcal/mol, which agrees very well with the experimental value 425.7±6.1 kcal/mol. An important finding is that the proper acidity trend may be reversed if the basis sets are not correctly selected.

19 Multivariate analysis of biogenic secondary organic aerosols analyzed by ultrahigh resolution mass spectrometry

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Aerosols play an important role in climate change by scattering and absorbing solar and terrestrial radiation. Secondary organic aerosols (SOA) which comprise up to 80% of the aerosol organic mass are formed by condensation of low volatility and semi-volatile oxidation products of volatile organic compounds (VOCs). Biogenic SOA is found more prominently than anthropogenic SOA globally. In this study, biogenic SOA were generated in a reaction chamber from the ozonolysis of α-pinene, β-pinene, d-limonene and β-caryophyllene. Individual VOCs were oxidized with a variety of relative humidity values (0-30 %) and with and without an OH radical scavenger. Aerosols generated in the chamber were collected on filters, which were then extracted using high purity water and acetonitrile for analysis using ultrahigh resolution Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS). ∼1000 molecular formulas were identified from each of the 21 SOA experiments, indicating the complex character of SOA composition. Overall ∼2600 unique formulas were identified from all the experiments, ∼30% of which appeared in at least 15 SOA samples. Cluster analysis and principle component analysis (PCA) were applied to the molecular formulas with relative abundances from the MS analysis. Cluster analysis showed a high degree of similarity for the SOA composition from the same precursor. α-pinene and β-pinene SOA composition are similar and grouped together in the dendrogram, which is similar to d-limonene SOA. The group of the SOA composition from the three precursors is separated from caryophyllene SOA. From PCA, principle component 1 (PC1) and principle component 2 (PC2) represented 52% and 24% of the original variance, respectively. The score plot, confirmed the classification of the SOA that is shown in cluster analysis by PC1 and PC2. These results provide the comparison of different biogenic SOA based on the molecular level composition analysis.

20 Formation of Polymeric Nanoparticle Scaffolds Directed by Peptide Assembly and Its Applications for Tissue Engineering

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A novel peptide-functionalized amphiphilic block copolymer was designed and synthesized, that can self-assemble into polymeric nanoparticles, and assemble again into continuous fibers and 3-D assemblies (scaffolds). Such self-assembled nanoparticle scaffolds are able to load different drugs to promote cell activities such as migration, proliferation and differentiation for tissue engineering. Two peptide sequences (peptide-1 and peptide-2) with opposite charges were synthesized that can assemble into β-sheets in aqueous solution with a pH value between 4.4 $\sim$ 10. Amphiphilic triblock copolymers (PVP-co-PMMA-co-PVP and PHEMA-co-PMMA-co-PHEMA) with carboxylic acid terminals (HOOC-A-B-A-COOH) were synthesized by RAFT polymerization using S,S'-bis(α,α'-dimethylacetic acid) trithiocarbonate (BDAT) as the chain-transfer agent. The amphiphilic copolymer was then reacted with the peptides via the carboxylic acid terminal and amine group to form peptide-copolymer conjugates. The two peptide-functionalized nanoparticles were self-assembled in sterile deionized water with pH 9.0 and 5.4 respectively, and then coupled together to assemble into polymeric nanoparticles fibers and 3D scaffolds [Figure 1]. Optical microscopy photographs and FESEM micrographs confirmed the formation of the nanoparticle assembly into fibers and scaffolds with and without drug models (here insulin and 4',5'-Dibromofluorescein were used). The insulin and fluorescein were sustainably released from the assembled nanoparticles over three weeks. Cytotoxicity tests using SW-620 cell lines were performed by MTS and showed that the synthesized peptides, copolymers and peptide-functionalized copolymers were biocompatible with the SW-620 cell. The self-assembled nanoparticle fibers and 3D scaffolds combine the advantages of flexible hydrogel scaffolds and versatile controlled release systems.

21 Seismic Risk Assessment of Base Isolated Buildings Considering Mainshock-Aftershock Effect

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The insufficient consideration of seismic risk, particularly that from mainshock-aftershock sequences, caused hidden danger for structural safety in many areas. A promising retrofit method for these structures is base isolation. In order to evaluate the effectiveness of this approach, a reinforced concrete (RC) frame based on a real building is designed to be retrofitted using base isolation. Then, seismic fragilities for both un-retrofitted and isolated buildings are analyzed, utilizing the results obtained from nonlinear finite-element analysis. A total of 22 earthquake motions with mainshock-aftershock sequences are utilized in the analyses. Te results of considering mainshock-aftershock and those of considering only mainshock are compared. The study shows that the well designed base isolation can reduce the seismic vulnerability of the RC frame effectively. It will underestimate the seismic risk for structures without considering the aftershock hazard.

22 Physical Evaluation of the Rheology of Foam-based Warm Mix Asphalt Contained Nano Hydrated Lime

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Although the Warm Mix Asphalt (WMA) is gaining popularity very rapidly and becoming a mainstream technique for producing asphalt mixtures, there are many concerns regarding its long term performance. Over the years, the Regular Hydrated Lime (RHL) has gained considerable recognition as a common additive to the bituminous pavements. However, the usage of Nano Hydrated Lime (NHL) (particles sizes $\ll$ 100 nanometer (nm)) has not been studied by pavement scientists before. The physical properties of foam-based WMA were studied since the pavement performance is primarily controlled by the rheological properties of asphalt cement. NHL materials with particle sizes of 50 nm and 100 nm were used in this study along with the RHL to investigate the effectiveness of the new generation fabricated NHL modification on the rheological properties of the foamed-based WMA. The NHL was added to the asphalt binder at ratios of 5%, 10%, and 20% (by weight). The foam-based WMA was produced by adding Advera® at ratios of 3%, 4.5%, and 6% (by weight). The binder physical properties were evaluated by the Dynamic Shear Rheometer (DSR) test. The overall results reveal that the binder physical properties can be enhanced successfully by adding small amounts of the NHL. The results also showed that as the particle size decreases, the binder stiffness (G*) increases. The addition of the NHL significantly increased the G* compared to the RHL. The application of the RHL with the normal dose (20% by weight of binder) can be replaced by adding 5% (by weight) of NHL (50 nm) with respect to G* results. The outputs of this study can be interesting from a practical point of view since it was proved that the NHL has interesting functionality on the rheology performance of the binders.

23 The Impacts of Freeze-Thaw on Cliff Recession at the Calvert Cliffs in Maryland

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Hydro-climatic impacts in water resources systems are typically assessed by forcing a hydrologic model with outputs from general circulation models (GCMs) or regional climate models (RCMs). Challenges of this approach include maintaining a consistent energy budget between climate and hydrologic models and also properly calibrating and verifying the hydrologic models. Subjective choices of loss, flow routing, snowmelt and evapotranspiration (ET) computation methods also remarkably increase watershed modeling uncertainty and thus impact assessment. An alternative approach, particularly appealing for ungauged basins or locations where record lengths are short, is to directly predict selected streamflow quantiles from regional regression models that include physical basin characteristics as well as meteorological variables output by climate models (Fennessey 2011). In this study, regional regression models are developed for the western Great Lakes states using ordinary least squares (OLS) and weighted least squares (WLS) techniques and applied to selected Great Lakes watersheds. Model inputs include readily available downscaled GCM outputs from the Coupled Model Inter-comparison Project (CMIP3). The model results, presented in a probabilistic context of multi-model predictions, show that temperature proxy potential evapotranspiration (PET), approaches in hydrologic models may underestimate runoff in a warming climate. Comparison of regression models against physically based hydrologic models driven using the same GCM outputs reveals that regression models can serve as an alternative approach and may provide insights into weaknesses of physically based models.

24 Hydrogen Production under Visible Light Photocatalytic Water-Splitting Using Nanostructured N-doped $CdIn_2O_4$ Solid Solution Photocatalyst

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Photocatalytic hydrogen production from water splitting utilizing solar energy has attracted attention due to global energy and environmental issues. The process of hydrogen production under visible light utilizes water and chemically stores solar energy by splitting the water into hydrogen (H_2) and oxygen (O_2). The utilization of hydrogen as a feul produces the stoicometric amount of water used to produce the hydrogen which can be reused without the need for makeup water providing the possibility of a closed loop operation. Photocatalysts have been developed by numerous researchers achieving high quantum efficiencies. However, most of the photocatalysts consist of metal oxides and work only in the ultraviolet region due to large band-gap. The absorption edge of oxides, band-gap, photocatalysts are extended to visible light spectrum by doping them with transitional metal cations and nonmetal anions. A comprehensive study aimed at engineering an efficient photocatalyst, process must consider the following challenges: 1) Photocatalysts must be able to effectively absorb and utilize visible photon energy to have the electron necessary to make the band gap transition with enough energy to reduce water to produce hydrogen; 2) Photocatalysts need to achieve efficient charge separation and migration to the catalyst surface; 3) The photocatalyst surface must provide efficient redox reaction sites for the conversion of water to hydrogen; 4) Photocatalysts need to be stable and resist photo-corrosion.
The objective of the proposed research is to synthesize nitrogen (N)-doped $CdIn_2O_4$ photocatalysts and study their photocatalytic water splitting properties.. The objective is reached using the Sol-gel method which produce controlled structural features and morphology; low particle size; high crystallinity and uniformity of atomic composition. The activity of the photocatalyst is being studied in a batch reactor. The photocatalyst is suspended in 50mL of deionised water with sacrificial reagents and irradiated with 400W Metal Halide lamp to simulated solar irradiance. The evolved gas is collected and was analyzed on Gas Chromatography (GC) using 5 Å molecular sieve column and a thermal conductivity detector (TCD). The photocatalyst are characterized by physicochemical and spectroscopy methods to study the structural, electronic and optical properties.
N-doped CdIn2O4 sample consists of well-crystallized particles and have cubic lattices. Doping of nitrogen shows a red shift in visible light absorption and band-gap narrowing. High crystallinity enhances the photocatalytic activity of hydrogen evolution. The results show that N-doped $CdIn_2O_4$ is capable of splitting water into hydrogen and oxygen under visible light.

25 Refinement of a Microfluidic Groundwater Model for Studying Tetrachloroethene Dissolution and Fate

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Chlorinated ethenes, like tetrachloroethene (PCE), are known/suspected carcinogens and common groundwater contaminants. They also form non-aqueous phase liquids (NAPLs) that slowly dissolve into groundwater and serve as long-term pollution sources. Certain anaerobic bacteria, called dehalorespirers, can respire, and potentially detoxify, chlorinated ethenes. These bacteria can also enhance dissolution and reduce longevity of NAPL sources. However, due to the complexity of subsurface environments and microbial communities, the factors that influence the microbial ecology at the NAPL-water interface are not completely understood. The overall goal

of this project is to use an integrated experimental and mathematical modeling approach to evaluate the effects of dehalorespiring bacteria on the longevity of NAPL pollutant source zones and contaminant detoxification in groundwater. The current study focuses on two sets of preliminary experiments that provided key information needed to conduct these physical and mathematical evaluations. A two-dimensional pore space network pattern was etched onto a silicon wafer to create a microscale model of a groundwater aquifer system with NAPL and dissolved-phase PCE. This micromodel can be used to validate computer model predictions by inoculating it with dehalorespiring bacteria and measuring effluent concentrations of chlorinated ethenes. One set of experiments was conducted to quantify PCE loss due to sorption to the micromodel because PCE is known to readily adsorb to many materials, but little is known about PCE sorption to silicon. Thus, batch and continuous-flow experiments were conducted using silicon wafers and micromodels, respectively, to quantify PCE sorption to silicon. Initial experiments showed that a pure PCE NAPL is difficult to control, which makes accurately modeling dissolution challenging. It was hypothesized that PCE would be less mobile if mixed with a less-soluble NAPL like hexadecane. Thus, a second set of experiments was conducted to determine the optimal PCE-hexadecane mixture and the effects of the hexadecane on PCE dissolution.

26 Dehalogenation of PCE Contaminants by *Dehalobacter restrictus*, *Desulfuromonas michiganensis* and/or *Dehalococcoides ethenogenes* in a Model Aquifer

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Chlorinated solvents such as tetrachloroethylene (PCE) and trichloroethylene (TCE) have been identified in 45% of the contaminated sites from the Federal Remediation Technologies Roundtable. PCE and TCE pose serious health risks including liver and kidney damage from long-term exposure. Classified as dense non-aqueous phase liquids (DNAPLs), chlorinated solvents sink to the bottom of contaminated aquifers and/or form pools on low-permeability confining layers. Microbial dehalogenation involves the successive removal of chlorine atoms on a compound, and is one bioremediation technique used to treat contaminated aquifers. Dehalogenating microbes such as *Dehalobacter restrictus*, *Desulfuromonas michiganensis* and *Dehalococcoides ethenogenes* often utilize similar terminal electron acceptors (e.g., PCE or TCE), electron donors (e.g., H_2), or carbon sources (e.g., acetate) in the subsurface environment. Associated synergistic, antagonistic and competitive microbial interactions can be simulated in a saturated soil matrix using an intermediate-scale flow cell (ISFC).The ISFC will be used to examine PCE transport and dissolution processes in a model aquifer. These results will be compared to the relative abundance and dehalogenation rates of *D. restrictus*, *D. michiganensis* and/or *D. ethenogenes* in the ISFC.

27 ATP-EMTP Modeling of a Resistive Superconductive Fault Current Limiter

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With the growth in energy demand, the existing power grid is constantly experiencing expansion. Interconnections between power systems and addition of new generating units both renewable and conventional ones lead to higher fault current levels. One of the newest approaches to reduce fault current levels utilizes installation of superconductive fault current limiters (SFCLs) in the

system. With this device, a fault current is limited by transition of a superconductive element into high-impedance state when the fault occurs. During normal operation, the superconductive element generates very low impedance and consequently low losses.
Before manufacturing and installation of a SFCL in a power system, behavior of this device is predicted through simulation studies. This research presents modeling of a resistive SFCL in the Alternative Transient Program (ATP) where simulations are performed in time domain.
Each phase of the SFCL contains four superconducting elements to allow reclosing. The behavior of each element is coded in the MODELS language and is a function of the circuit current. The SFCL model was applied to a 3-phase radial distribution system of 15 kV in order to verify the behavior and study transients associated with the switching between various elements.
Four types of faults were studied: single-phase-to-ground, line-to-line, double-line-to-ground, and three-phase-to-ground. The fault currents in the utilized distribution system were reduced by about 50% comparing to the prospective faults. Also, this research presents results on comparison of the design parameter of the superconductive elements - transition index, which is responsible for the speed of operation of the device.

28 Inside the Burkean Parlor: Forays into STEM Students' Rhetorical Analyses of a YouTube Documentary

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Over the last three decades, scholarship in rhetoric, composition and technical communication has theorized the enculturation process of college students in sui generis discourse communities. As part of this concern, this study makes forays into the argumentative skills of 20 American students of STEM majors in deconstructing the rhetorical tools employed in a YouTube documentary, using theories of enculturation and Aristotelian rhetoric. The case study seeks to unravel the rhetorical strategies these students found to have been employed in the video, and how they articulated the persuasiveness of the video on the audience. Key findings show that although students have an active knowledge of the rhetorical strategies employed in the documentary, their capacity to articulate them is still progressive. The study holds implications for composition research in writing across the curriculum, and pedagogy.

29 Theoretical Prediction and Experimental Confirmation of Efficient Food Dyes for Dye-sensitized Solar Cells

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In this poster, energy criteria were proposed for an efficient dye used in Dye-sensitized Solar Cells (DSSCs). Furthermore, ab inito density functional theory (DFT) calculations were employed to predict the energies of the highest occupied molecular orbital (HOMO) and the lowest unoccupied molecular orbital (LUMO) of three inexpensive food dyes, Erythrosine B, Amaranth, and Sunset-Yellow-FCF. The combination of the criteria and the DFT calculations predicted that, for ZnO-based DSSCs with I^-/I_3^- as electrolyte, Erythrosine B would be an efficient dye, whereas Amaranth is inefficient and Sunset-Yellow-FCF is unworkable. Furthermore, this prediction was experimentally confirmed, namely, Erythrosine B sensitized ZnO-DSSC showed 1.8% power conversion efficiency under AM 1.5 solar illumination. In contrast, power conversion efficiencies are 0.4 and 0.0% for the DSSCs with Amaranth and Sunset-Yellow-FCF dyes, respectively.

30 Proof of Concept for a Simple Smartphone Sky Monitor

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We present a novel approach of obtaining a cloud and bright sky monitor by using a standard smartphone with a downloadable app. The addition of an inexpensive fisheye lens can extend the angular range to the entire sky visible above the device. A preliminary proof of concept image shows an optical limit of about visual magnitude 5 for a 70-second exposure. Support science objectives include cloud monitoring in a manner similar to the more expensive cloud monitors in use at most major astronomical observatories, making expensive observing time at these observatories more efficient. Primary science objectives include bright meteor tracking, bright comet tracking, and monitoring the variability of bright stars. Citizen science objectives include crowd sourcing of many networked sky monitoring smartphones typically in broader support of many of the primary science goals. The deployment of a citizen smartphone array in an active science mode could leverage the sky monitoring data infrastructure to track other non-visual science opportunities, including monitoring the Earth's magnetic field for the effects of solar flares and exhaustive surface coverage for strong seismic events.

31 Young Adults Outmigration in the United States

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Nonmetropolitan America is experiencing an aging trend due to the outmigration of young adults. Such outmigration has negative community development consequences. For example, young adult outmigration is an important economic development concern. Well-educated young adults are usually viewed as important components of higher levels of human capital, which are associated with higher levels of income, increased productivity, and economic growth. The loss of human capital results in the local economic slowdown. Therefore, the focus of my proposed work is to analyze the outmigration of U.S. young adults aged 20 to 29 years. My research question is what characteristics of places attract/repel young adults. These characteristics may include environmental, social, economic, educational and public services factors. This study will examine the extent to which each of these factors affect young adult net migration rates between 2000 and 2010. For example, this paper will analyze the degree to which environmental factors affect young adult migration patterns. Since young adults' outmigration may affect community development in terms of economic development and aging, the implication of this research is highly related to community development. This research can inform planners and community developers of means through which they may be able to reshape local rural communities to slow out-migration of young adults and/or attract incoming young adults.