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Session 1: Oral Presentations

Effect of Melt-Spinning Parameters on the Formation of MnAl₆ Quasicrystals

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Melt-spinning has been shown to be an effective process to produce a class of ordered, but non-periodic crystals called quasicrystals. However, many of the factors related to the creation of the quasicrystals through melt-spinning are not optimized for specific chemistries and alloy systems. In this research, melt-spinning was utilized in the creation of metastable quasicrystalline MnAl₆ through rapid solidification of an Al-15 wt% Mn alloy. Other resulting phases of the solidification include an Al-Mn solid solution and stable (orthorhombic) MnAl₆. Wheel speed of the melt-spinning wheel and orifice diameter of the tube reservoir were varied to determine their effect on the resulting volume proportions of the phases and the amount of Mn in the Al-Mn solid solution. X-ray diffraction was conducted on the resulting product and characteristic peak intensities of the phases were used to determine the relative volume proportions. The peak positions of the Al-Mn solid solution from the x-ray diffraction were used to determine the lattice parameter of the solution and then a Vegard's law calculation applied to relate the lattice parameter to the amount of Mn in solution.

Molecular Modeling of Epoxy Polymers

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Epoxy-matrix composites are one of the primary structural materials used in modern civilian and military aircrafts. Their popularity is due to their excellent specific stiffness, specific strength, and processing properties. Like all polymers, epoxies are known to exhibit changes in the molecular structure due to aging, which can have a profound effect on the long-term durability of composite structural components. While a moderate understanding exists of the physical mechanisms of the polymer aging process, a thorough study of how these mechanisms affect the mechanical behavior on the atomic scale has not been conducted. The overall objective of this research is to predict the effects of physical aging on the mechanical properties of cross-linked epoxy polymers using multiscale computational modeling. EPON-862 (Diglycidyl ether of

Bisphenol F) and the hardener compound DETDA (Di-Ethylene Toluene Diamine) were modeled in a 2:1 stoichiometric ratio using Molecular Dynamics (MD) simulations. A static, multistep cross-linking approach has been developed to establish well-equilibrated molecular structures containing 25,272 atoms at four different crosslink densities: 54%, 63%, 76% and 88%. The resulting models were simulated over a wide range of temperatures to predict the glass transition temperature, thermal expansion coefficients and elastic constants as a function of crosslink density. The predicted properties match closely with those reported in the literature for the same epoxy system, and the simulations predict an increase in the glass transition temperature and elastic moduli as the crosslink density increases. Accordingly, the thermal expansion coefficients are found to decrease with increase in crosslink density. These results are the first step in establishing a molecular modeling approach that will predict the influence of molecular structure on mechanical performance of the EPON-862 system. Ultimately, the influence of aging will be incorporated into the model once the influence of the crosslink density is fully understood on the molecular level.

Improvement of Decision Making in Complex and Dynamic Environments

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Many of the most critical decisions are made within complex and dynamic environments - when information is difficult to interpret and constantly changing. Understanding how successful decision makers generate, assess, and select courses of action is the first step to improving upon the tools and training used to facilitate successful performance. Recently, two cognitive mechanisms have been proposed to explain successful decision making in dynamic domains. The Take-The-First heuristic suggests that successful decision makers use experience-based associative networks to generate very few options and, typically, the first option generated is best. Generating more options is assumed to decrease decision quality and reduce the likelihood that the best option is selected at all, let alone first. In contrast, Long Term Working Memory theory suggests that successful decision makers use a more complex situational-model-building process that allows experts to encode, index, and store relevant information in an accessible manner. Therefore, the generation of more relevant options—when they exist in the world—is indicative of a more developed situational model and lead to decisions of higher quality. Empirical support has been demonstrated for both models for different types of behaviors (e.g., predictions and decisions) under different situational conditions. Consequently, our goal is to establish some boundary conditions which dictate their use. Using an option-generation paradigm in soccer, the current research investigates the utility of each model when examining

effect of skill level and time constraint on prediction and decision-making. Preliminary data suggest decision-strategy selection may be influenced by these factors.

Biofilm Response to Nutrient Mitigation Using Salmon Carcass Analog in Central Idaho Streams

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In the Pacific Northwest, salmon returns have declined 10 to 20-fold due to over-harvesting, habitat degradation, hatchery supplementation and hydroelectric dams. As a result of population declines, nutrients delivered to streams by spawning salmon have reached 5-7% of historic levels. Artificial nutrient enrichment is an increasingly popular mitigation technique to support salmon recovery efforts, and it is assumed that added nutrients increase biofilm standing crop and production, which are then passed up the food web to grazers and eventually to juvenile salmon. Yet, studies demonstrating biofilm responses to nutrient mitigation are limited. We conducted an experimental study of biofilm standing crop, respiration, net ecosystem production (NEP), and nutrient limitation responses to salmon carcass analog (SCA; made from dried and pasteurized marine fishmeal) in six tributaries of the upper Salmon River, Idaho. Our experimental design includes upstream control and downstream treatment reaches (3 km) in four streams, with two treatment levels: 30 g (low) and 150 g (high) analog/m². Biofilm standing crop on rocks did not significantly respond to SCA addition. Respiration measured using light-dark recirculating chambers was three-fold higher in treatment vs. control segments under high SCA levels ($p=0.017$) but did not differ under low or no SCA levels. NEP did not respond significantly to SCA additions. Nutrient enrichment bioassays suggested that biofilms were co-limited by nitrogen and phosphorous ($p < 0.001$) but the level of limitation differed among SCA and control segments ($p < 0.001$). Our study suggests that biofilm standing crop did not increase due to nutrient mitigation treatments; however, increased respiration and changes in nutrient limitation indicate that biofilm activity may change in response to mitigation treatments. This discrepancy between biofilm activity and standing crop may occur if grazers quickly remove additional biofilm standing crop, providing a potential link from nutrients to juvenile salmon.

Fish Contaminants through the Tribal Perspective: An Ethnography of the Tribal Fish Harvest

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‘Fish’ and ‘contaminants’ appear differently based on the perceptions and priorities of those who encounter them. This ethnographic study of a tribal nation in Michigan’s Upper Peninsula, the Keweenaw Bay Indian Community (KBIC), reveals significant differences in perspectives on (contaminated) fish. Several tribal communities across the nation engage in traditional fishing practices and embrace environmental values reflecting their cultures. Fishing communities are vulnerable to adverse health and cultural effects presented by current policy, fish consumption advisories (FCAs), and chemical contaminants and mercury. This study examines fish contaminant knowledge and factors that contribute to harvesting decisions and behaviors among KBIC fishermen and women. The tribal perspective on contaminants exhibits minimal knowledge of toxicity and minimal impacts on fishing. Within the KBIC, harvesting is based on their own criteria within a larger context of knowledge and understanding: the historical and political timeline of the region as well as cultural beliefs, values, and lifeways. Perspectives have been influenced by the unique timeline: the Michigan Supreme Court decision which reaffirmed all 1854 reserved treaty rights, the *People v. Jondreau* (1971), is pivotal in FCA beliefs. Advisories came onto the scene directly after the landmark decision and were believed by tribal members to be a continuation of the State’s attack on tribal fishing. KBIC fishing culture reveals that community ‘relationship with environment’ is the fundamental and guiding framework associated with *all* harvesting lifeways. The harvest is valued as a food source, conducted as a component of spirituality, and ‘regulated’ in part by the traditional belief system. Adhering to State FCA advice is perceived as a cultural risk to harvesting continuity and to core lifeways. These findings support the importance of including the tribal perspective within environmental policy formation and have implications for advisories which are currently limited in culturally relevant information.

Sonic Log Prediction in Carbonates

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Well logging is the practice of measuring properties of rock surrounding a wellbore. Sonic logs primarily serve the purpose of porosity estimation on the basis of time required by seismic waves to travel through the rock unit being logged. Density and neutron porosity tools also estimate the

porosity of the formation but use the electron density and the hydrogen density of the formation respectively. Because of some distinct advantages, density-neutron combination has superseded the sonic tool. On other hand, sonic log remains important because of its application in surface based seismic imaging. This fact has led to many attempts to predict the sonic logs from other available data. The work presented here concentrates on sonic log prediction in carbonate rocks of Michigan's Traverse Limestone. Well logs from fifty different wells were analyzed to define the mineralogy of the Traverse Limestone using conventional mineral identification approaches. Sonic response was predicted in each well from porosity, using Wiley's time average equation, incorporating the sonic properties of the constituent minerals, a relation widely used in the petroleum industry. The predicted sonic logs were then compared with measured sonic logs, using root mean square (RMS) of the difference. These initial results demonstrate errors related to clay minerals (shale) and the "secondary" porosity associated with dolomitization. To counter the effect of clays, I used a modified time average equation, accounting for clay content based on the gamma ray log, and accounting for the secondary porosity associated with dolomite. This resulted in a reduction of average RMS error in 50 wells from 6.00 $\mu\text{sec}/\text{ft}$ to 3 $\mu\text{sec}/\text{ft}$. The results of this study are useful not only for prediction of sonic logs where none exist, but also for the understanding of rock physics in complicated carbonate rock systems.

Probabilistic and reliability Analysis of Soil Liquefaction Potential

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There are many simplified procedure developed in past to evaluate the liquefaction potential with the use of deterministic value to know that whether the liquefaction occur or not. Those simplified procedure were unable to say the liquefaction probability for a given factor of safety which is of utmost importance while taking decision for construction of buildings, dams, bridges etc. A probabilistic framework has been proposed here to know about the liquefaction probability for deterministic safety factor. To accomplish this goal a global dataset from Moss et al (2006) has been used. Moreover, a reliability analysis has been performed to know the effect of different parameters on the factor of safety (FS). Factor of safety is the ratio of cyclic resistance ratio (CRR) and cyclic stress ratio (CSR).

Influence of 24-Hour Sleep Deprivation on Anxiety and Cardiovascular Reactivity in Humans

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Hypertensive responses to 24-hour total sleep deprivation (TSD), self-perceived anxiety, and mental stress have been studied independently, but not collectively. We hypothesized that TSD-induced anxiety would be associated with increased resting mean arterial pressure (MAP) and cardiovascular reactivity to acute mental stress (5 min of mental arithmetic). State-anxiety, MAP, heart rate (HR), and forearm vascular conductance (FVC) were measured in 28 subjects (14 men, 14 women; age 22±1 yrs) after normal sleep (NS; 7±0 hrs) and after 24-hour TSD (randomized, crossover design). TSD increased state-anxiety (28±1 to 33±1 units; P<0.01) and resting MAP (72±1 to 75±1 mmHg, P<0.01), but increases in MAP were not correlated with increases in state-anxiety (r=0.17, p=0.20). Mental stress elicited similar increases (P<0.01) in MAP (Δ9±1 vs. Δ9±1 mmHg), HR (Δ15±1 vs. Δ18±2 beats/min), and FVC (Δ1.2±0.2 vs. Δ1.2±0.2 units) during NS and TSD, respectively. Increases in state-anxiety were not associated with cardiovascular reactivity to mental stress. When probed for sex differences, men and women demonstrated similar response patterns. In conclusion, TSD elicits concurrent increases in state-anxiety and resting MAP, but these responses appear to occur independently. Moreover, TSD-induced state-anxiety does not alter cardiovascular reactivity to mental stress. Supported by NIH (HL-098676).

Assessing Public Outreach: Surveys and Interviews of Participants in Cliff Mine Archaeological Field School Tours

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A growing need for support from non-archaeologists is driving the current trend in public archaeology. Research into public opinions and impressions of archaeological research and heritage management is the next logical step in understanding how archaeologists interact with and understand the expectations of visitors to archaeological sites. For this research, on-site surveys were given at Michigan Technological University's 2011 archaeological field school at the historic Cliff Mine site near Calumet, Michigan over a period of five days in June. Demographic data were examined through seven specific questions in a pre-tour survey and

qualitative data were analyzed through an additional 10 open-ended questions. A post-tour survey contained 12 open-ended questions with an option to provide contact information for a future interview. Results show that participants were local to the Upper Peninsula, retired, of either sex, and within the 46-75 age range. Participants enjoy hiking, exploring the Cliff area, and collecting mineral samples in mining waste rock piles. They find value in preserving local heritage and many participants expressed interest in participating in excavations and donating to the Department of Social Sciences to continue our research. Participants support industrial archaeology, hope to see more research at the Cliff site, and are interested in mining heritage sites in the Keweenaw and beyond. Suggestions from participants for improving their experience included placing signage, passing out maps and historical information, and lowering tour sizes. Research methods and data used in this study are concluded to be useful for future research exploring and assessing public outreach at the field schools of other universities.

White-tailed deer initiate a regime shift through complex interactions in nitrogen cycling, browse preference, and vegetation dynamics

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Regime shifts occur when an ecosystem transitions from one stable state to another. Regeneration patterns and demography suggest that relict eastern hemlock (*Tsuga canadensis*) forests of the Great Lakes region are on the precipice of a regime shift to northern hardwood dominance. Prior to European settlement, patch stability was maintained in hemlock-hardwood forests through positive feedbacks in nitrogen cycling, with slower cycling in hemlock-dominated compared to hardwood-dominated patches. We hypothesize that increased winter white-tailed deer (*Odocoileus virginianus*) use in hemlock patches is accelerating nitrogen cycling dynamics, which favors sugar maple (*Acer saccharum*) establishment over hemlock regeneration due to differences in nitrogen use efficiency. Deer use of hemlock stands has increased due to a dramatic reduction of hemlock cover on the landscape and a doubling of the deer population. Concentrated deer use will increase nitrogen ion availability through urinary and fecal deposition. Increasing sugar maple in a given stand would further accelerate nitrogen cycling through the production of labile litter and by attracting more deer through increased browse availability. We tested this hypothesis by measuring nitrogen-ion availability in three 4-ha deer exclosures and three control sites. We also measured deer use (fecal pellet density) and tree regeneration (density), and plan to compare patterns in spatial autocorrelation between these variables. A preliminary analysis suggested that ammonium is more available in control sites compared to deer exclosures, which is in support of our hypothesis. Our results suggest that

hemlock forest patches are shifting to sugar maple dominance through positive feedbacks driven by nitrogen cycling, plant life history traits, and deer browse preference.

All Archives are Not Created Equal: The Birth of Three Significant Repositories of American Business Records

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As American industry has declined, many buildings and sites associated with manufacturing, mining, and heavy industry have been altered, abandoned, or removed. Archival records are increasingly important evidence of industrial history, but it is unclear whether a comprehensive or coherent amount of historical material is being retained for future use by historians and other researchers. This presentation will compare and contrast the founding and early history of three important business archives. The Baker Library at the Harvard Business School in Cambridge, Massachusetts, was founded in 1908 and accelerated its collecting of business manuscripts following the construction of a new building in 1927. Baker drew upon alumni and the members of the fledgling Business Historical Society to develop its collection of business and economic collections to support research and graduate studies of Harvard students and faculty. The Hagley Museum and Library in Wilmington Delaware was founded in 1953 by Pierre S. du Pont, president of the E.I. du Pont de Nemours chemical company and chairman of General Motors. Formed initially as a library for du Pont's family papers and books, it merged with a du Pont industrial museum at the site of the company's former powder works in 1961 and became an active collector of business manuscripts. The Smithsonian Institution, the United States' federal museum system, established its Museum of History and Technology in 1955 in Washington, D.C. While gathering material and information for interpretive exhibits opened in a new museum building in 1964, museum curators discovered and acquired archival records from factories and business firms around the country. Although the mission, funding, and archival collecting activities of these repositories would change over time, an examination of their establishment and early work highlights important differences in each institutional context which continue to affect their selection of manuscript material for permanent preservation.

Phytoremediation of Lead (Pb) Metal Using *Chrysopogon Zizanioides* (Vetiver)

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Phytoremediation is being developed as eco-friendly technology to the organic and heavy metal pollution. Metal accumulation ability depends upon physiochemical soil properties and physiological, genetic traits of the tolerant plant species. Plants specifically tolerate certain metals and individual metals have different mechanisms of accumulation. Metal transporters, phytochelatins, metallothioneins play important role in metal uptake and transport. Several studies were done on metal tolerance but mechanisms underlying hyper accumulation are not well understood.

Vetiver can grow in wide range of soil and climate conditions. It tolerates wide range of heavy metals, organic pollutants and hyper accumulates lead metal without toxic effects. Field level experiments are being conducted to study the phytoremediation of lead metal in real world. Studies to describe the genetic mechanisms of metal uptake, transport and accumulation are being pursued. Proteomic approach is followed to understand the molecular mechanisms behind the hyper accumulation process.

Metabolomic and Proteomic Analysis Identifies Candidates for Anticancer Activity of Rice Callus Suspension Culture

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Over 60% of anticancer drugs available today are synthetic or semisynthetic analogs of natural products. Callus suspension cultures are known to provide distinctive advantages for production and extraction of secondary metabolites. Here, we studied the effect of rice callus suspension culture at six dilutions on three different cell lines at three cell densities (two cancer cell lines RXF-393 and SW-620 and a normal control MRC-5) over four treatment time points to determine best strategy for assessing potential anticancer activity (cytotoxicity) using crystal violet assay. Rice callus suspension cultures significantly inhibited the growth of human cancer and renal cell lines at densities of 5,000 and 10,000 cells per mL when incubated for 72 and 96 hour compared to paclitaxel (Taxol®) and etoposide which are established anti-cancer agents. Microscopic analysis using inverted microscope and Scanning Electron Microscopy (SEM) was done to study morphological changes in cell lines. Altered features in treated samples like

reduction in cell number, flatter morphology and homogeneous sizes of cells than in control were observed. Mass spectrometry analysis (Electrospray Ionization Tandem Mass Spectrometry ESI-MS/MS and Gas Chromatography Mass Spectrometry GC-MS) was carried out and a number of distinct mass spectra were identified in the suspension culture compared to blank plant medium. The mass spectra were searched against National Institute of Standards and Technology (NIST) and other libraries to identify the secondary metabolites. The candidate compounds identified include hydroxymethylfurfural (HMF), sulfapyridine and dicumarol which are reported to possess anti-tumor properties whereas dapsone and sulfamethazine whose derivatives show anti-inflammatory and anti-bacterial properties.

Two dimensional PAGE was performed using proteins from the cell lines treated for 24 hrs and 72 hrs and the differentially expressed protein spots compared to untreated and blank plant medium treated cell lines were identified. These spots were eluted from the gel, subjected to trypsin digestion and analyzed using both ESI-MS/MS and Matrix-assisted laser desorption/ionization Time of Flight Mass Spectrometry (MALDI-TOF MS). The generated peptide mass fingerprints (PMFs) were searched against MASCOT database to identify the proteins. In total 14 proteins (11 up regulated and 3 down regulated) were identified of which some are known oncogenes and tumor suppressor genes. Further investigation of the identified metabolites or their derivatives combined or individually would aid to us to explore the role of the identified proteins and other cellular components in regulation of signal transduction pathways, metabolic and morphological changes resulting in anticancer activity.

Using a Prediction and Option Generation Paradigm to Understand Decision Making

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In many complex domains, as opposed to selecting between explicitly presented alternatives, decision makers are first required to generate alternative options. However, skilled performers use different option generation strategies during perception and action, for instance, when predicting situational events compared to when selecting personal responses. Current research suggests that the accuracy and quality of prediction is positively related to the number of decision alternatives generated, whereas the quality of response selection is negatively related to the number of options generated. The goal of this study was to reconcile theoretical differences in explanations of strategy use by examining the role of decision type (i.e., prediction, response) and skill level on the adoption of each option generation strategy. Twenty skilled and 20 less-skilled police officers interacted with 20 dynamic law enforcement situations presented via video-based simulation. In their unedited form, ten situations culminated with the suspect(s)

carrying out actions that required a lethal (i.e., shoot) response; the other ten situations could be resolved successfully without shooting. For this experiment, all video clips were occluded prior to the culmination of the situation, at a point when new, additional task-relevant contextual information became available that would provide some additional basis for predicting the outcome. After occlusion, participants predicted the outcome of each situation and generated response options. Analysis revealed that quality of prediction was positively related to the number of prediction options generated, while quality of response selection was negatively related to the number of response alternatives generated. Although skill level did not significantly affect the number of options generated, skilled officers generated higher-quality options than the less-skilled officers. These findings provide the basis for an evidence-based approach to training decision-making skills. Future research will derive an expert model from the data, which will be used to train option generation strategies of less-skilled participants.

Approximation of Constraint Low-Thrust Space Trajectories Using Fourier series

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The problems of spacecraft trajectory design and optimization attracted the attention of researchers since the mid-1920s when Walter Hohmann published his work on trajectory design. The mission trajectory scenario may turn out to be composed of several trajectory segments. One or more segments may have continuous thrust applied at different thrust levels and in different directions. A fundamental task in a global trajectory optimization tool is to find the optimal trajectory for a continuous-thrust trajectory segment, where the spacecraft needs to depart from a current state (planet or asteroid) and arrive at another one in a given time of flight. However, trajectory optimization is a very challenging and time-consuming task. In this paper, we build upon existing techniques to present an alternative Fourier series approximation for rapid low-thrust rendezvous/orbit raising trajectory construction with thrust acceleration constraint handling capability. The new flexible representation along with the constraint handling capability makes this method a suitable candidate for feasibility assessment of a whole range of trajectories within the given system propulsive budget. In addition, the solutions present opportunities for direct optimization techniques. A key point in the proposed method is its ability to solve problems with a greater number of free parameters. Several case studies are presented: simple Earth-Mars rendezvous, Low Earth Orbit (LEO) -to- Geostationary Earth Orbit (GEO) rendezvous/orbit raising, and two phasing problems. Results clearly depict the advantage of the proposed method in handling thrust constraints and its applicability to a wide range of problems.

Magnetization and Magnetostriction of Terfenol-D near Spin Reorientation Boundary

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Magnetostrictive materials are capable of converting energies between magnetic and mechanical forms, thus finding important applications in sensors, actuators, and transducers. While most magnetic materials exhibit magnetostrictive strain less than 100 ppm, a quasi-binary alloy $Tb_xDy_{1-x}Fe_2$, nicknamed Terfenol-D following its compositions terbium (Ter), iron (Fe), dysprosium (D) and inventor Naval Ordnance Laboratory (NOL), exhibits a giant magnetostrictive strain up to 1600 ppm, thus became the leading magnetostrictive materials. However, the inability to develop other magnetostrictive materials with comparable or better performance seriously limits a broader application of such functional materials. In this research we focus on the spin reorientation boundary (SRB) of the $Tb_xDy_{1-x}Fe_2$ phase diagram to investigate the mechanism for giant magnetostriction, based on a striking analogy to the morphotropic boundary (MPB) in a leading piezoelectric material PZT that is an electric counterpart of Terfenol-D. The fact that both materials achieve best performance at their respective SRB and MPB strongly suggests that the very existence of SRB is a unique condition for giant magnetostriction. In this work magnetization and magnetostriction behaviors of Terfenol-D near SRB between $\langle 111 \rangle$ and $\langle 100 \rangle$ easy directions are analyzed by simulating magnetic domain rotations under increasing magnetic field and compressive stress along $\langle 112 \rangle$ growth direction. It reveals significant changes in magnetization and magnetostriction behaviors when the temperature and/or composition cross SRB. In particular, the switching magnetic field first decreases then increases as phase of Magnetization crosses SRB from $\langle 100 \rangle$ region into $\langle 111 \rangle$ region, while the magnetostriction first increases then saturates, implying indeed an optimum combination of large magnetostriction and low switching field near the SRB. This finding has general implications for other magnetostrictive quasi-binary alloys that also exhibit SRBs, which are potential candidates for new giant magnetostrictive materials. A recent discovery of greatly enhanced magnetostriction in quasi-binary alloy $TbCo_2-DyCo_2$ provides supporting evidence to our finding.

An Invisibility Cloak at Microwave Frequencies Designed by Identical Dielectric Resonators

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The first cylindrical invisibility cloak composed of metallic split ring resonators operating at microwave frequencies was designed by Schurig et al. However, the high loss (loss tangent $\sim 10^{-2}$) due to metal limits the size of the cloaked object to one wavelength. To reduce the loss, Gaillot et al. proposed to design a cloak for terahertz frequency by concentric layers of dielectric resonators. In the two cloak designs, different sizes of resonators had been employed to provide effective permeability dispersion along the radial direction, which increases the implementation complexity. We propose at the first time to design and implement the cloak at microwave frequencies by using identical dielectric resonators. To provide the effective permeability dispersion, different air fractions along the radial direction of the cloak are employed. The performance of the cloak has been verified by full-wave simulations of the true multi-resonator cloak structure rather than effective parameter layers, and also by experimental measurements. The wave front reconstruction and low scattering cross section (SCS) of the cloak have been observed. It is worthy of stressing out that these results demonstrate for the first time decrease of SCS compared to that of the bare object, i.e. the real cloaking effect for the cloak design simulated with the multi-resonator structure.

Sex differences in sympathetic neural responses to 24-hour sleep deprivation in humans

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Sleep deprivation has been linked to hypertension, and recent evidence suggests that associations between sleep deprivation and hypertension are stronger in women. We hypothesized that 24-hour total sleep deprivation (TSD) would elicit augmented pressor and sympathetic neural responses in women compared to men. Resting heart rate (HR), blood pressure (BP), and muscle sympathetic nerve activity (MSNA) were measured in 30 healthy subjects (age, 22 ± 1 yr; 15 men and 15 women). Relations between diastolic BP and MSNA were used to assess sympathetic baroreflex function. Subjects were studied twice, once after normal sleep and once after TSD

(randomized, crossover design). TSD elicited similar increases in BP in men and women. TSD reduced MSNA in men (25 ± 2 to 16 ± 3 bursts/100 heart beats; $P=0.02$), but not women. TSD did not alter sympathetic baroreflex sensitivity in either sex, but the operating point was shifted downward and rightward in men (40 ± 4 to 27 ± 7 units; $P=0.03$). TSD reduced testosterone in men, and these changes were correlated to changes in resting MSNA ($r=0.59$, $p=0.04$). Resting HR and estradiol were not altered by TSD in either sex. In conclusion, TSD-induced hypertension occurs in both sexes, but only men demonstrate altered resting MSNA. The sex differences in MSNA are associated with sex differences in sympathetic baroreflex function (i.e., operating point) and testosterone. Supported by NIH (HL-098676).

The Revised Chebyshev Algorithm for Solving Optimal Control Problems

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In this presentation, an efficient Chebyshev algorithm is introduced to solve optimal control problems which are widely used in engineering applications such as astronomy technologies, rocket orbit search, missile control, etc. We employed Chebyshev expansions to approximate both the control and state functions. The discretization process and related techniques are different from existing methods that are commonly used. The optimal control problems are transformed into mathematical programming problems. Further theoretical development is given to support the method. Numerical examples and comparisons with other methods are listed to demonstrate the efficiency of the proposed method.

Session 2: Poster Presentations

Characterization of the Lateral Organ Boundaries Domain Genes *PtaLBD1*, *PtaLBD4*, *PtaLBD15* and *PtaLBD18* in a *Populus trichocarpa* x *Populus deltoides* cross

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Considering the important role of woody plants in decreasing atmospheric CO₂, wood products and bio-energy, structural gene function and gene regulation needs to be understood. The Lateral Organ Boundaries Domain (LBD) family of transcription factors is involved in secondary woody growth. 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 SNPs variation will be associated with height and diameter growth and with wood anatomy. Primers were developed to sequence the coding regions and promotor regions of 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. PCR products were directly sequenced using traditional Sanger sequencing (Nevada Genomic Center). Gene sequences were edited using the software Codon Code Aligner with a Phred score higher than 25 for quality control. Sequences were aligned using the software Bioedit. Most of the gene fragments were successfully amplified and sequencing of the fragments is under way.

Effects of protection on amount and structure of forest cover at two scales in Bozin and Marakhil protected area, Iran

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Official protection can play a major role in the conservation of biodiversity. Bozin and Marakhil Forest in Kermanshah province of Iran covers 23,724 ha of semi-arid Zagros forests. It was designated as a protected area for Eurasian roe deer (*Capreolus capreolus*) in 1999. Using remote sensing data from 2001 and 2009, we evaluated the effects of this protected designation on forest area and structure at two spatial scales. We processed and classified Landsat images for

the two dates covering the protected area and the adjacent unprotected areas for the broad scale analysis using non-parametric Random Forest (RF) method. We classified IKONOS and GeoEye images of the two dates covering a part of protected and unprotected areas for fine scale analysis using the density slicing of the Normalized Difference Vegetation Index (NDVI). We calculated all Fragstats metrics and selected the variables at both scales by applying a multivariate factor analysis based on Principal Component Analysis (PCA) and Varimax rotation. Wilcoxon rank sum test was used for the comparison of spatial variables between protected and unprotected areas. Protection had a scale dependent influence on habitat availability and structure. A difference due to protection at the fine scale was increased fractal dimension of forest patches as a measure of landscape complexity, likely due to reduced human impact. The official protection maintained habitat availability, contiguity, and complexity at the broad scale, at the expense of increasing human pressure on the surrounding unprotected areas. Fitting power law models to patch size distributions before and after protection and the statistical comparison of the goodness of fits between alternative models gives similar results. Given this scale dependency of protection effects on habitat amount and structure, the actual effects of protection would depend on the practical home range size and scale at which species use the habitats.

Characterizing the Dielectric Behavior of Human Mesenchymal Stem Cells

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Characterizing the dielectrophoretic response of stem cells at various stages of growth and in the presence of promoters is an important first step in designing an electrokinetic microdevice to separate stem cell types. Dielectrophoresis (DEP) is a technique utilizing nonuniform electric fields to polarize cells based on the polarizability and dielectric properties of their membrane, cytosol, and other structurally dominant organelles. Based on these properties, cells will exhibit either positive DEP force, cells move to areas of stronger electric field strength, or negative DEP force, cells are repelled from areas of stronger electric field strength. The magnitude of the DEP force is tunable by adjusting the electric field magnitude and shape, while the directionality and magnitude are both tunable by adjusting the surrounding medium conductivity and field frequency. Hemapoetic stem cell identification has been accomplished by antibody tagging of unique cell-surface antigens followed by flow cytometry and fluorescent-activated cell sorting. This approach requires expensive raw materials, is labor intensive, and has seen limited

adaptation to other stem cells. Therefore a label-free, one-step identification technique to identify and separate all types of stem cells is needed.

In this work, a microfluidic device with gold quadrupole electrodes spaced 50 microns apart within a microfluidic channel and chamber device is used to quantify the DEP response of human mesenchymal stem cells (hMSCs) that were differentiated into osteoblasts and adipocytes based on environmental promoters. The hMSCs were characterized from 100 kHz to 80 MHz frequency at a rate of 0.67 MHz/sec for 120 seconds in dextrose media at 0.01 S/m to 0.90 S/m conductivities. Narrower frequency sweeps were used to map out ranges with positive, negative, or cross-over frequency DEP behavior of the hMSCs in different stages of growth and in the presence of promoters. COMSOL simulations and MATLAB help fit the data to a multishelled spherical DEP polarization model in order to back out structural polarizability and conductivities of components of the hMSCs. Electrokinetically identifying differences in stem cells have broad implications in purification and control for tissue engineering and cell therapy applications.

Thallium Doping of $(\text{PbSn})_{.5}\text{Te}_{.5}$ and Iodine Doping of PbTe to Create More Efficient Thermoelectric Materials

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Thermoelectric materials have been used for decades as power generating elements in small and reliable power generators. However, the low efficiency of these materials, less than 10%, has limited their use to niche applications where constraints for size and reliability outweigh the need for efficiency. The Lead Telluride alloy system has been used in the past to create these materials, and recent literature suggests that this system has more potential than previously thought. A model was developed to predict the figure of merit, zT , characterizing the material's efficiency for the n-type material of interest, PbTe + PbI. Sample sets of PbTe+PbI_.0012 (mol fraction) and PbTe+PbI_.0027 were produced at compositions corresponding to the maximum predicted zT . Room temperature conductivity measurements suggest a zT of approximately 1.3 which corresponds with the predictions of the model. This validates the model but is a mediocre result in terms of efficiency. The p-type material of interest, $(\text{PbSn})_{.5}\text{Te}_{.5}$ + TlTe, was investigated to determine the effect of tin in the lattice. Sample sets of PbTe + TlTe_.02 (mol fraction), and $(\text{PbSn})_{.5}\text{Te}_{.5}$ + TlTe_.02 were produced, and room temperature conductivity measurements suggest that the addition of tin increases the electron mobility and the effectiveness of the thallium dopant making the samples overdoped for maximum zT . The results of the $(\text{PbSn})_{.5}\text{Te}_{.5}$ + TlTe investigation are promising, and the experiment should be repeated with a lower doping concentration.

Micron-scale Ion Concentration Gradients in Nonuniform AC Electric Fields

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Erythrocytes were observed to first swell slightly and then shrink substantially over time in phosphate buffer saline in a two dimensional nonuniform AC dielectrophoretic field. We hypothesized that this cell behavior was due to changing osmotic pressure between the cell and the local medium as propagation of an ion concentration gradient occurs in the electric field area. Cells are known to respond rapidly to the tonicity of the surrounding media; isotonic media yields an erythrocyte typical biconcave shape while hypotonic will cause erythrocytes to swell and hypertonic causes cells to shrink. Ion behaviors were examined with COMSOL ‘Transport of Dilute Species’ physics to simulate concentration, diffusion, convective and electromigration transport without inter-ion forces under 1MHz sinusoidal AC field. Results have shown that high ion concentration increased in the regions adjacent to the electrode over 100 cycles of the AC field. Simulations were also conducted by COMSOL using the ‘Nernst-Planck equation’ to include ion-ion interactions in addition to the ‘Transport of Diluted Species’ physical mechanisms. Results have shown the high ion concentration area was first formed at the surface of higher density electrode and then spread out toward the lower density electrode through 100 cycles with directional oscillating concentrations. These results have important implications in the field. Research in this field has, until now, assumed polarization of dielectrics in dielectrophoretic fields occurs in relatively constant medium conditions. The Debye layer comprises tens to hundreds of nanometers from the dielectric particle surface or electrode particle surface; ion behaviors in this layer have been studied. This work elucidate the formation and transportation of waves of ions tens to hundred of microns from the electrode surfaces in non-uniform AC electric fields and corresponding experimental results suggest complex interaction between the dynamic ion distribution in the medium and the particle’s induced dipole response.

Effect of Melt-Spinning Parameters on the Formation of MnAl₆ Quasicrystals

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Melt-spinning has been shown to be an effective process to produce a class of ordered, but non-periodic crystals called quasicrystals. However, many of the factors related to the creation of the quasicrystals through melt-spinning are not optimized for specific chemistries and alloy systems. In this research, melt-spinning was utilized in the creation of metastable quasicrystalline MnAl₆ through rapid solidification of an Al-15 wt% Mn alloy. Other resulting phases of the solidification include an Al-Mn solid solution and stable (orthorhombic) MnAl₆. Wheel speed of the melt-spinning wheel and orifice diameter of the tube reservoir were varied to determine their effect on the resulting volume proportions of the phases and the amount of Mn in the Al-Mn solid solution. X-ray diffraction was conducted on the resulting product and characteristic peak intensities of the phases were used to determine the relative volume proportions. The peak positions of the Al-Mn solid solution from the x-ray diffraction were used to determine the lattice parameter of the solution and then a Vegard's law calculation applied to relate the lattice parameter to the amount of Mn in solution.

The Effect of Encoding Type and Experience on Spatial Recognition of Dynamic Information

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Although previous research indicates that expert soccer players have better incidental recognition of patterns of play when viewed from the same angle (e.g., pseudo, first-person perspective) as in the encoding phase, others have shown little to no skill difference when asked to recognize from a new perspective (e.g., 90° rotation). In the first study, dynamic scenes were presented during the encoding and recognition phase whereas, in the latter study, dynamic scenes and static images were used, respectively. Moreover, participants in the first study anticipated the opponent's intentions during encoding whereas those in the second study watched the dynamic scenes passively. Using a series of experiments, the current research aims to use soccer footage filmed from multiple angles to investigate the effect of type of encoding (anticipation vs. passive viewing), recognition task type (static vs. dynamic), and level of experience on recognition of

dynamic sequences presented from a different viewpoint. We hypothesize that (a) when information is encoded for the purpose of anticipation as opposed to simply viewing the film, experts will outperform their less-skilled counterparts in recognition; (b) when participants are presented with dynamic rather than static scenes during recognition, even after rotation, skill-based differences in recognition ability will be apparent; and (c) individual differences in spatial (i.e. mental rotation) ability will mediate recognition ability.

Investigation of Jigging for the Beneficiation of High-MgO Phosphate Ores

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Dolomite [$\text{CaMg}(\text{CO}_3)_2$] is an intolerable impurity in phosphate ores due to its MgO content. Traditionally, the Florida phosphate industry has avoided mining high-MgO phosphate reserves due to the lack of an economically viable process for removal of dolomite. However, as the high grade phosphate reserves become depleted, more emphasis is being put on the development of a cost effective method for separating dolomite from high-MgO phosphate ores. In general, the phosphate industry demands a phosphate concentrate containing less than 1% MgO.

The dolomite impurities have mineralogical properties that are very similar to the desired phosphate minerals (francolite), making the separation of the two minerals very difficult. Magnesium is found primarily as distinct dolomite-rich pebbles, very fine dolomite inclusions in predominately francolite pebbles, and magnesium substituted into the francolite structure. Jigging is a gravity separation process that attempts to take advantage of the density difference between the dolomite and francolite pebbles. For this study, a unique laboratory scale jig was constructed and tested using a “through the screen” jigging procedure. Two different samples of high-MgO Florida phosphate ores were tested: (1) Plant 1 was sized to 4.00x0.85mm and contained 1.55%MgO; (2) Plant 2 was sized to 3.40mmx0.85mm and contained 3.07% MgO. A sample from each plant was visually separated by hand into dolomite and francolite rich fractions, which were then analyzed to determine the minimum achievable MgO levels. Samples from Plant 1 and Plant 2 were tested using previously optimized jigging parameters at high and low feed rates. For Plant 1 phosphate ore, a concentrate containing 0.89%MgO was achieved at a recovery of 32.0%BPL. For Plant 2, a phosphate concentrate containing 1.38%MgO was achieved at a recovery of 74.7%MgO. Each concentrate approached the minimum achievable MgO levels that were determined during the mineralogical characterization of Plant 1 and Plant 2 phosphate samples.

The Analysis of Cytotoxic Reactive Species Formed from Insulin

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Amyloid diseases, such as Alzheimer's disease and Parkinson's disease, are characterized by the abnormal accumulation of protein fibrils in specific tissues, resulting in cell death. Discovering the mechanism that causes cell death may help treat these diseases. Recent literature reported that cytotoxic high molecular weight (HMW) aggregates are formed during the dissolution of insulin fibrils. There is some evidence that HMW aggregates also exist during the formation of insulin amyloids and may be a critical missing link to the understanding of the amyloid fibrillation process. Here, we use insulin as a model amyloid protein to search for a cytotoxic amyloid aggregate. We have found evidence that HMW aggregates exist independent of insulin fibrils. Using seeding experiments, which consists of adding supernatant samples formed during the different phases of the insulin fibril formation process to fresh insulin; it was observed that the reactive species can be removed by a 0.2 μm filter. Meanwhile, reactive solutions that are filtrated by a 0.45 μm or a 0.8 μm filters maintain the ability to increase the rate of the fibrillation process, although to a lesser extent than unfiltered samples. This indicates that the size of the reactive species may not be constant. Furthermore, this result coupled with a ThT fluorescence assay, a dye that detects β -sheet amyloid structures, demonstrated that the concentration of HMW aggregates may change during the aggregation process, with the highest concentration found during the elongation phase. This is corroborated with ANS fluorescence and MTT cytotoxicity, demonstrating that the elongation phase has an increase in hydrophobic and cytotoxic species, respectively. The results of this project provide significant insight into the formation of HMW aggregates that are reactive and cytotoxic. Further work to deduce the structure of these reactive species could lead to currently undiscovered therapeutic targets for amyloid diseases.

Determination of the Acousto-Optic Effect in Polymer Waveguide Materials

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Polymer materials exhibit many useful properties, which allow for their use as integrated optical waveguides. However, many useful waveguide devices in the optical regime such as switches, deflectors, filters, and isolators have yet to be developed in polymer material. A potential way of creating these devices is by use of the acousto-optic effect. We have examined a specific siloxane polymer material that is currently being used for waveguide fabrication to determine if it exhibits the acousto-optic effect. The specific acousto-optic cases examined were bulk wave and guided-wave interactions and operations within the Raman-Nath and Bragg diffraction regimes.

Optimal Distributed Control Methodologies in Small Scale Power Systems

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The small scale power system (SSPS) is a collection of sources and loads that shares a common network which can be isolated during disturbances. Micro-grids, aircraft power systems, naval ship electric power systems (NSEPS), automotive power systems, and telecommunication system power systems are typical examples of SSPS. The analysis and development of control systems for SSPS lacks a slack bus. Therefore, the control system should provide the required flexibility to ensure operation as a single aggregated system. In a SSPS most of the cases for the sources and loads must be equipped with power electronic interfaces. This interface can be modeled as a dynamic controllable quantity. The mathematical formulation of the controllers is carried out with the help of game theory, optimal control, and fundamental theory of electrical power systems. Then, the micro grid can be viewed as a dynamical multi-objective optimization problem with nonlinear objectives and variables. This research explores the optimal solutions with regards to start up transient modeling, bus selection modeling, and level of communication within the micro grids. In each approach a detail mathematical model is built in order to observe the system response. These mathematical models create the path for designing distributed controllers within the system. The experimental results also obtained have validated the proposed controllers.

Purification of Synthetic Oligodeoxynucleotides via Catching by Polymerization

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In recent years, large quantities pure synthetic oligodeoxynucleotides (ODNs) are needed for preclinical research, clinical trials, and patient use. These ODNs are synthesized on an automated synthesizer. Typically, the synthesis of ODNs generates impurities including failure sequences, which are difficult to remove. The reason is that they have the same properties as the full length ODNs. Currently, ODNs purification technologies can remove those impurities, such as reverse phase high-performance liquid chromatography (RP HPLC), anion exchange HPLC, polyacrylamide gel electrophoresis (PAGE). However, all these methods are inconvenient or costly to scale up. To solve the problem, two non-chromatographic methods of ODNs purification by polymerization are described. In the first method, during automated synthesis, the full-length ODNs are tagged with methacrylamide group via a cleavable linker while the failure sequences are not. The full-length ODNs are incorporated into a polymer through a copolymerization process, and failure sequences and other impurities are removed by washing. The full-length ODNs are obtained by cleaving from the polymer. In the second method, the failure sequences are capped by a methacrylated phosphoramidite followed by radical acrylamide polymerization and water extraction to retrieve the full-length ODNs. The purity of ODNs has been confirmed by RP HPLC. The identity of ODNs has been established by comparing with authentic ODNs and Matrix Assisted Laser Desorption Ionization-Time of Flight (MALDI-TOF) analysis. These methods do not require any expensive equipment and materials. Therefore, they are useful for large-scale purification of ODNs.

A Novel Treatment for Fracture Healing in Rats

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Fracture healing models are a common study for research involving new or improved bone regenerating treatments. Intermittent injection (daily or bi-daily injections delivered close to the fracture) of Human Parathyroid Hormone (hPTH) has been shown to increase mechanical strength and overall callus formation during fracture healing. At Michigan Technological University in the Bone Lab of the Biomedical Engineering department there has been some focus on replacing the hPTH with Black Bear Parathyroid Hormone (bbPTH). The reason for the replacement is that it has been proven that black bears do not lose bone mass during hibernation.

This is unusual especially when compared to bed ridden human patients whom lose one to two percent of bone mass within a month. Fifteen Sprague Dawley rats (n=15) were used as the animal model with four different groups. Group 1 was an empty defect; this group did not contain any of the bbPTH. Group 2 contained bbPTH in a hydrogel at 40 µg/ml. Group 3 also contained bbPTH in a hydrogel at 120 µg/ml. Group 4 was just the hydrogel alone. Each rat was anesthetized then an incision was made from the hip-joint to the knee. Once opened the muscle was separated at the fissure to expose the femur with the least amount of tissue damage. Next, a Polyether ether ketone (PEEK) plate was attached to the femur (anterior-laterally) using threaded Kirschner wires. Next, a 5 mm critical-sized defect was created in the femur at approximately the center. The treatment, randomly assigned to each rat, was added to the defect, and then the wound was closed up. This study showed no significant results between any of the groups. In the future delivery vehicle model modification may be necessary to show better results.

Binding Effects in Hematite and Magnetite Concentrates

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A local taconite pelletizer produced both magnetite and hematite pellets. Plant personnel believed less bentonite (as binding agent) was required to make hematite pellets. Lab-scale pelletization tests were completed to validate the industrial observation. Hematite pellets met industrial minimum wet drop (5 drops to fracture) and dry crush (22 N/pellet) values without bentonite addition; however, magnetite concentrate pellets required 6.6 kg/t (0.66 %) bentonite to exceed these values. Based on pelletization theory, this difference could be caused by factors including particle size, mineralogy and effects of processing reagents. Experimental results are presented to fundamentally explain the enhanced strengths observed in the hematite concentrate pellets.

The Influence Of Repetitive Loads On Foot Sensitivity And Dynamic Balance

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Balance plays an integral role in daily activities, with deficits often resulting in injuries. Decreased foot sensitivity has been suggested as a limiting factor for balance tasks. Age, neuropathies, injuries, temperature, and pressure have been identified as influencing factors on foot sensitivity. There is limited research regarding the influence of loading on foot sensitivity. The purpose of this study is to investigate the effects of repetitive additional load on foot sensation and sway area. Ten healthy subjects (age: 19.5 ± 1.5 , 5 female, 5 male, BMI: $20.93\text{kg/m}^2 \pm 2.86$) attended three appointments, each with a randomly assigned 20 minute intervention as follows: rest, walking with no load, and walking with a weighted vest equal to current BMI + 9. Foot sensation was tested using Semmes-Weinstein monofilaments (great toe, 1st, 3rd, 5th metatarsal heads, heel). Four dynamic unipedal reaching stances alternating vision (eyes open (EO), closed (EC)) and surface (floor (F), balance pad (D)) were tested pre and post intervention on the subject's dominant leg determined by the Balance Recovery Test. Foot sensation, sway area, and time to failure (TTF) were measured for the balance task. Foot sensation was tested immediately following intervention. Data was standardized according to pretest data. Foot sensation was unchanged following interventions. Sway area was not significantly different for EOF, ECF, EOD. In ECD sway area increased 12.5% for subjects following the "no load" intervention while the "rest" intervention increased 135%. This difference in increase is significant ($p=0.03$). TTF increased 131% following "rest" while decreasing 3% following "no load" ($p=0.01$). The interventions may not have been enough to elicit a significant response in foot sensation. Less increase in sway area for "no load" compared to "rest" was observed which could be explained by a complementary effect of vision and fatigue, due to reported differences in TTF.

Evaluating Relationships Between LiDAR-Derived Vegetation Structure and Butterfly Density to Improve Butterfly Habitat Assessments

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Multi-scale information regarding vegetation structure and composition is critical for the successful assessment of wildlife habitats, including the quantification of species distribution and abundance. Light Detection and Ranging (LiDAR) is a powerful remote sensing technology that provides detailed 3-dimensional structural information with a great potential for characterizing habitat features, including vegetation structural parameters. Previous habitat assessment studies have used LiDAR data to compare vegetation structure to various species, namely birds, but few have focused on insects or have integrated both local and landscape-scale data. Our study pairs landscape-scale LiDAR data with field-based habitat measurements in order to better characterize the species-habitat relationships of four butterfly species in the Palouse Range of Northern Idaho, USA. In this study, we employed LiDAR data to characterize landscape-scale vegetation structural attributes and combined these with vegetation field-measurements of local habitat characteristics (e.g. vegetation composition) that were thought to influence the butterfly species under concern. A non-metric multi dimensional scaling ordination identified relationships between these habitat composition and structure variables and the composition of these four butterfly species. Butterfly species were distributed into two groups, one more associated with the percent cover of larval host plants, and one more associated with LiDAR-derived vegetation structure information. Significant habitat variables were used to generate logistic and stepwise models. The strongest models used both local- and landscape-scale variables, although LiDAR variables explained more habitat characteristics significant to butterfly density. These results suggest that LiDAR data can successfully identify vegetation structure attributes important to butterfly species. We conclude that incorporating LiDAR data in the evaluation of habitat-species relationships may contribute to our understanding of such relationships, and allow for more complex assessments of habitat quality, composition and structure across large spatial extents.

Inland Spiny Water Flea (*Bythotrephes longimanus*) Dispersal and Impacts on Zooplankton Communities

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We show that *Bythotrephes longimanus*, an invasive cladoceran from Northern Europe, is rapidly spreading through the northern Great Lakes region along a temperature-dependent latitudinal band. *Bythotrephes* is a voracious predator, and individuals consume up to 40 smaller invertebrates per day. Though the species is characterized by a large spine, providing protection from small fish, it also produces unusually thick shelled resting eggs that can pass through fish guts in viable condition. We conducted zooplankton surveys of inland lakes to document range expansion and follow zooplankton community makeup of invaded versus non-invaded lakes. Sediment cores from invaded lakes demonstrated assemblage shifts over a longer time scale. Additionally, gut contents from small fish seined in invaded lakes were analyzed for ingestion of egg carrying- *Bythotrephes*. Zooplankton community composition seems altered in invaded lakes, shifting dominance towards larger bodied or gelatinous cladoceran species. The transfer of baitfish from one lake to another apparently facilitates the spread of the spiny water flea, but there appears to be a temperature dependent geographic restriction. We suggest how control measures can limit further spread.

Evaluation of Gene Association Methods for Co-expression Network Construction and Biological Knowledge Discovery

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Although construction of co-expression network followed by network studies has been proven to be a particularly effective approach for biological knowledge discovery from gene expression data, the methods that can be used for gene association in constructing co-expression network have not been well evaluated. Selection of different gene association methods for constructing co-expression network is critically important because different gene association methods can lead to structurally distinct networks from which distinct knowledge of interest can be discovered via network analysis. In this study, we evaluated eight gene association methods that

include Distance Covariance, Hoeffding, Kendall, Pearson, Spearman, Theil-sen, Rank Theil-sen, and Weight Rank. We tried these eight methods for co-expression network construction and decomposition via a triple-link algorithm and found Theil-sen and Rank Theil-sen perform very well in almost all conditions. Spearman, Kendall, and Hoeffding are medium-robust, and Distance Covariance and Pearson are less proficient. However, Distance Covariance has potential to associate genes pairs of multiple relationships and can be promising if the relationships can be dissected.

Pt (II)-Catalyzed Isomerization of Oxo-Alkynes

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Cyclic allyl vinyl ethers are synthesized by Pd (II)-catalyzed isomerization of alkynyl epoxides and an alkynyl allyl alcohol. Two allyl vinyl ethers were further converted to piperidine derivatives by thermal rearrangement.

Role of ATX-2, An RNA-Binding Protein in Centrosome Duplication

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Cancer is one of the most common human diseases, featuring abnormal and improperly controlled cell divisions resulting in invasive growth and tumors. Abnormal centrosomes are associated with cancer, as they are responsible for DNA segregation during mitosis. Centrosomes are the main sites for governing microtubule organization. Centrosomes must duplicate precisely once per cell cycle to form bipolar spindles that segregate equal amounts of DNA into two daughter cells. ZYG-1 is a key factor of *C. elegans* centrosome duplication. In the absence of ZYG-1, centrosome duplication fails, resulting in embryonic lethality. SZY-20 is a genetic suppressor of ZYG-1 and partially restores centrosome duplication and embryonic viability to *zyg-1* mutants. To further understand how centrosome assembly is regulated, we have investigated an RNA-binding protein, ATX-2 (a human Ataxin-2 homolog) in conjunction with SZY-20 and ZYG-1. We identified ATX-2 from a pull-down assay using the SZY-20 antibody.

We have examined if ATX-2 exhibits a genetic interaction either with SZY-20 or ZYG-1 in centrosome duplication. Using RNAi and a confocal microscope, we examined how depletion of ATX-2 affects centrosome assembly and embryonic viability in *zyg-1(it25)* embryos. Interestingly, ATX-2 partially restored centrosome duplication by 37%, and increased embryonic viability in *zyg-1(it25)* mutants, suggesting that ATX-2 acts as another genetic suppressor of *zyg-1*.

Water Resources System Archetypes: Towards a Holistic Understanding of Persistent Water Resources Problems

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Water resources modeling, a well-established tool in water resources planning and management practice, facilitates understanding of the physical and socio-economic processes impacting the wellbeing of humans and ecosystems. While watershed models continue to become more holistic, there is a need for appropriate frameworks and tools for integrated conceptualization of problems to provide reliable qualitative and quantitative bases for policy selection. In recent decades, water resources professionals have become increasingly cognizant of important feedback relationships within water resources systems. We contend that a systems thinking paradigm is required to facilitate characterization of the closed-loop nature of these feedbacks. Furthermore, a close look at different water resources issues reveals that, while many water resources problems are essentially very similar in nature, they continuously appear in different geographical locations. In the systems thinking literature, a number of generic system structures known as system archetypes have been identified to describe common patterns of problematic behavior within systems. In this research, we identify some main system archetypes governing water resources systems, demonstrating their benefits for holistic understanding of various classes of persistent water resources problems. Using the eutrophication problem of Lake Allegan, Michigan, as a case study, we illustrate how the diagnostic tools of system dynamics modeling can facilitate identification of problematic feedbacks within water resources systems and provide insights for sustainable development.

Visualization of PEFC Flow Channels with Different GDL Properties

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Water management in polymer electrolyte fuel cells (PEFCs) is one of the critical issues threatening cell performance and its durability. Product water from electrochemical reaction can fill gas diffusion layer (GDL) pores as well as flow channels to hinder reactant transport to the catalyst layers. In this study, in situ visualization of liquid water behavior in PEFC is performed using laboratory-scale transparent cell. Using a high-speed camera, liquid water behavior in the cathode flow channels, such as emergence, deformation, detachment, and transport, is captured and analyzed as function of GDL wettability. Interaction between the fuel cell performance and the liquid water behavior will be studied as well. We expect that with hydrophilic GDL liquid water tends to spread out on the GDL surface. This phenomenon will decrease the water removal rate and results in rapid GDL flooding. As GDL becomes more hydrophobic, since liquid water forms droplet, the GDL surface area covered with water decreases, and at the same time the projected area of the droplet in the airflow increases. The force asserted on the droplet from airflow increases with the droplet projected area, and eventually exceeds the surface tension force keeping the droplet on the surface to blow it away. Thus the advantages of the hydrophobic GDL are two-folds. One is the lowered surface coverage, and the other is easy droplet removal. The droplet detachment diameter is carefully measured, and its impact on the cell performance is investigated for different GDL wettability. Furthermore, the effect of microporous layer (MPL) on liquid water formation and its interaction with cell performance are studied. Although the roles or working mechanisms of MPL are not clear yet, it is widely recognized that the addition of MPL improves the fuel cell performance. In this study whether the addition of MPL alters the liquid water behavior will be investigated.

Influence of Visual Conditions and Leg Dominance on Balance Performance on Unstable Surfaces

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Maintaining stability on unstable surfaces in a quiet stance depends on the integration of afferent information. It has been well documented how balance is affected by full and no vision; however the effect of vision impairment on dynamic balance is inconclusive. Leg dominance has been reported to have no effect on full vision and no vision conditions. However, the research on impaired vision and balance performance is limited and inconclusive. The purpose of the study was to investigate the influence of vision and leg dominance for balance performance on unstable surfaces. Twenty four females (Mean \pm SD; Age= 19.21 \pm 1.179; Weight= 72.138 \pm 13.45 kg; Height = 166.00 \pm 6.276 cm) who were considered healthy performed a static and dynamic balance task on and off a balance pad under three different vision conditions; full, none, and impaired vision, on the dominant and non-dominant leg. Dominant leg was assessed by using the recovery balance test, and sway velocity was the dependent variable for balance. A 3x2 Repeated Measures ANOVA was used to compare differences between the vision conditions and dominant leg on static and dynamic balances. Significance existed between full vision (d: 9.7 \pm 2.6m/s, nd: 9.0 \pm 1.6m/s) compared to no vision (d: 12.8 \pm 3.1m/s, nd: 12.5 \pm 2.5m/s) and impaired vision (d: 10.8 \pm 3.5m/s, nd: 13.4 \pm 4.5m/s , with $p < 0.001$) were found. Significant differences between no vision and impaired vision ($p = 0.925$) were not observed. The dominant leg showed significantly reduced sway velocities compared to the non-dominant leg ($p = 0.012$) for impaired vision in the dynamic stance, however there was no significance in the static stance ($p = 0.207$). In conclusion, leg dominance influenced balance performance for impaired vision. These findings imply that impaired vision might be related to higher risks of instability and fall related injuries then eyes open and closed conditions.

Tensile Modulus Modeling of Carbon Nanotube/Polycarbonate and Carbon Black/Polycarbonate Composites

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Conductive carbon fillers are often added to thermoplastic polymers to produce a composite that can be used for electrostatic dissipative and semiconductive applications. The carbon filled composite also has increased tensile modulus. In our research, we added 0.5 to 8 wt% carbon nanotubes (CNTs) or 2 to 10 wt% carbon black (CB) to polycarbonate (PC). These composites were extruded and injection molded into test specimens and the tensile modulus was measured using ASTM D638. The tensile modulus is the initial slope of the stress-strain curve. The Halpin-Tsai model has been used by previous researchers to model the tensile modulus of composites containing CNTs. The Nielsen and Halpin-Tsai models have both been used in the past to model tensile moduli of composites containing CB or CNT. In our work, several different tensile modulus models were used to compare with the experimental results. Our results showed that adding higher modulus filler, and larger amounts of it, increased the composite tensile modulus. For our work, the Nielsen model showed good agreement with the experimental results for the CB/PC composites and the 3D randomly oriented fiber Halpin-Tsai model fits the experimental results well for the CNT/PC composites.

Application of Ultra-High Performance Concrete (UHPC) as a Thin-Topped Overlay for Concrete Bridge Decks

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As transportation and bridge infrastructure across the globe approaches the end of its service life, new innovative materials and applications are needed to sustainably repair and prevent damage to these structures. A major contributor to the degradation of a bridge system is the deterioration of the concrete bridge deck, as it is directly exposed to de-icing salts and serves as protection for the underlying superstructure. Overlays are often applied to bridge decks to protect the superstructure from deterioration. However, the maintenance, repair, and replacement of these systems are perpetual drains of the financial resources of state and national transportation agencies. The feasibility of using Ultra-High Performance Concrete (UHPC) as a thin-bonded overlay on concrete bridge decks is investigated in this study. Design optimization of the bridge

deck overlay system was examined to minimize overlay thickness, dead load, and cure time without sacrificing bond integrity or loss of protective capabilities. This was done with a 3-D finite element model of a simply supported bridge under a notional truck, the HL-93 design truck common to the United States, in the worst case loading position. It was found that the state of stress at the bond interface was significantly less than the ultimate strength determined in previous research. A minimum overlay thickness of 0.25 inches on an uncracked concrete bridge deck was recommended to reduce the initial cost and dead load, while ensuring the integrity of the interfacial bond. From the findings of this research, it was noted that the constructability of a UHPC overlay would be the limiting factor in determining the required thickness, not the live load induced state of stress at the interface.

A Multilevel Approach to Assess Invasion Patterns of European Earthworms in Great Lakes National Wildlife Refuges

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The presence of exotic European earthworms in forested landscapes has been linked to potentially detrimental changes in biodiversity, community composition, forest floors and soils, and ecosystem processes, deterring restoration and preservation efforts. In the Upper Great Lakes region, many studies describe the impacts earthworms have on forest ecosystems at the stand level. However, whether or not earthworm invasion patterns respond to higher-level controls across a larger landscape is presently unknown. Furthermore, there is a lack of information regarding earthworm invasion within National Wildlife Refuges in this region. This research examines patterns of earthworm abundance and community composition at the landscape, stand, and plot levels to identify potential correlates and deduce specific drivers and constraints of earthworm invasion. It is hypothesized that earthworm communities will be influenced by the patterns of anthropogenic activity, landscape composition and fragmentation, stand characteristics, and soil properties both within and surrounding individual Refuges and forest stands.

Kinetic Analysis of Carbon Dioxide Absorption in an Alkaline Solution

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Fossil fuel combustion accounted for roughly 97% of the total carbon dioxide (CO₂) emissions in 2008. Capture of this CO₂ is critical to the future use of fossil fuels and the preservation of the environment. To meet the growing need for CO₂ capture, Michigan Technological University (MTU) has begun researching CO₂ capture using alkaline solutions. An experimental set-up has been developed to study the reaction kinetics of CO₂ absorption in alkaline solutions. In this experiment, a CO₂/air mixture is bubbled through a series of Erlenmeyer flasks filled with the alkaline solution. The gas exiting the series of flasks is fed to a gas analyzer that records the % CO₂ in the exhaust gas stream. The concentration of the alkaline solution was varied to determine the concentration that optimized CO₂ absorption. Additives which would regenerate the alkaline solution were also explored. Current research involves increasing the scale of the project, converting the process into a continuous process instead of batch, and finding a stable form for the carbon dioxide.

Reduction of Virus Infectivity in the Presence of Osmolytes

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Osmolytes are organic compounds that are able to stabilize proteins against environmental stress, such as extreme temperature or high osmotic pressure, affecting the water content of the cells. In the presence of changing solvent conditions, protecting osmolytes have the ability to fold the protein by structuring water around the protein surface, which stabilizes the protein. Denaturing osmolytes have the opposite effect of binding to the surface of the protein, causing the protein to unfold. We are interested in how the presence of osmolytes affects virus infection in cell culture. We have discovered that osmolytes reduce the infectivity of a model non-enveloped virus, porcine parvovirus (PPV). The PPV infection cycle starts with virus attachment to susceptible host cells, and then the virus penetrates the cells to uncoat its genetic material. The genetic material is replicated using host cell enzymes and co-factors. After the new genome of the virus is replicated, the virus assembles a protective protein coat enveloping the nucleic acids and is then released from the cell. Viral replication disrupts cellular processes and causes disease. The PPV replication cycle is disrupted by adding osmolytes during cell culture infection. By titrating

the virus with the MTT assay, we found that the 50% infectious dose (MTT_{50}/ml) was reduced from 8 \log_{10} to 4 \log_{10} in the presence of 1M glycine and 1M trimethylamine N-oxide. Protecting osmolytes are likely interacting with the PPV capsid, which being a non-enveloped virus, is composed only of proteins. This interaction could be contributing to reduced viral entry into the cells. We propose that the presence of protecting osmolytes can reduce virus infectivity of other non-enveloped viruses, such as the rhinovirus, known to cause the common cold in humans.

Determining how different Cutting maneuvers affect the forces applied on the ACL
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Different cutting maneuvers affect the knee, more specifically the Anterior Cruciate Ligament (ACL), very differently. It is known that ACL injuries account for a large percentage of sports-related injuries. An in-depth investigation of cutting maneuvers at various angles was performed to provide a clearer understanding for determining which movement strategies increase the risk of ACL injuries and how they influence the pressure distribution underneath the foot. Pressure distribution of the foot, center of pressure, ground reaction force, and knee angle during cutting maneuvers were all analyzed in this research. Twelve female athletes from Michigan Technological University were selected randomly from the volleyball, basketball, and soccer teams. They performed two sets of a series of cutting maneuvers at 45- and 60-degree angles, with a fatigue period in between the two sets. There were four sets of balance test, one before and one after each set of cutting maneuvers. Data was recorded by the *Vicon Motion Analysis System*, the *HR pressure mat*, and the force plate. The purpose of this study was to investigate how a shift of center of pressure (COP) during a dynamic movement (such as cutting maneuvers) would impact the knee joint kinematics in female athletes. It is hypothesized that a shift of COP to the medial side of the foot during a dynamic movement will increase the risk of ACL tears.

Analysis of a New Regularization Method in Ill-Conditioned Linear Systems

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Tikhonov regularization is commonly used when looking to de-blur an image from noise in the data. A new regularization method was investigated entitled the Multiplicative Regularization Method (MRM). The MRM looks at eliminating the regularization parameter in the Tikhonov method through fixed-point iteration. When the noisy data is close enough to the exact data and converges to the exact data as the regularization parameter goes to zero, there is a unique solution for the MRM. Our objectives were to show that the MRM has a unique solution for every (noisy) data vector b and that the regularization parameter λ can be found through fixed-point iteration. In addition we compared the MRM to the L-curve method to provide numerical comparisons through a series of test problems. As a conclusion we found that the MRM performed comparably to the L-curve method and often was a better solution to an ill-conditioned linear system.

Self-Powered Nanodevices: Nanogenerators Based On Gallium-Nitride Nanowires

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Thin films and nanowires are considered suitable building blocks for next-generation energy harvesting devices. A giant piezoelectric size effect has been identified for both GaN and ZnO nanowires by many researchers. However, GaN exhibits a larger and more extended size dependence than ZnO. We propose to use Gallium-Nitride based nanowires for efficient nanogenerators for nanoscale devices and nanosensors. The coupling of piezoelectric and semiconducting properties in GaN creates a strain field and charge separation across the nanowires (NW) as a result of its bending, and this charge separation can be used for powering nanoscale devices. Calculations for GaN based on models similar to ZnO nanowires for energy harvesting applications show a clear possibility for realization of smart self-powered nanostructures. Since giant size piezoelectric effect is been reported (by first principle investigations) for Gallium-Nitride nanowires, vertically aligned nanowires of GaN seems to be more promising candidate for next generation energy scavenging participant for nanotechnology.

A small scale device model is also made which can represent the possible structure of GaN nanowires based nanogenerator and results clearly show superiority over established ZnO nanowires for energy harvesting applications. A scalable method for fabricating high quality GaN nanowires for energy harvesting purpose is also discussed using conventional metalorganic chemical vapor deposition (MOCVD) and plasma enhanced evaporation and deposition on cheaper substrates. Clearly, GaN nanowires have the potential of converting mechanical, vibrational, and/or hydraulic energy into electricity for powering nanodevices.

pH Gradients in Insulator-Based Dielectrophoresis of Biomolecules

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Direct current (DC) insulator-based dielectrophoretic (iDEP) microdevices are becoming popular for many cellular and biomolecular separations. Because of the large DC fields used in iDEP, electrode reactions and ion transport mechanisms can become important and impact ion distributions in the nanoliters of fluid in iDEP microchannels. Natural pH gradient formation in a 100 μm wide, 1 cm-long microchannel under applicable iDEP protein manipulation conditions was monitored. Using fluorescence microscopy with the pH-sensitive dye FITC Isomer I and the pH-insensitive dye TRITC as a reference, pH was observed to drop drastically in the microchannels within 1 min in a 3000 V/cm electric field; pH drops were observed in the range of 6–10 min within a 100 V/cm electric field and varied based on the buffer conductivity. To address concerns of dye transport impacting intensity data, electrokinetic mobilities of FITC were carefully examined and found to be (i) toward the anode and (ii) 1 to 2 orders of magnitude smaller than H^+ transport, which is responsible for pH drops from the anode toward the cathode. The results indicate that pH changes are severe and rapid enough to influence the net charge of a protein or cause aggregation during iDEP experiments. The results also elucidate reasonable time periods over which the phosphate buffering capacity can counter increases in H^+ and OH^- for unperturbed iDEP manipulations.

LiDAR And MSS Studies Of Lake Superior Coastal Environments

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The Keweenaw Peninsula was one of the first great metal mining regions in North America. Between 1850-1929, the district was the second largest producer of copper in the world. Native copper in the Portage Lake Volcanic Series came from two principle kinds of ore: basalt lava flows (amygdule deposits) and inter-bedded sediments (conglomerates). Both were crushed with early gravity and later giant steam-driven stamps to release the native copper and silver. Over 140 mines worked the central deposits and over 40 mills processed stamp rock . During this period, the Mohawk and Wolverine Mills sluiced a combined 22.7 million metric tons (Mt) of stamp sands onto one large cone-shaped pile at Gay. Wave action along the outer edge erodes the pile's beach back, yet the high specific gravity and angular nature of particles helps maintain a near-vertical face along the eroding cliff. Strong prevailing currents transported stamp sand particles southwestward, covering natural Jacobsville Sandstone outcrops and white beach sands. We used the Compact Hydrographic Airborne Rapid Total Survey (CHARTS) system, that collects LiDAR (Light Detection and Ranging) and multi-spectral scanner CASI (Compact Airborne Spectrographic Imagery), to survey spatial substrate types near Gay, in the Grand Traverse Bay portion of the Keweenaw Peninsula. High resolution LiDAR scans allowed construction of detailed bottom maps. Using a combination of historic oblique photos, aerial photography and LiDAR , we estimated the time course and amount of tailings that have eroded into Grand Traverse Bay from the Gay pile. Spectral reflectance differences between tailings and natural sediment types allowed us to construct an underwater substrate map from MSS (multi-spectral scanner) images and to document dispersal of tailings across the bay.

Dielectrophoretic Response of Polystyrene Particles and Perfluorocarbon oil-core, Chitosan/Poly-L-lysine shell Nanoparticles

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Dielectrophoresis (DEP) microdevices utilize non-uniform electric fields and are able to assemble, discriminate, and manipulate particles based on a particle's polarizability and interactions with the surrounding medium. Core-shell nanoparticles (CSnp) can be custom synthesized with various liquid core and solid shell materials; applications include drug delivery, nanoreactors, and diagnostic markers. In this research, these CSnps facilitate systematic investigation of nanoscale DEP polarization mechanisms through independent variation of shell and core sizes. Core material is perfluorocarbon oil within a phospholipid micelle which then templates for three shell materials (chitosan, Poly-L-lysine, and CaPO₄) which were chosen for their known synthesis procedures. We report the frequency-dependent, and medium conductivity-dependent responses of ~250 nm CSnps with 200 nm core and 25 nm shell. Experiments were conducted within a 100 nl chamber housing 100 um wide Au quadrupole electrodes spaced 25 um apart. Frequencies from 100kHz to 80MHz at a fixed local field of 10V_{pp} were tested and the frequency-dependent DEP responses of the nanoparticles were quantified by tracking two dimensional pearl-chain assembly via video microscopy image intensity profiles. Average velocity of particles moving up the electric field gradient (positive DEP) and down the electric field gradient (negative DEP) were quantified and compared with spherical core-shell models for the Clausius-Mossotti factor in order to back calculate core and shell dielectric properties such as permittivity and conductivity. Velocities were compiled as a function of frequency and medium conductivity. The DEP experiments also reveal two-dimensional nanoparticle patterning into pearl-chains chain translation into spectrophotometric bands, which were subsequently spectrally probed for coherent light scattering. The structural color generated from the packed nanoparticles could be a new method to sense DEP behaviors.

Computational Prediction of the Behavior of MOF-74 Under Hydrated Conditions

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The organized lattice structure of metal-organic framework MOF-74 remains stable under room temperature and moderate moisture levels, making it a promising candidate material for gas capture and storage. Periodic density functional theory calculations were used to characterize MOF-74-M (M= Mg, Zn) in the bulk phase with respect to coordinating aqua ligands. We are able to predict distortions arising in hydrated environments, along with the enthalpy of adsorption for H₂O and some properties of vibrational spectra. The functional we use includes an empirical correction for London dispersion forces and results indicate that the binding energy has substantial contributions from long-range interactions between the framework and guest molecules. Other small molecule adsorptions on MOF-74 have been previously investigated via computational methods, however there remains a general lack of published data for cases with water and other common solvents. Such information is critical to an understanding of the activation conditions and adsorption selectivity toward various chemical species. Our work demonstrates a computational approach which is both efficient and accurate in describing these characteristics, giving results that are in excellent agreement with experiment. This technique has proved to be a useful tool for adsorption studies and may be applied to other interesting framework materials.

Self-Powered Piezoelectric Nanostructures

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Wireless nanodevices and nanosystems are important through their applications in biomedical sensing, environmental monitoring, and even personal electronics. Power source requirement and miniaturization of their power package are the key challenges of wireless nanodevices. Ideally, these devices could be self-powered or harvest energy from environment based on piezoelectric property. The energy sources could be mechanical movement (such as body movement, muscle stretching, blood pressure), vibration (such as acoustic/ultrasonic wave), and hydraulic (such as flow of body fluid, blood flow, contraction of blood vessels). The coexistence of semiconducting and piezoelectric properties in ZnO, GaN and CdS make them the perfect choice for converting nanoscale mechanical energy into electrical energy for nanosensors and powering nanodevices and nanosystems.

The deflecting semiconducting piezoelectric nanowires cause electric potential through the nanowires. There are some difficulties to harvest the electric potential, which results from the deflecting of nanowires, but this potential is significant. For instance, simulation results were shown that ZnO nanowires are able to generate electrical potential of ± 0.4 V which is a high signal. The aim of my SURF project was to conduct direct experimental tests to measure the potential generated in a single ZnO nanowire subjected to various loading conditions. Experiments were performed inside the chamber of a transmission electron microscope (TEM) using in situ scanning tunneling microscopy (STM) holder.

Schedule of Events

Day One [February 2, 2012]

Day Two [February 3, 2012]