2018 Graduate Research Colloquium

Contents

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Tuesday, February 27, 2018

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1:00 PM	Oral and Poster Sessions	MUB Ballroom

Wednesday, February 28, 2018

Time	Event	Location
9:00 AM	Oral Sessions	MUB Ballroom
12:00 PM	Lunch	
1:00 PM	Oral Sessions	MUB Ballroom
6:00 PM	GRC Banquet	MUB Ballroom

Poster Session Presentations

Tuesday February 27th, 2018

MUB Ballroom A1, 9:00 AM – 12:00 PM

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Poster Session Presentations

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Oral Presentation Session Schedule

Measurement Techniques and Analysis Methods

Tuesday February 27th, 2018, 9:00 AM – 10:00 AM, MUB Ballroom A2

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9:00 AM	**Shining new light into an old imaging technique**	**Anindya Majumdar**
9:20 AM	**Behavioral-based Vehicular Control in a Semi-Autonomous World**	**Mojtaba Bahramgiri**
9:40 AM	**Dropwise Condensation Visualization Using Automated SPR Microscopy System**	**Shahab Bayani**

Oral Presentation Session Schedule

Power and Energy

Tuesday February 27th, 2018, 10:00 AM – 11:00 AM, MUB Ballroom B1

Presentation Time	Title	Name
10:00 AM	**Experimental Study of Flame Stretch in DI-SI Engine**	**Behdad Afkhami**
10:20 AM	**Numerical investigation of oil droplet combustion using single cell ignition model**	**Ankith Ullal**
10:40 AM	**Experimental Investigation of Water Injection Technique In Gasoline Direct Injection Engine**	**Niranjan Miganakallu**

Tuesday February 27th, 2018, 1:00 PM – 2:00 PM, MUB Ballroom B3

Presentation Time	Title	Name
1:00 PM	**A Bayesian Framework for EV Battery Capacity Fade Modeling**	**Mehdi jafari**
1:20 PM	**A Novel Low Latency, High Resolution and Low Cost Time Synchronization**	**Ali Aghdaei**
1:40 PM	**The modeling of Geomagnetic Induced Current and study of System Impact Assessment**	**Hemanth Kumar V**

Tuesday February 27th, 2018, 2:00 PM – 2:40 PM, MUB Ballroom B1

Presentation Time	Title	Name
2:00 PM	**Aeroelastic Behavior of Variable Speed Wind Turbine**	**Sarah Jalal**
2:20 PM	**Building Envelope based Triboelectric Wind Energy Harvesting System for Smart City Applications**	**Si Liu**

Wednesday February 28th, 2018, 1:20 PM – 2:00 PM, MUB Ballroom B1

Presentation Time	Title	Name
1:20 PM	**Modeling Li-ion Batteries for Electric Vehicles**	**Anurag kamal**
1:40 PM	**An Ideal Electrode Material, 3D Surface-Microporous Graphene for Supercapacitors with Ultrahigh Areal Capacitance**	**Liang Chang**

Oral Presentation Session Schedule

Computational, Mathematical, and Physical Sciences

Tuesday February 27th, 2018, 11:00 AM – 12:00 PM, MUB Ballroom A2

Presentation Time	Title	Name
11:00 AM	**Message Coverage Maximization in Vehicular Networks**	**Ali Jalooli**
11:20 AM	**Improved Caching for Web Services**	**Daniel Byrne**
11:40 AM	**Multiscale Modeling of PEEK using Reactive Molecular Dynamics Modeling and Micromechanics**	**Will Pisani**

Tuesday February 27th, 2018, 3:00 PM – 4:00 PM, MUB Ballroom A2

Presentation Time	Title	Name
3:00 PM	**Computational Fluids Dynamics: Torque Converter**	**Edward De Jesus Rivera**
3:20 PM	**Energy efficient mission planning for multiple AUVs under complex current**	**Bingxi Li**
3:40 PM	**Enabling Continuous Undersea Operation with an Adaptable Docking System**	**Brian Page**

Wednesday February 28th, 2018, 10:00 AM – 11:00 AM, MUB Ballroom B2

Presentation Time	Title	Name
10:00 AM	**An Information-Theoretic Approach to Partitioning Simultaneous Transmit and Receive Digital Phased Arrays**	**Ian Cummings**
10:20 AM	**Probing Galactic Cosmic Ray Origin with High Energy Gamma-Ray Emission**	**Binita Hona**
10:40 AM	**The Radial Basis Functions Method applied to groundwater flow : The Drawdown Problem.**	**Nadun Dissanayake**

Oral Presentation Session Schedule

Environmental Studies and Sustainability

Tuesday February 27th, 2018, 1:00 PM – 1:40 PM, MUB Ballroom B2

Presentation Time	Title	Name
1:00 PM	**Pathogen & Indicator Organism Reductions & Biosolids Changes During Storage**	**Tanner Keyzers**
1:20 PM	**Low-Cost Low-Tech Pilot Scale Results for Class A Biosolids Treatment at Portage Lake Water and Sewer Authority**	**Karina Eyre**
1:40 PM	**Detailed molecular analysis of ambient biomass burning influenced aerosol and fog water from the Po Valley**	**Matthew Brege**

Wednesday February 28th, 2018, 9:00 AM – 10:00 AM, MUB Ballroom A1

Presentation Time	Title	Name
9:00 AM	**Bonding Properties of Cross-Laminated Timber Made from Mixed Species**	**Munkaila Musah**
9:20 AM	**Environmental conditions mediate a rapid shift in plant communities following timber harvest**	**Stefan Hupperts**
9:40 AM	**Application of an open-source remote sensing software to monitoring weather and pest related forest disturbances, Elm River Township MI**	**Elizabeth Montgomery**

Wednesday February 28th, 2018, 1:00 PM – 2:00 PM, MUB Ballroom A2

Presentation Time	Title	Name
1:00 PM	**Collaborative Governance and Wisconsin's Biomass Harvesting Guidelines**	**Jennifer Dunn**
1:20 PM	**Co-production as policy tool for household waste sorting in Shanghai**	**Hongmei Lu**
1:40 PM	**The Third Shift? Gender Roles and Empowerment in a Women's Ecotourism Cooperative**	**Mayra Sanchez Morgan**

Wednesday February 28th, 2018, 2:00 PM – 2:40 PM, MUB Ballroom B2

Presentation Time	Title	Name
2:00 PM	**Multisite calibration approach of the SWAT model in a complex cloud forest dominated watershed in Veracruz, Mexico**	**Sergio Miguel Lopez Ramirez**
2:20 PM	**Aggregation of atmospheric tar ball particles from fires: effects on the atmosphere**	**Janarjan Bhandari**

Oral Presentation Session Schedule

Advances in Modern Medicine & Health

Wednesday February 28th, 2018, 10:00 AM – 11:00 AM, MUB Ballroom A2

Presentation Time	Title	Name
10:00 AM	**Prevascularized Human Mesenchymal Stem Cell Sheet for Diverse Tissue Engineering**	**Wenkai Jia**
10:20 AM	**Virus Purification in Aqueous Two-Phase Systems**	**Pratik Joshi**
10:40 AM	**Controlling the Nano-surface Finish of Medical Implants**	**Derryl Poynor**

Oral Presentation Session Schedule

Novel Materials and Transport Phenomena

Wednesday February 28th, 2018, 2:00 PM – 2:40 PM, MUB Ballroom B3

Presentation Time	Title	Name
2:00 PM	**Assessment of nanoparticles dispersion in asphalt during bubble escaping and bursting: Nano hydrated lime modified foamed asphalt**	**Lingyun You**
2:20 PM	**Visualization of Evaporation/Condensation in Cryogenic Propellants**	**Kishan Bellur**

Oral Presentation Session Schedule

Biological Sciences

Wednesday February 28th, 2018, 3:00 PM – 4:00 PM, MUB Ballroom A1

Presentation Time	Title	Name
3:00 PM	**A Novel Plant Derived Lysin: A Potential Multi-Functional Tool for Biomedical Research**	**Jared Edwards**
3:20 PM	**The cancer-specific protein galectin-3 remains active even after substantial degradation by autolysis: Implications in biological functions**	**Priyanka Kadav**
3:40 PM	**Examining Aspen Expansion in a Native Fescue Grassland Through Geo-spatial Techniques.**	**Chris Anderson**

Poster Abstracts

9:00 AM – 10:00 AM Session

A Novel Levodopa-PAK-Tempo Conjugate (LPTC) Protects the Heart against Ischemia/Reperfusion Injury via Inhibiting Mitochondrial Fission and Oxidative Stress
(Poster #1)

Shanshan Hou, Xin Yan, Lanrong Bi*

Recently, we discovered a novel levodopa-PAK-Tempo conjugate (LPTC-5) that possess both free radical scavenging properties and mitochondrial-fusion promoting activity. The free radical scavenging activity of LPTC-5 was confirmed in a PC12 cell survival assay. In addition, we found that LPTC-5 could restore the mitochondrial tubular network in response to genetically induced fragmentation. The therapeutic potential of LPTC-5 was examined in both *in vitro* and *in vivo* experimental ischemia/reperfusion (I/R) models. We demonstrated that LPTC-5 could protect cells from ROS overproduction and inhibit cytochrome c release in a simulated I/R cellular model. Furthermore, we have demonstrated that LPTC-5 could attenuate organ damage induced in a cardiac I/R animal model. Our findings suggest that the protective effect of LPTC-5 resides in maintenance of optimal mitochondrial function by inhibiting mitochondrial oxidative stress and fragmentation.

A cyanine-based fluorescent cassette with aggregation-induced emission for sensitive detection of pH changes in live cells
(Poster #2)

Mingxi Fang, Haiying Liu

An aggregation-induced emission (AIE) cyanine-based fluorescent cassette with a large pseudo-Stokes shift was designed and prepared to sensitively image pH changes in live cells via through-bond energy transfer (TBET) from a etraphenylethene (TPE) donor to a cyanine acceptor.

The regulation of the yellow gene in the evolution of a complex abdominal color pattern in Drosophila guttifera
(Poster #3)

Kamal Raja, Peter Nouhan, Evan Bachman, Alexander McQueeney, Elizabeth Mundell, Alexandri Armentrout, Amber Peabody, Mujeeb Shittu, Thomas Werner

Changes in the expression of developmental genes play an important role in morphological evolution. However, the genetic and molecular mechanisms that generate complex morphological traits during animal development remain largely unknown. Here we sought to identify the molecular mechanisms underlying the formation of the complex abdominal color pattern of Drosophila guttifera. The abdominal color pattern of this species consists of four distinct sub-patterns: one pair of dorsal, median, and lateral rows of black spots, plus a dark dorsal midline shade on a brownish background. The pigmentation gene yellow is necessary for the formation of black pigment in insects. Using in situ hybridization and immunohistochemistry, we show that yellow mRNA and Yellow protein are expressed in patterns very closely resembling the adult color pattern. Using a transgenic fluorescent reporter assay, we identified one cis-regulatory element (CRE), which drives gene expression comprising all six rows of spots in the epidermis of the developing abdomen. Further sub-divisions of this CRE and subsequent transgenic reporter analyses revealed the core CRE to be a stripe-inducing element, when a cluster of putative repressor (Engrailed-binding) sites was excluded from the CRE. We compared the activity of the D. guttifera CRE to the orthologous sequence from Drosophila deflecta, a species that shows a similar spotted abdominal color pattern. We found that the core CREs of both species drive abdominal stripe expression patterns in the transgenic D. guttifera background, thus suggesting that spot patterns on fruit fly abdomens may have evolved from an ancestral stripe pattern through partial repression of portions of the stripes. Adult abdominal pigment patterns of closely related species confirm this mechanism by displaying color pattern variations from stripes to spots with all intermediate stages. This project was funded by NIH grant 1R1SGM107801-01A1.

Nicotine Attenuates Acetate-Induced Increase of Cytosolic Reactive Oxygen Species in Dopaminergic-Like PC12 Cells (Poster #4)

Jessica E. Behnke, Andrew D. Chapp, Zhiying Shan, Qinghui Chen

We have previously reported that the major ethanol metabolite, acetate (6 mM), significantly ($p<0.05$) increases levels of cytosolic calcium in NGF-derived PC12 cells measured in real time with Fluo-4AM. This acetate-induced increase in intracellular calcium was eradicated with application of the NMDA-R pore blocker, memantine (10 µM), and memantine alone had no effect on the baseline levels of cytosolic calcium. Rises in intracellular calcium through glutamatergic channels binds with calmodulin to trigger a cascade leading to the formation of nitric oxide (NO), which can contribute to cell death. We hypothesized that treatment of PC12 cells with acetate (6 mM) would elicit an increase in the levels of cytosolic ROS. Furthermore, it has been shown that nicotine induces protection against glutamate cytotoxicity, although the mechanism is still not fully understood. NGF derived PC12 cells exposed to (6 mM) acetate had a significant ($p<0.05$) increase in ROS relative to control, measured using flow cytometry with an oxidative stress detection probe (CellROX orange, Thermofisher). Co-application of acetate (6 mM) and nicotine (10µM) was able to significantly attenuate the acetate-induced increase in cytosolic ROS back to baseline levels. This data suggests that nicotine's neuroprotective effect on glutamate cytotoxicity may be due, at least partially, to nicotine's ability to reduce the amount of NO formed intracellularly.

Advanced Woody Biomass Logistics for Co-firing in existing Coal Power Plant: Case Study of the Great Lakes States
(Poster #5)

Sangpil Ko, Pasi T. Lautala

One of the core decisions on securing the supply of biomass to co-firing power plants is the design of a proper logistics system. While technologies have been developed to improve the characteristics of feedstock, their effects in the logistics systems have received less attention. This paper compares the conventional woody biomass logistics system with the advanced woody biomass logistics system which includes the torrefaction process to upgrade the feedstock. More specifically, this study uses a mixed integer linear program to integrate conventional and advanced biomass logistics and applies them to a case study of 26 coal power plants in the Great Lakes States to determine the most feasible logistics system for each plant. The results revealed that the amount of cost savings from the advanced woody biomass logistics depends on the capacity and location of the power plant. To categorize the cost savings of individual plants, it was found that plants can be divided to seven groups based on three parameters: 1) annual coal tonnage shipped (total capacity), 2) availability of biomass in the vicinity, and 3) average distance from biomass collecting sites. Overall savings from advanced logistics were small, but cost reductions for plants within each of the seven groups demonstrated similar cost reductions. The sensitivity analysis showed that trucking costs and feedstock purchasing costs were most sensitive to variation. For torrefaction effects, energy content after torrefaction had more significance than mass reduction.

Investigative Study on Nitric Oxide Production in Human Dermal Fibroblast Cells
(Poster #6)

Maria P. Kwesiga, Jennifer Hannon, Emily Cook, Smitha Rao, Caroline Gwaltney, Megan C. Frost

Every year, a diabetic foot ulcer develops in 9.1 to 26 million people with diabetes worldwide. One of the major complications of these ulcers is lower extremity amputations due to the inability of these wounds to heal. The mortality rate after an amputation in a diabetic patient is 70% following a 5 year period. Not to mention the high costs of care that exceeds $172 billion annually in the United States alone. Nitric oxide is a signaling molecule produced in the body and a key player in all the stages of wound healing. The levels and duration of nitric oxide produced vary depending on the conditions and the cells present at the wound site. The production of NO in macrophage cells and its role as an immune modulator has been well documented. However, little is known about the production of nitric oxide in fibroblast cells, which lay down the extracellular matrix that facilitates the migration of keratinocyte cells to close the wound. This is a problem that is frequently encountered in diabetic patients. Our goal is to analyze the levels of nitric oxide produced by fibroblasts in real time under normal and high glucose conditions. The baseline levels of NO produced from these cells in both the physiological and pathological state will lead to the development of wound dressings with tunable nitric oxide releasing properties that simulate the appropriate in vivo production of NO during the different stages of wound healing. Consequently, allowing diabetic foot ulcers to heal in an orderly and timely manner.

Colorimetric virus detection using gold nanoparticle aggregation (Poster #7)

Xue Mi, Ellie M. Lucier, Eugenia Li Ling Yeo, James Chen Yong Kah, Caryn L. Heldt1*

According to the Centers for Diseases Control (CDC), about 19 million people contract gastroenteritis caused by norovirus every year. A common way to be exposed is through touching surfaces and objects that are contaminated. But how do you know that an object is contaminated? Traditional virus detection methods require the specific detection of either viral capsid proteins by antibodies or viral nucleic acids by complementary oligonucleotides. The antibodies and oligonucleotides are expensive, have limited chemical stability, and can only detect one specific type of virus at a time. This project uses the biochemical surface properties of viruses for nonspecific virus detection, which could become an early screening step for viral cleanliness of a surface. It has been found that the osmolytes glycine and mannitol can preferentially flocculate a model virus porcine parvovirus (PPV), as compared to a model protein bovine serum albumin (BSA). This project will apply that knowledge to induce the aggregation of virus attached to gold nanoparticles (AuNPs) and detect the aggregation by measuring the surface plasmon resonance red-shift and aggregation index (AI) of aggregated AuNPs. The AI and size distinctions between PPV and BSA coated AuNPs with 1 M glycine and 1 M mannitol at various ionic strengths have demonstrated that this method is promising for virus detection. The lowest concentration of PPV that can be detected is 5 log10 (MTT50/mL), which is lower than standard antibody assays.

Energy-Efficient ECG Compression in Wearable Body Sensor Network by Leveraging Empirical Mode Decomposition (Poster #8)

Hui Huang, Shiyan Hu, Ye Sun

Wearable body sensor network (BSN) is widely used in daily monitoring, well-being management, and rehabilitation. Energy efficiency imposes a stringent constraint in wearable BSN, in which wireless transmission is significantly power-demanding. Compressed sensing (CS) provides a good solution to reduce power consumption for data transmission due to the sparsity of signals which can use limited transmitted data to reconstruct original signals. In this study, we develop a new method for non-sparse ECG signal compression by leveraging empirical mode decomposition (EMD) and online dictionary for wearable devices. Comparing to the state-of-the-art of ECG compression which can achieve the compression ratio (CR) of around 25 with the root mean square error (RMSE) around 5%, our method can achieve the CR up to 60 with the same level of RMSE for wearable ECG. In addition, our method also has low computational complexity, which can achieve lower compression energy. The validation experiments are conducted on both clinical data and wearable ECG detected by our BSN in noisy environment. The proposed method shows high feasibility for real CS on board to achieve ultra-low power consumption.

Community scale solar electricity for rural communities: Designing for resilience, access, and identity
(Poster #9)

Emily Prehoda, Richelle Winkler, Chelsea Schelly

Community Solar is a relatively new model for a solar electricity system where generation is centralized in one community-based location while costs and benefits are distributed across voluntary owners who choose to buy shares (and receive credits) in the community-owned system. Community Solar is gaining increasing attention across the United States because of its potential to increase access to renewable energy and to democratize energy governance. It may be particularly significant for rural communities, as they face the combined challenges of economic vulnerability and limited resiliency, but most current Community Solar projects are located in larger urban areas and in relatively wealthy communities. This paper utilizes a mixed methods approach to explore opportunities and challenges associated with Community Solar adoption in two economically disadvantaged rural communities in Michigan's Upper Peninsula. Our research team collaborated with community organizations to explore potential design scenarios that would ensure technical and financial feasibility while also increasing access for low to moderate income households and build community identity. These cases highlight some of the challenges that emerge during efforts to promote renewable energy transitions. They also provide a set of strategies for integrating community members into decision-making so that programs can adequately reflect specific community needs, take advantage of existing social capital, and correspond to community values. Building creative community partnerships and integrating community participation increase a community's ability to surmount challenges to solar PV technology adoption. Ultimately, the project goal is to utilize the results of this comparative case study to build a replicable model for community solar technology projects to improve rural communities' resilience and more equitable access to less carbon intensive energy sources while also articulating and bolstering rural community identity.

Poster Abstracts

1:00 PM – 4:00 PM Session

Addressing the Nucleation Mechanism of Paracetamol-Oxalic Acid Cocrystal through a Quantum Mechanical Description of the Chemical Reactivity of its Molecular Components

(Poster #1)

Gemechis D. Degaga, Dr. Kapil Adhikari, Dr. Loredana Valenzano*

The active pharmaceutical ingredient (API) paracetamol (PCA), also known as acetaminophen, is the most commonly used analgesic and antipyretic. The two most stable crystalline PCA polymorphs are identified as the monoclinic form I and the orthorhombic form II. Commercially available PCA tablets consist of the most thermodynamic stable monoclinic form bind to large amounts of polymeric binders which, although, inhibit solubility and dissolution rate upon the administration of the drug. The insertion of other inactive molecules able to bind to the API and enhance not only its beneficial properties but also its shelf-life stability, allows for the making of API cocrystals, a crystalline engineering concept widely used by pharmaceutical industries in the last few decades. Our work aims at addressing the physical-chemical properties of small molecular clusters of the API cocrystal formed by PCA and oxalic acid (OXA) with the main goal of describing the most likely molecular nucleation pathway that culminates in the formation of a planar and stable monolayer of crystalline PCA-OXA. As such, intermolecular interactions ruled by long-range dispersion forces and, most predominantly, by the hydrogen bond net characterizing the 1:4 PCA-OXA molecular ratio, are described at electronic structure level for different molecular clusters forming the PCA-OXA cocrystal. In this work, the chemical reactivity and the nucleation mechanism of PCA-OXA are addressed at electronic structure level as described by physical-chemical properties such as electrostatic potential maps, HOMO-LUMO energy gaps, and Fukui indexes which allow for the determination of global and local reactivity descriptors. In addition, the influence of solvation effects provided by an aqueous environment will also be described.

Effect of Processing on Nix-Gao Bilinear Indentation Results Obtained for High Purity Iron

(Poster #2)

Prasad Pramod Soman, Erik Gregory Herbert, Katerina E Aifantis, Stephen A Hackney

Instrumented indentation of a high purity Fe surface with unresolved surface deformation due to mechanical polishing is compared to the same grain surface annealed at increasing time and temperature. The differences in indentation size effect behavior with annealing are correlated with hardness and electron back-scatter diffraction measurements as independent measures of surface layer deformation. It is found that the Nix-Gao plot evolves from non-linear (bi-linear) towards the predicted linear relationship as the surface deformation is removed. The experimental observations are rationalized by inclusion of a depth dependent, polishing induced forest dislocation density within the Nix-Gao model.

Molecular Modeling of epoxy polymers
(Poster #3)

Prathamesh P. Deshpande, Gregory M. Odegard

Epoxy polymers have been prominently used in carbon fiber composites. These composites are widely used as a major structural material for developing parts of aircrafts and automobiles. They are increasingly replacing metals due to the properties like the resultant lightweight products, stiffness and strength. The epoxy system under study consists of a resin, bisphenol F diglycidyl ether or EPON 862, and a hardner, diethyltoluenediamine or DETDA. Using molecular dynamics, the mechanical properties of the pure epoxy system are studied and further consideration is made for use in carbon fiber composites.

Multi-robot platform design for use in long duration outdoor area coverage missions
(Poster #4)

Sharvil Patankar

The battery life of aerial robots is inadequate for the long mission time of outdoor area coverage missions that are used for surveying and mapping of large areas. Using mobile and static ground chargers can increase the total mission flight time and allow persistent coverage of the mission area. This requires energy efficient multi-robot trajectory planning which can be done using genetic algorithms. The trajectories need to be implemented on a hardware platform that takes in account considerations like perception, localization, communication, path planning, actuation, debugging and error handling. This poster shows the development of a hardware platform to implement and test the trajectories generated from the developed genetic algorithms in outdoor environments. Multicopters were used as the hardware platform, the flight controller was used for low level actuation and sensing, and an onboard single board computer was used for the high level path planning, communication and localization. Tests of LiDAR and camera sensor showed promise for precise landing on the charging stations. The demonstration of global positioning system (GPS) and inertial measurement system (IMU) to fly multi-robot missions both in and out of simulations showed the capability of the planned trajectories.

Fourier Space Spectroscopy For Plasmonic Dispersion Maps
(Poster #5)

Aeshah Muqri, Dr. Jae Yong Suh

Imaging and light detection techniques and devices are experiencing rapid improvements and are widely utilized in most scientific and college labs. Microscopes specifically, can be equipped to do a variety of experiments ranging from surface mapping and photon analysis to milling for pattern generation and device production. Recently we constructed a versatile Fourier space scope at Dr.Suh’s lab. I will be presenting the design, in-house construction, and obtained results of an analysis microscope that relies on extracting the Fourier space image of microscale lattices from a microscope objective. This is very useful tool for scanning of momentum-energy dispersion maps without the need for physical rotation as is conventionally used.

Adsorption removal of micropollutants using Nanoparticles (Poster #6)

Mohammad Alizadeh Fard, Brian Barkdoll

Residue from pharmaceuticals and personal care products (PPCPs), can be found in water bodies like groundwaters, great lakes and surface waters. A large amount of these substances end up in our waters because they are not bio-degradable. In this study, a cheap and reliable hydrothermal method was applied to synthesize polyvinylpyrrolidone coated magnetite nanoparticles to separate a wide range of micropollutants (Galaxolide, Tonalide, Triclosan, Triclocarban, Bisphenol-A, BP3, Carbamazepine and Diclofenac) from aqueous solutions. Based on gas chromatography−mass spectrometry data, these nanoparticles could be utilized to remove micropollutants over a short time with a high removal efficiency under environmentally friendly conditions. In addition, regeneration of the adsorbent performed with methanol and UV/H2O2 and results showed that the adsorbent was recovered effectively. Repeating the experiments with the regenerated polymer showed high removal efficiency. It is therefore concluded that using the coated polymer on magnetite nanoparticles is a sustainable and reliable method to remove micropollutants from water.

Evaluating the behavior of polychlorinated biphenyl compounds in Lake Superior using a dynamic multimedia model (Poster #7)

Tanvir Khan, Judith Perlinger, Noel Urban

Certain toxic, persistent, bioaccumulative, and semivolatile compounds known as atmosphere-surface exchangeable pollutants or ASEPs are emitted into the environment by primary sources, are transported, deposited to water surfaces, and can be later re-emitted causing the water to act as a secondary source. Polychlorinated biphenyl (PCB) compounds, a class of ASEPs, are of major concern in the Laurentian Great Lakes because of their historical use primarily as additives to oils and industrial fluids, and discharge from industrial sources. Following the ban on production in the U.S. in 1979, atmospheric concentrations of PCBs in the Lake Superior region decreased rapidly. Subsequently, PCB concentrations in the lake surface water also reached near equilibrium as the atmospheric levels of PCBs declined. However, previous studies on long-term PCB levels and trends in lake trout and walleye suggested that the initial rate of decline of PCB concentrations in fish has leveled off in Lake Superior. In this study, a dynamic multimedia flux model was developed with the objective to investigate the observed levelling off of PCB concentrations in Lake Superior fish. The model structure consists of two water layers (the epilimnion and the hypolimnion), and the surface mixed sediment layer, while atmospheric deposition is the primary external pathway of PCB inputs to the lake. The model was applied for different PCB congeners having a range of hydrophobicity and volatility. Using this model, we compare the long-term trends in predicted PCB concentrations in different environmental media with relevant available measurements for Lake Superior. Combining the weak role of sediment resuspension in elevating PCB levels in water and absence of significant temporal trends in fish PCB concentrations in the past 20 years; we propose that future research explore the role of food web dynamics in the levelling off of PCB concentrations in Lake Superior fish.

Hydrologic Impacts of Developing Forest-based Bioenergy Feedstocks in Wisconsin, USA and Entre Rios, Argentina
(Poster #8)

Azad Heidari, Alex Mayer, David Watkins

Growing demand for biomass-derived fuels has resulted in an increase in bioenergy projects across the Americas in recent years, a trend that is expected to continue. However, the expansion of bioenergy feedstock production might cause unintended environmental consequences. Accordingly, the goal of this research is to investigate how forest-based bioenergy development across the Americas may affect hydrological systems on a watershed scale. This study focuses on biofuel feedstock production with hybrid poplar cultivation in a snow-dominated watershed in northern Wisconsin, USA, and eucalyptus cultivation in a warm and temperate watershed in Entre Rios, Argentina. The Soil and Water Assessment Tool (SWAT), calibrated and validated for the two watersheds, is used to evaluate the effects of land use change corresponding to a range of biofuel development scenarios. The land use change scenarios include rules for limiting the location of the biofuel feedstock, and rotation time. These variables in turn impact the magnitude and timing of runoff and evapotranspiration. In Wisconsin, long term daily streamflow simulations indicate that planting poplar will increase evapotranspiration and decrease water yield, primarily through reduced baseflow contributions to streamflow. Results are also presented in terms of changes in flow relative to biomass production, to understand the sensitivity of potential biofuel generation to hydrologic impacts, and vice versa. In the end, alternative management practices were evaluated to mitigate the impacts.

Hydrological Modeling of Middle Rio Grande Basin to optimize water management
(Poster #9)

Marjan Monfarednasab, Alex Mayer

Middle Rio Grande Basin located along New Mexico, Texas, and north part of Mexico was the primary water resource for agriculture in these regions. However, due to drought and high water demand it cannot any longer satisfy the water needs in the regions. The goal of this work is to model the Rio Grande basin to optimize the dwindling water supplies. Finite difference method (FDM) is implemented to develop coupled Rio Grande river and aquifer’s model. This model is calibrated by using field data from gauges along the river and observation wells in alluvial aquifer though 1994-2013. In our future work, data from diver diversions and local municipal water system will be included in the model to predict Rio Grande basin behavior in the upcoming years. The final model can be implemented to improve the irrigation efficiency and Channel Lining, manage environmental flows and pumping along the basin.

Edge line Strength Test of Glass Beams
(Poster #10)

Nabhajit Goswami, Stephen M Morse*

Glass is extensively used in construction despite the lack of methodologies to determine the load resistance of glass for a wide range of possible loading and support conditions. Glass fails due to the presence of flaws that act as stress

concentrators when the glass is in tension. The limitations associated with the current standard for determining load resistance of glass that only addresses flaws on the surface, led to this study. The load resistance of a glass lite is determined by a glass failure prediction model that addresses all known factors that affect glass strength, along with the flaws in the surface while the surface is in tension. However, flaws are not limited to surfaces. Edge lines and edge surfaces have flaws too. The proposed glass failure prediction model for edge line considers the effect of flaws in the edge lines, thereby calculating flaw parameters for the edges separately. Edge flaws are affected by factors such as tools used for cutting, edge treatments such as chamfering, polishing among others. This test incorporates the concept of unsymmetrical bending of a rectangular beam. The beam is tested using four-point bending test that places a single edge-line of the specimen in tension while the other edge-line is on the neutral axis and thus unstressed. It was found that the non-tool edge line compared to the steel-scored edge line and the carbide scored edge line, had higher load resistance. Additionally, the steel scored edge line and the carbide scored edge line had different load resistance. Hence, the load resistance of a glass is affected by the tool used to cut a glass.

Oral Presentation Abstracts

Measurement Techniques and Methodology

Shining new light into an old imaging technique

Anindya Majumdar, Sean J Kirkpatrick

Interference of random coherent electromagnetic waves (such as laser light) results in granular structures known as speckle patterns. They are an ubiquitous phenomena in the sense that apart from the coherence, they do not require any other conditions for existence. Scattering from any sort of structure, such as a rough surface or biological tissue, results in the formation of these speckles. These patterns have been the subject of extensive research and are a subject of large number of applications exploiting speckle metrology and interferometry. Two vital characteristics of a speckle field are the minimum size of the speckles and the contrast in the field. The minimum size, or the correlation length in the field, characterizes the structure which acted as the scatterer to produce the speckles. The contrast is the ratio of the standard deviation to the mean intensity in the field, and characterizes the motion in the scattering object. Higher the motion, lower the contrast.

Laser Speckle Contrast Imaging (LSCI) is a technique employing speckle properties, conceived in the early 1980s and by now a well-understood and established imaging methodology for biophysical dynamics. In the presented work, we have used new mathematical formulations, namely Poincaré descriptors, to estimate speckle sizes. These descriptors are statistical tools used to study variations or self-similarity in neighboring values of a quantity. We have modified this definition to examine correlations between not only neighboring intensity values, but also those with larger spatial and temporal distances between them. We show that Poincaré descriptors are useful in quantifying the width of the coherence areas (the statistical definition of speckle size) in all three dimensions and also for quantifying motions in speckle patterns of low contrasts, from which information about the dynamics of the scattering medium can be inferred. These formulations can potentially improve LSCI.

Behavioral-based Vehicular Control in a Semi-Autonomous World

Mojtaba Bahramgiri, Reza Zekavat

In this work, we address how connectivity-based localization is incorporated for mobility/vehicular behavioral study in a semi autonomous world where variety of autonomous, semi autonomous and traditional vehicles are operating. This study aims to reduce road accidents and injuries and offer traffic situation awareness to autonomous, semi autonomous vehicles via V2V, V2I and V2X communication and localization..

Dropwise Condensation Visualization Using Automated SPR Microscopy System

Shahab Bayani Ahangar, Chang Kyoung Choi

Condensation is ubiquitous in many engineering application and advanced technologies. Condensation of vapor can occur in two modes of filmwise and dropwise condensation. It has been shown that surface heat transfer coefficient is much higher for dropwise condensation mode. To develop high performance dropwise condenser, the first step is to understand the mechanism governing dropwise condensation. Optical microscopy and environmental SEM are some of observation techniques that has been reported in literatures for sessile drop coalescence observation. However, these common techniques cannot guaranty both high temporal resolution and spatial resolution in phase change phenomena observation. In this work, a new approach to visualize water drop condensation at high temporal and lateral resolution has been introduced based on surface plasmon resonance (SPR) microscopy. A novel automated SPR system was developed by incorporating motorized rotating stages and optical arrays. This SPR platform was capable of angular SPR microscopy and intensity SPR microscopy. Different stages of drop coalescence were visualized by coupling high speed imaging with SPR microscopy. The results indicate SPR microscopy is a suitable tool for visualization phase change phenomena such as condensation.

Oral Presentation Abstracts

Power and Energy

Experimental Study of Flame Stretch in DI-SI Engine

Behdad Afkhami, Yanyu Wang, Scott A. Miers, Jeffrey D. Naber

Combustion processes of fossil fuels remain an important concern for the foreseeable future, since they will remain the main source of energy for power generation and transportation in next decades. When it comes to internal combustion engines, understanding the behavior of the flame and how it propagates during combustion process is important because it gives the capability to better understand fuel consumption, engine performance and exhaust emissions. For liquid or gaseous fuels, flame velocity that propagates normal to itself and relative to the flow into the unburned mixture is one of the most important quantities to study. In general a flame propagates in a non-uniform flow field and its curved frontal area changes continually which is known as flame stretch. The concept becomes more important when it is realized that the stretch affects the flame speed.

The current research experimentally studies flame stretch under engine in-cylinder conditions since there has not been enough studies of this kind in this area. For this reason, a one-cylinder, direct-injection, spark-ignition, naturally-aspirated optical engine was utilized to image the flame propagation process inside an internal combustion engine cylinder on the tumble plane. The flame front was found by processing high speed images which were taken from the flame inside the cylinder.

Flame front propagation analysis showed that after the flame kernel was developed, during flame propagation period, the stretch rate decreased until the flame front touched the piston surface. This was a common trend for stoichiometric, lean and rich mixtures. To study this phenomenon fundamentally, the trajectory of the flame centroid was tracked until the flame front hits the piston surface. The results showed that the end centroid for the rich mixture deviated less than those of the lean and stoichiometric mixtures compared to start point. This was due to the lower Markstein number for the rich air-fuel mixture compared to the stoichiometric or lean mixture. In other words, the rich mixture was less affected by the flame stretch. The same conclusion was also made by analyzing the flame equivalent radius and calculating flame propagation speed. Since the images consist of pixels, uncertainty analysis was conducted to determine the effect of pixel's size on the flame stretch calculation. Results showed that maximum relative uncertainty of about 4.5% occurred at early flame propagation period and it decreased by increasing the flame radius.

Numerical investigation of oil droplet combustion using single cell ignition model

Ankith Ullal, Dr. Youngchul Ra

Pre-ignition in internal combustion engines is an abnormal combustion phenomenon which often results in structural damage to the engine. It occurs when an ignition event takes place in the combustion chamber before the designed ignition time. In this work, a numerical investigation of lubrication oil as a pre-

ignition source is studied in natural gas engines used for marine applications. This was done by simulating experiments of oil-induced ignition and subsequent combustion in a constant volume combustion chamber (CVCC). An in-house version of the KIVA4 CFD code was used for this simulation. The numerical setup consists of generation of a computational grid for the CVCC and initial chamber conditions for mixture composition, pressure and temperature. Initial composition of the chamber gases is obtained from the pre-burn process of a known composition of C_2H_2/oxidizer mixture. Initial pressure and temperature were set to 40 bar and 700 K respectively. Natural gas was injected from a single-hole injector at an injection temperature and pressure of 300 K and 100 bar, respectively. Similar to the experimental setup, a continuously rotating fan was modeled for effective mixing of the mixture. Few oil droplets of known size are injected into the CVCC. For accurate prediction of oil droplet ignition, the cell containing the oil droplet is to be refined. The refinement level is decided such that the vapor stratification near the droplets within a single cell are resolved. The refinement is carried out using a library of another CFD code and the communication between the two CFD codes is achieved using an interface program. Combustion calculations are then carried out on the refined grid. A comparison of results with and without single cell ignition model is presented to show the merit of the model in increasing accuracy of ignition delay. Parametric studies were also conducted by varying droplet and jet conditions and their results are presented as well.

Experimental Investigation of Water Injection Technique In Gasoline Direct Injection Engine

Niranjan Miganakallu, Jeff Naber

This paper experimentally investigates the effect of water injection in the intake manifold on a naturally aspirated, single cylinder, Gasoline Direct Injection engine to determine the combustion and emissions performance with combustion knock mitigation. The endeavor of the current study is to use water injection to attain the optimum combustion phasing without knocking. Further elevated intake air temperature tests were conducted to observe the effect of water injection with respect to combustion and emissions. Experiments were carried out at medium load condition (800 kPa NIMEP, 1500 RPM) at intake air temperatures between 30 – 90° C in steps of 20° C. Two fuels, an 87 AKI and a 93 AKI were used in this study. Baseline tests were undertaken with the high-octane fuel (93 AKI) to achieve optimal combustion phasing corresponding to Maximum Brake Torque (MBT) without water injection. Water injection was utilized for the low octane fuel to achieve combustion phasing of 8-10° ATDC and within the controlled knock limit. Combustion phasing was achieved by controlling the ignition timing, water injection quantity and timing to the knock threshold. The results showed that water injection and the resultant charge cooling mitigates combustion knock and an optimum combustion phasing based on indicated fuel conversion efficiency is achieved with a water to fuel ratio of 0.6. Water injection reduces the NOx emissions while achieving better indicated thermal efficiency compared to the baseline tests. A detailed comparison is presented on the combustion phasing, indicated thermal efficiency, burn durations, HC, NOx and PN emissions in this paper.

A Bayesian Framework for EV Battery Capacity Fade Modeling

Mehdi Jafari, Laura E. Brown, Lucia Gauchia

The battery degradation modeling in literature is mostly performed by deterministic mathematical equations which are derived from regression on the experimental data. However, the battery capacity fade modeling through measurements of current, Ah, temperature, etc. has many sources of uncertainties that cannot be completely presented by a deterministic mathematical equation. The Bayesian statistical approach is a method that can work with unseen, anticipated variables and historical data to consider uncertainties in the estimation and therefore it is an appropriate solution for the battery degradation modeling problem.
In this study, we present a Bayesian Networks (BNs) approach for the electric vehicle battery capacity fade modeling. Battery capacity fade is caused by factors that carry heavy uncertainty, such as battery usage depending on driver behavior, temperature profile depending on location and thermal management system, etc.; all these variations complicate the battery aging modeling with traditional frameworks. That is why we propose that the modeling should be carried out in a Bayesian Network framework that is capable of incorporating uncertainty and causality.
Therefore, we presented Hierarchical Bayesian model for the battery capacity fade with full conditionals. A Markov Chain Monte Carlo (MCMC) sampling method is used to calculate the posterior distributions for all random variables. A set of training and test data are used to validate the model. The model is flexible on observed/unobserved variables and it can be applied for studies with different test conditions. The R2 index for validation results is more than 0.95 that indicates the precision of the model in estimating the capacity fade. Additionally, the model is used to estimate the capacity fade in real driving cycles. The results indicate that the capacity fade is highly dependent to the driver's acceleration profile.

A Novel Low Latency, High Resolution and Low Cost Time Synchronization

Ali Aghdaei

This paper presents an oversampling-based low latency, high resolution and low cost timing synchronization technique for digital receivers. Traditional timing synchronization employs Matched filter to estimate the signal coarse Time-of Arrival (TOA). Here, latency increases through oversampling and resolution improves via higher bandwidth. The proposed method uses single bit quantization to employ XNOR blocks instead of multiplier and accumulator (MAC) blocks in the traditional method. This substantially decreases complexity incorporating less FPGA surface area.

The modeling of Geomagnetic Induced Current and study of System Impact Assessment

Hemanth Kumar Vemprala, Neelima Katta Prabhakar Naidu

Geomagnetic Disturbance (GMD) is a naturally occurring events that could impact the power system elements and cripple the normal power system operations. Historically, the major GMD storms and the associated Geomagnetic Induced Currents in the transmission system had caused system interruptions. With the increase in long transmission line corridors, number of substations and with impending GMD storms, the possibility and impact of GIC on the power grid is more severe than previously observed. The focus of this research is to accurately model the GIC effect combined with time series varying geo-electric field in time

domain environment - EMTP/ATP. This further paves way for the real-time monitoring and analysis of the GIC on the power grid using time domain solvers. The modeling of power system network in time domain software such as ATP provides a most accurate and is inclusive of power system characteristics such as frequency dependency, nonlinear effects, and natural resonances. The benchmark IEEE test case along with the earth model is implemented in ATP. The half-cycle saturation effects on transformers due to quasi-dc current flow and the mitigation currently proposed by standards are investigated.

Aeroelastic Behavior of Variable Speed Wind Turbine

Sarah Jalal

Increased demand for energy has led to extensive efforts in improving technologies that efficiently harness energy from the available natural wind resource. This calls for the development of dynamic and efficient control strategies and is a one of the key research aspects of wind turbine technology. Such operational control systems are needed to reduce the loads on the turbine blades and maximize the output power thereby ensuring high quality power generation. One of the popular methods to optimize and control the power in a wind turbine is using variable speed wind turbine which has been regulated to increase power production by changing the rotational speed (rpm) of the turbine as per the varying wind condition. Interest in variable speed wind turbines (VSWT) has grown in the last two decades because of the better quality of power generated. VSWT use power electronic and aerodynamic control strategies to control torque, power and also rotational speed of the blades. The amount of electrical power directly depends on the method used for controlling the generator. Thus the control strategy has a significant role in this kind of a wind turbine. Different methods have been proposed for power control and load reduction of wind turbines. Stall and pitch control are two common approaches for controlling the power in varying wind speeds, in order to have a smooth power and also mitigate the mechanical loads. To this end, wind turbine simulation models are extensively being used to optimize both aerodynamic and structural aspects of blades. The first step in the development of a suitable stall-controlled strategy for a VSWT requires a wide range of experiments to assess the aeroelastic response of the rotor blade under different wind conditions. The next step consists of the analysis of the responses observed and their effects on important structural parameters like deformation, thrust etc.

Building Envelope based Triboelectric Wind Energy Harvesting System for Smart City Applications

Si Liu

The goal of this research is to propose a wind energy harvesting system for smart city applications based on triboelectricity generators that can be integrated with building envelopes to harvest nearby wind energy in urban area. Due to the drawback including frequent infrastructure replacement and long-distance transportation of external power source, energy harvesting technology to scavenge ambient energy from surroundings has been a favorable alternative to power numerous intelligent sensors and devices in smart city, and wind is considered one of the most ideal energy source among all that available in city environment. This research has designed of flapping type triboelectric wind energy harvesting system that can be integrated with building envelopes to support the power consumption of smart city system. Compared with typical wind energy harvesting by wind turbines at multi-scale, our system is capable to utilize wind flow of wider ranges, including chaotic turbulence wind flow and wind flow at low speed. In addition, the system is based on ultra-low-cost materials and manufacturing procedure, together with simple installation and maintenance process in what follows.

Modeling Li-ion Batteries for Electric Vehicles

Anurag Kamal

With a growing use of lithium ion batteries in the world, there is a need for battery models which could accurately predict the state of charge (SOC) and health (SOH) of the battery packs. The problem grows critical with all-electric automotive applications, where a stranded vehicle in case of an inaccurate SOC prediction could be deemed as a hazardous condition for an individual.

Researchers across the world are working towards developing electro-chemical models which can predict the state of the batteries accurately, however, there is a balance between the computational power required for the model, and the accuracy with which it can predict the results. The aim of this research is to develop a model which can predict the battery SOC and SOH with a greater accuracy, with the low computational power available with automotive battery management system.

The current state of research is the development of the bottom-to-top models which incorporate different numbers of physical equations, representing varying complexity. The ongoing work is to incorporate aging mechanisms of a top order model and validating the model through empirical results. The final phase for completing the thesis, the goal would be generating the same results through a bottom-up model.

An Ideal Electrode Material, 3D Surface-Microporous Graphene for Supercapacitors with Ultrahigh Areal Capacitance

Liang Chang, Yun Hang Hu

The efficient charge accumulation of an ideal supercapacitor electrode requires abundant micropores and its fast electrolyte-ions transport prefers meso/macropores. However, current electrode materials cannot meet both requirements, resulting in poor performance. Herein, we creatively constructed three-dimensional cabbage-coral-like graphene as an ideal electrode material, in which meso/macro channels are formed by graphene walls and rich micropores are incorporated in the surface layer of the graphene walls. The unique 3D graphene material can achieve a high gravimetric capacitance of 200 F/g with aqueous electrolyte, 3 times larger than that of commercially used activated carbon. Furthermore, it can reach an ultrahigh areal capacitance of 1.28 F/cm2 and excellent rate capability as well as high cycling stability. The excellent electric double-layer performance of the 3D graphene electrode can be attributed to the fast electrolyte ion transport in the meso/macro channels and the rapid and reversible charge adsorption with negligible transport distance in the surface micropores.

Oral Presentation Abstracts

Computational, Mathematical, and Physical Sciences

Message Coverage Maximization in Vehicular Networks

Ali Jalooli, Min Song, Wenye Wang

The success of vehicular networks is highly dependent on the coverage of messages, which refers to the Euclidean spatial distance, density of nodes, and the messages' trajectory over time. Many of existing works performed in 1-Dimensional (1-D) environments (e.g., straight highways) and/or have focused on vehicle-to-vehicle (V2V) communications to enhance the coverage area in a road network. However, there still lacks a clear understanding of using road infrastructures to improve the message coverage in 2-D environments, e.g., urban areas. In this paper, we study the crucial problem of optimal utilization of roadside units (RSUs) based on the objective of message coverage maximization in an urban environment. We initially study the message coverage for V2V networks, and then propose an efficient algorithm, which by taking the message coverage into consideration chooses the optimal locations for the RSUs deployment to achieve the maximum message coverage.

Improved Caching for Web Services

Daniel Byrne, Nilufer Onder, Zhenlin Wang

Web services often employ memory caches to store the data in memory that is most commonly accessed. The memory cache improves a service's performance by serving its requests from memory, avoiding fetching them from the backend database. Since the memory space is limited, maximizing the memory utilization is key to delivering the best performance possible. In addition, application data access patterns change over time, so the system should be adaptive in its memory allocation policy as opposed to current static allocations.

In this work, we address both multi-tennancy (where a single cache is used for multiple applications) and dynamic workloads (changing access patterns) using a sharing model that relates the cache size to the application miss-rate, known as a miss-ratio curve. Intuitively, the larger the cache, the less likely the system will need to fetch the data from the database. Our efficient, online construction of the miss-ratio curve allows us to determine a near optimal memory allocation given the available system memory, while adapting to changing data access patterns. We show that our model outperforms the existing state-of-the-art sharing model in terms of overall cache hit-rate and does so at a lower time cost. We show that for a typical system, overall hit-rate can be improved by up to 2% and 99.9th percentile latency is reduced by as much as 2% under standard web application workloads containing millions of requests. The improvements result in a 6% percent increase in the number of operations per second the caching system can perform.

An Information-Theoretic Approach to Partitioning Simultaneous Transmit and Receive Digital Phased Arrays

Ian T. Cummings, Timothy J. Schulz, Jonathan P. Doane, Timothy C. Havens

Dynamically reconfigurable digital phased array technology has become more common and advances in signal processing techniques have enabled digital self-interference cancellation sufficient for practical simultaneous transmit and receive applications. As systems implement these technologies, techniques for configuring arrays must be developed. In this work, we consider operating an array in an imaging mode and demonstrate the effectiveness of the Fisher Information of a point target's position in determining the optimal partitioning of an array into transmit and receive elements. We demonstrate that the partitions formed by optimizing the Fisher Information metric perform better than those that consider other metrics. (Note: Abstract taken directly from our associated accepted conference paper with the same title.)

Computational Fluids Dynamics: Torque Converter

De Jesús Rivera, Edward

Cost and time is of utmost importance for any new product introduction (NPI). A reliable computational tool allow engineers to reduce research and development (R&D) time and costs. Over the past 20 years, significant advances in computational fluid dynamics (CFD) have been achieved allowing engineers to solve complex problems in turbomachinery. A CFD model of a torque converter was analyzed using a commercially available software over a wide range of speed ratios. Results obtained with the CFD model were compared to test results showing high correlation between the two methods. Cost comparison shows the importance of utilizing computational methods in the early stages of the NPI when compared to building and testing the product.

Energy efficient mission planning for multiple AUVs under complex current

Bingxi Li, Barzin Moridian, Nina Mahmoudian

Energy distribution and extended operation time are essential for long-term missions using Autonomous Underwater Vehicles (AUVs) with the advance of both static and mobile charging underwater platforms technologies. This presentation provides mission planning methods which enable multiple AUVs to finish the long-term missions with the support of multiple mobile charging AUVs. The mission planning methods plan the trajectories and recharging scheduling of AUVs using a Genetic Algorithm and a graph transformation method. The proposed methods allocate energy resources, which will result in a mobile power delivery system that meets overall mission specifications by: 1) reconfiguring itself to the number of operational AUVs, and 2) responding to energy consumption needs of the network and complex current. Simulation results using realistic scenarios demonstrate the capabilities and effectiveness of the mission planning methods.

Enabling Continuous Undersea Operation with an Adaptable Docking System

Brian R. Page, Nina Mahmoudian

Autonomous Underwater Vehicles (AUVs) have seen widespread adoption and increased usage over the past decade with their increasing capability to perform surveys, science, and surveillance. One limiting factoring in AUV adoption is limited endurance, with most AUVs having operation times of less than one day. To support extended missions, the current solution is to manually retrieve and recharge the AUV between dives. One potentially disruptive technology being

developed globally is autonomous underwater docking and recharging. Docking stations will enable AUVs to operate with nearly unlimited endurance, dramatically reducing the cost of marine science. Existing docking stations have taken many designs, but the most prevalent is the funnel design that fully captures the AUV. These funnel docking stations enable large capture envelopes and a solid connection between vehicle and station. However, they are specific to individual AUVs and require bulky subsea installations. Further, fixed docking stations requires AUVs to transit away from the working zone to the charging location rather than being charged in optimal locations. To enable persistent AUV operation a new docking system is required that is capable of supporting a wide range of AUVs and mobile charging.
The authors are developing an adaptive docking system that is capable of supporting nearly any AUV through the novel application of a universal docking station and a standard docking adapter. Additionally, the docking system can support mobile charging. The adaptive docking system design is simple to manufacture, transport, and install, has been optimized to maximize performance, and is currently being experimentally validated. This oral presentation presents the design and capabilities of the docking system, as well as preliminary simulation results of docking to both a fixed and mobile charger. The docking system consists of a universal docking receiver and a docking adapter that can be customized to each unique AUV quickly.

Multiscale Modeling of PEEK using Reactive Molecular Dynamics Modeling and Micromechanics

W.A. Pisani, M. Radue, S. Chinkanjanarot, B.A. Bednarcyk, E.J. Pineda, J.A. King, G.M. Odegard

Polyether ether ketone (PEEK) is a high-performance, semi-crystalline thermoplastic that is used in a wide range of engineering applications, including some structural components of aircraft. The design of new PEEK-based materials requires a precise understanding of the multiscale structure and behavior of semi-crystalline PEEK. Molecular Dynamics (MD) modeling can efficiently predict bulk-level properties of single phase polymers, and micromechanics can be used to homogenize those phases based on the overall polymer microstructure. In this study, MD modeling was used to predict the mechanical properties of the amorphous and crystalline phases of PEEK. The hierarchical microstructure of PEEK, which combines these phases, was modeled using a multiscale modeling approach facilitated by NASA’s Multi-Scale Generalized Method of Cells (MSGMC). The bulk mechanical properties of semi-crystalline PEEK predicted using MD modeling and MSGMC agree extremely well with vendor data, thus validating the multiscale modeling approach. It should be noted that no experimental input data or calibration of model parameters were used to arrive at the predictions. This validated multiscale modeling approach can be used improve the properties of PEEK through parametric studies; one such study could assess the influence of crystallinity on mechanical properties. This approach can inform the design process to better tailor PEEK materials to meet specific performance requirements.

Probing Galactic Cosmic Ray Origin with High Energy Gamma-Ray Emission

Binita Hona

Unlike cosmic rays, gamma rays are not deflected by interstellar magnetic field and hence can point towards their source of emission. This provides a unique opportunity to study astrophysical sources and understand very high energy physics in our galaxy. The Cygnus arm of our galaxy is a star forming region with multiple gamma-ray sources and is being studied by many observatories. The High Altitude Water Cherenkov (HAWC) Observatory has the best sensitivity to very high energy gamma ray emission and has detected bright emission from the Cygnus region. One bright source in the Cygnus region is 2HWC J2031+415, which is an unidentified source. Possible counterparts are a cocoon of freshly accelerated cosmic rays detected by Fermi-LAT at lower energies and Pulsar Wind Nebula detected by VERITAS observatory. The goal of my analysis is to investigate the morphology of 2HWC J2031+415, possible correlation with mission at lower energies and the emission origin. This presentation will give a brief overview of the research obtained with HAWC data along with the results seen at lower energies to have a deeper understanding of 2HWC J2031+415 region at very high energies.

The Radial Basis Functions Method applied to groundwater flow : The Drawdown Problem.

Nadun Dissanayake, Cecile Piret, John Gierke, Bengt Fornberg

We use the finite difference based Radial Basis Functions method in modelling groundwater flow and in particular in solving the drawdown problem in homogeneous and heterogeneous media. We propose a new procedure for stably computing the solution even in the vicinity of a well. Mathematically as a singularity. We first validate our method and verify it's high order accuracy by solving a well known benchmark problem in homogeneous settings. We then adapt our algorithm to model ground water flow in heterogeneous aquifer.

Oral Presentation Abstracts

Environmental Studies and Sustainability

Pathogen & Indicator Organism Reductions & Biosolids Changes During Storage

Tanner Keyzers, Karina Eyre, Eric Seagren, Jennifer Becker

Biosolids are a nutrient rich, organic material produced by water resource recovery facilities (WRRFs), with potentially beneficial applications such as land reclamation. Biosolids are classified as Class A or Class B depending on the pathogen and indicator organism (PIO) levels. Producing Class A biosolids can be challenging for smaller WRRFs because they lack the resources to implement the conventional technologies typically used. One alternative for smaller WRRFs is to use low-cost low-tech (LCLT) methods such as long-term storage, air-drying, or cake storage. However, wide-spread adoption of these methods has been restricted by the lack of information on PIO inactivation and biosolids properties during LCLT treatment. The overall goal of the current project is to develop a rational design approach for LCLT Class A biosolids treatment processes. As part of that effort, pilot-scale studies were performed at two similar WRRFs, the Portage Lake Water and Sewage Authority (Houghton, MI), and the Gogebic-Iron Wastewater Authority (Ironwood, MI). These studies assessed the impact of key process parameters on inactivation of PIOs during long-term storage followed by air-drying. During long-term storage, biosolids were placed in test boxes (4ft high × 8ft long× 4ft wide) to 3 feet deep, where temperature, total solids (TS), volatile solids (VS), ammonia, volatile fatty acids, pH, and PIOs, including Ascaris ova, poliovirus and fecal coliforms (FC), could be measured. The data trends from each plant are similar, with pH and VS decreasing slowly over time and an increase in TS. PIO trends were also similar with FC levels below Class A (<1000 MPN/g TS) after winter storage. However, Class A requirements were not reached for viable Ascaris ova after 1 year of storage. The similarity of environmental and physical/chemical parameters, and PIO levels shows the potential for reproducible and predictable results using LCLT treatment methods at different locations.

Low-Cost Low-Tech Pilot Scale Results for Class A Biosolids Treatment at Portage Lake Water and Sewer Authority

Karina Eyre, Jennifer Becker, Eric Seagren, Tanner Keyzers, Christa Meingast

Class A biosolids are produced at water resource recovery facilities (WRRF) and treated to reduce pathogens sufficiently to allow for unrestricted land application. Class B biosolids are also treated to reduce pathogens, but to a lesser degree, and they do not have to meet guidelines for parasitic worm (helminth) ova and enteric viruses. Consequently, there are restrictions on access to, and use of, land on which Class B biosolids are applied, and many WRRFs are seeking to upgrade to Class A biosolids treatment. A pilot-scale study was conducted at the Portage Lake Water and Sewer Authority to: (1) determine if additional treatment of Class B biosolids via long term storage followed by air drying could be used to achieve Class A requirements for pathogen inactivation and (2) identify the pathogen inactivation mechanisms. Anaerobically digested and dewatered biosolids were stored in triplicate indoor and outdoor test beds for one year, and then formed into

windrows and turned twice a week. Key physical and chemical parameters were measured to evaluate their effects on pathogen inactivation. Ambient weather conditions and biosolids temperature were also monitored. Attenuated human poliovirus and viable Ascaris ova were used as indicators for enteric virus and helminth ova, respectively, and fecal coliform bacteria were also monitored. Significant differences emerged in the physical and chemical properties of biosolids stored indoor and outdoors. Class A fecal coliform levels were achieved; however, the potential for regrowth is of concern after significant precipitation. Viable Ascaris levels decreased, particularly during the summer, but more than one year of storage will be required to achieve Class A helminth standards in northern climates. Volatile acids and competition from indigenous organisms may have contributed to Ascaris ova inactivation. Nitrification of biosolids ammonia and low pH levels meant that unionized ammonia likely did not contribute to pathogen inactivation.

Detailed molecular analysis of ambient biomass burning influenced aerosol and fog water from the Po Valley

Matthew Brege, Marco Paglione, Stefania Gilardoni, Stefano Decesari, Maria Cristina Facchini, Lynn R. Mazzoleni

Sub-micrometer atmospheric aerosol presents a variety of health risks, and is a substantial source of uncertainty in anthropogenic climate forcing estimates. Aerosol-cloud interactions are poorly represented in atmospheric climate modeling, due to an insufficient understanding of the molecular level chemistry and its chemical transformation with atmospheric aging in cloud and fog water droplets. To address this, we explored the molecular properties of biomass burning emissions influenced samples with different degrees of atmospheric aging. Specifically, two ambient samples of fog water and two samples of PM1 aerosol collected in the Po Valley (Italy) were selected for analysis using ultrahigh resolution Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS). One of each sample type was defined as mainly influenced by “fresh” biomass combustion emissions and other was mainly influenced by “aged” biomass combustion emissions. Over 4300 distinct molecular formulas were assigned to electrospray ionization FT-ICR MS anions. The selected samples had an atypically large frequency of molecular formulas containing nitrogen and/or sulfur atoms, attributed to multifunctional organonitrates, organosulfates and nitrooxy organosulfates. In the “fresh” samples formulas representing larger and more unsaturated molecules were observed with higher carbon numbers and more double bond equivalents. In the “aged” samples formulas representing more oxidized and more saturated molecules were observed with higher O:C and H:C ratios. In general, fog compositions were more aged than aerosols. Molecular similarity was observed between the aged aerosol and fresh fog samples implying that fog nuclei must be composed of somewhat aged aerosol. Overall, functionalization with nitrate and sulfate moieties and oxidation trigger an increase in the molecular complexity in this environment. This study highlights the strength of ultrahigh resolution MS for observing the detailed molecular level composition of atmospheric fog and aerosol systems.

Bonding Properties of Cross-Laminated Timber Made from Mixed Species

Munkaila Musah, Xiping Wang, Robert Ross, Xinfeng Xie

Interest in cross-laminated timber (CLT) in the construction industry has grown significantly in North America in recent years. CLT opens new markets for sawn lumber products from both softwood and hardwood species. However, research on using hardwood species in CLT production is still at early stage, and only a few species have been studied. To improve our understanding of the bonding properties of CLT manufactured from hardwoods and softwoods, we designed and conducted experiments to examine the bond performance of CLT made from both hardwood and softwood species. The study utilized seven (7) northern hardwood species, two (2) softwood species from the Great Lakes region of the United States and two (2) commercially available structural adhesives (melamine formaldehyde and resorcinol formaldehyde adhesive systems). The selected hardwoods includes both ring-porous and diffuse-porous species, and the specific gravities (SGs) of the wood range from 0.37 to 0.64. The bonding strength and durability were tested in accordance with ASTM and AITC standards for cross-lamination of individual species and mixed species. The results from this study will provide key base¬line technical data on bonding properties for using northern hardwoods in CLT production.

Environmental conditions mediate a rapid shift in plant communities following timber harvest

Stefan F Hupperts, Yvette L Dickinson, Christopher R Webster, Robert E Froese

The importance of disturbance in shaping forest ecosystems has long been understood by ecologists, but incorporating disturbance ecology into forest management has, until recently, largely been neglected. Historical forestry practices tended to favor timber production by promoting few, economically important tree species, a practice which has likely led to a decline in the capacity of the ecosystem to recover and adapt following a perturbation. The widespread and long-term use of one silvicultural system in Great Lakes northern hardwoods, for example, created microsite conditions which gave shade- and leaf litter- tolerant sugar maple (Acer saccharum Marsh) a competitive advantage over less tolerant species such as yellow birch (Betula alleghaniensis Britton), whose functional traits are better suited for sites with greater light availability and less leaf litter. The objective of this research is to investigate the roles of competitive and environmental filtering in structuring plant communities across a range of timber harvesting disturbances from low disturbance to patch clearcut. Plant community patterns were assessed and compared to environmental conditions such as leaf litter depth, soil water content, and light availability. After harvest, we found a shift in plant community composition which was most driven by increased light availability. Moreover, we recorded a decline in leaf litter depth and concurrent increase in soil water content, likely an effect of fewer trees transpiring. Species such as sugar maple and spinulose woodfern (Dryopteris carthusiana (Vill.) H.P. Fuchs) were strongly associated with leaf litter depth, lower soil water content, and less available light, while yellow birch and several ruderal species were not associated with those factors. Incorporating these plant community responses and underlying competitive interactions across a broad range of disturbance severities may better inform forest managers and ecologists alike.

Application of an open-source remote sensing software to monitoring weather and pest related forest disturbances, Elm River Township MI

Elizabeth A. Montgomery

Dead wood is an integral part of the forest system. Over the course of its decomposition, it cycles nutrients locally, is a substrate upon which diverse woodland communities are supported, and across a landscape, can fulfill residential fuel wood demands.
In this study, Multi Spec open-source software will be applied to quantify dead wood production by sequential forest disturbances, emerald ash borer invasion followed by the creation of large, multi-tree gaps in a summer 2016 windstorm, Elm River Township, MI.
Field measurements of downed dead tree volumes are compared to pixel counts of classified, drone-collected aerial imagery. The resulting volume measurements are extrapolated to additional gap photographs for the purpose of estimating total coarse woody debris production by storm winds over the study parcel. Other observed effects of wind-related tree fall such as pit and mound topography, water retention, and tree regeneration will also be discussed. The scale of windstorm damage will be compared to the measured scale of ash mortality across the same landscape.
The quantity or volume of down dead wood produced or maintained in a forest affects biotic processes, fuel wood supply, and incendiary potential. Both wind and pest disturbance types are common and can be mediated by stand management, forest demographics, and global environmental change.

Collaborative Governance and Wisconsin's Biomass Harvesting Guidelines

Jennifer L. Dunn, Kathleen E. Halvorsen, Chelsea Schelly

Collaborative governance is becoming more popular in state and national agencies tasked with solving complex problems related to natural resources. It aims to bring together all actors involved in a specific problem who share a common goal. Collaborative governance is beneficial to natural resource agencies as it can provide avenues for funding, knowledge transfer, and connections to the communities they serve. Our research aims to enhance the understanding of the value of collaborative governance through a case study analysis of the creation of the Wisconsin Biomass Harvesting Guidelines (BHGs). In 2008 the Wisconsin Forest Council was asked by the governor to create biomass harvesting guidelines to protect the future of Wisconsin's forests for future forest product markets. Interviews were conducted with state and non-state actors to examine the role each of them played in the guidelines creation and revisions. We discuss the advantages and disadvantages of collaborative governance for both the state and non-state actors in this case study as well as the perspectives each key actor has about the BHGs. Lastly, this case study can serve as an example for other agencies of the value of collaborative governance in natural resource management.

Co-production as policy tool for household waste sorting in Shanghai

Hongmei Lu

Rapid urban population growth in China has made Municipal Solid Waste (MSW) management a severe administrative challenge in large cities. Waste sorting is

regarded as an effective way towards recycling and reducing waste. Shanghai as one of the eight pilot cities in China, has implemented the policy of MSW sorting since 2000, however, it has yet to achieve success. In contrast to the unsatisfactory efficiency of this top-down regulation, a bottom-up, community-based voluntary way of waste sorting emerged and showed great vitality and efficiency in both urban and rural area of Shanghai. The case findings suggest that such a co-production approach could be a potential policy tool, in which the community-based volunteers serve as advocators and overseers of household waste sorting. Nevertheless, co-production needs also strong pushing and pulling forces from the well-designed regulation and market mechanism: strict volume-based waste charge mechanism and rebuilt of city recycling system. Waste management as a kind of public service has long been regarded as the responsibility of the government, this paper may serve as a meaningful empirical exploration to find another way to tackle the waste management dilemma in China.
Key Words: household waste sorting; co-production; policy tool; Shanghai

The Third Shift? Gender Roles and Empowerment in a Women's Ecotourism Cooperative

Mayra S. Morgan and Richelle Winkler

Ecotourism could be a valuable tool to promote conservation, local development, and women's empowerment, with its attention to social justice and encouragement of participation and empowerment of local people, including women. However, little attention is currently devoted to women's participation in ecotourism. This is particularly true in places such as Quintana Roo, Mexico, where the tourism industry is the main economic activity in the area.

This paper investigates how local gender dynamics influence a female-run ecotourism cooperative in rural Mexico. It is based on a case study of the "Orquideas de Sian Ka'an" in Punta Allen town in Quintana Roo, Mexico. The researchers spent 4 weeks conducting interviews and participant observations during the fall 2016. Findings show that women have distinct, gender-based family and community demands that prevent their ability to work and lead in the ecotourism cooperative. The cultural expectations and resulting struggles are so substantial that they are preventing the basic functionality of the organization, such that the "Orquideas" exists more on paper than in reality achieving work. In this community context, the women's most important role is to be wives and mothers and to fulfill the substantial daily expectations associated with those roles. Besides the household demands, most of the women have to work in other cooperatives or lodging places as secretaries, cookers or maids. This leaves little time or energy for a "third shift" in entrepreneurial development. Women put their own interests and goals, associated with the cooperative, on the back burner.

If these challenges continue to be overlooked ecotourism becomes a "gender blind" industry that does not contribute to women's empowerment, and only reinforces traditional gender models and uneven power relations that put many women in disadvantage positions instead of promoting gender equity and social justice.

Multisite calibration approach of the SWAT model in a complex cloud forest dominated watershed in Veracruz, Mexico

Sergio M. Lopez R., Alex Mayer, Leonardo Saenz

The primary focus of the broader research project is to better understand the impact of land use change on the provision of water in a tropical montane watershed. The Soil and Water Assessment Tool (SWAT) is a widely used hydrological model for hydrology, plant growth, sediment, nutrients and pesticides. The multisite calibration approach will use detailed data from eight head water catchments (~ 1 km2) to obtain representative parameter sets for hydrologic response units; then the main channel processes will be calibrated considering flow data from 2 watersheds (50 km2); finally, data from plot experiments will serve to adjust the parameters that control evaporation and interception processes. A sensitivity analysis (SA) was conducted to identify relevant parameters that relate to the calculation of stream flow. The swat cup tool was used to run 500 simulations at monthly scale for 25 years. The objective functions used in this study were: Nash-Sutcliffe Efficiency (NSE), Coefficient of Determination (R2) and Percent Bias (PBIAS). Preliminary results from SA show and excellent performance of the flow modelling (NSE =0.83, R2= 0.83 and PBIAS =-4.8 %) and the following parameters were identified as top sensitive: SCS curve number (CN2), soil hydraulic conductivity (Sol K), depth of the soil (Sol Z) and maximum leaf area index (Blai).
These results will be used to guide the calibration process and to improve the SWAT model performance and its capabilities to account for spatial heterogeneity of a montane tropical basin influenced by cloud forest.

Aggregation of atmospheric tar ball particles from fires: effects on the atmosphere

Janarjan Bhandari, Claudio Mazzoleni

Tar balls (TBs) are spherical aerosol particles common in smoke plumes from wildfire and wood burning. TBs have a size range of ~100-300 nm diameter and are composed mostly of carbon and oxygen. Under an electron microscope, TBs are generally seen as randomly distributed independent spheres. Previous studies show that TBs absorb sunlight and warm the atmosphere.
So far, these studies focused on the optical properties of individual TBs. But, in a recent study, our group found a significant fraction of TB aggregates. These TB aggregates consists of a large number of TBs that are joined together forming a chain-like structure. The abundance of TBs in aggregated form motivated us to explore how differently aggregates absorb (warming) and scatter (cooling) sunlight in the atmosphere with respect to individual TBs. With this goal, we investigated some optical properties of these aggregates and also estimated their radiative effects in the atmosphere. We performed numerical calculations for individual i.e., non-aggregated TB spheres, and compared with the properties of the aggregates. We also performed sensitivity studies using different number and sizes of TBs within an aggregate, to simulate their optical properties in the visible region of the sunlight spectrum. Our simulations show that TB aggregates have optical properties remarkably differently from individual TBs, suggesting that models need to incorporate aggregation to accurately estimating the effects of TBs in the atmosphere and on climate.

Oral Presentation Abstracts

Advances in Modern Medicine & Health

Prevascularized Human Mesenchymal Stem Cell Sheet for Diverse Tissue Engineering

Wenkai Jia, Qi Xing, Dhavan Sharma, Mitchell Tahtinen, Feng Zhao

Engineering vasculature in thick artificial tissue is important to maintain the tissue function and integration into host post-implantation. Human mesenchymal stem cell (hMSC) sheet has attracted great attention in tissue engineering area based on the multi-differentiation and regeneration properties of hMSCs. The vascularization of hMSC sheet can be fulfilled through co-culturing hMSCs with endothelial cells (ECs), which provides us a strategy for engineering prevascularied tissue. However, the incorporation of ECs in hMSC sheet and differentiation induction of hMSCs to specific phenotype might alter hMSCs' regeneration properties. The objective of this study is to investigate the hMSC properties in the co-culture environment after differentiation, including paracrinic property and immune-regulatory ability, which is important for the application of prevascularized hMSC sheet for diverse tissue regeneration. Prevascularized hMSC sheet was created by co-culturing hMSCs sheet and ECs. The differentiation of the prevascularized sheet was induced by treating the sheets with bone differentiate medium (BDM), BDM cocktail medium, fat differentiation medium (FDM), and FDM cocktail medium for osteogenic and fat differentiation. Vascular structure, vascular maturation and angiogenic growth factors concentration were analyzed to study the ability of MSCs to maintain vasculature after differentiation. The immune-regulatory ability of hMSC was measure by tissue subcutaneous implantation in rat. Results indicated that hMSC maintained multi-differentiation when culturing with ECs. However, inducing hMSC differentiation with pure differentiation medium decreased angiogenic factor secretion and damaged vascular structure. With cocktail differentiation medium provided, the hMSC sheet was able to maintain vasculature integrity. The differentiated prevascularized hMSC sheets maintained immune-regulatory property and supported tissue regeneration in vivo. The study demonstrated the feasibility of applying differentiated prevascularized hMSC sheet in diverse tissue engineering, providing benefit for accelerated tissue engraftment and regeneration.

Virus Purification in Aqueous Two-Phase Systems

Pratik Joshi, Matthew Weiss, Caryn L. Heldt

A need exists to reduce the cost of viral vaccine processing to increase vaccine coverage, especially in underdeveloped countries. Currently, 20-30% recovery in viral vaccine production is acceptable and commonplace. We propose to enhance the recovery using an alternative, non-conventional method utilizing aqueous two-phase systems (ATPS). ATPS is a potential alternative to current methods, such as chromatography. ATPS, formed by two incompatible, water-containing solutions, provides an inexpensive, biocompatible, and environmentally friendly system that can be easily adapted to continuous processing. However, the lack of understanding of the driving mechanisms of biomolecules in ATPS poses a major challenge for industrial implementation. Our goal is to understand the dominant

forces in ATPS and to reduce the experimental design to a smaller set of parameters that would increase industrial adaption of the technology. From our previous study, the surface charge and viral hydrophobicity are likely to be dominant forces. Our model system is the separation of non-enveloped, porcine parvovirus (PPV) in a polyethylene glycol (PEG) and citrate solution at pH 7. The PEG phase is fairly hydrophobic compared to the highly hydrated citrate phase, even though both are approximately 70% water. This more hydrophobic phase attracts the hydrophobic virus while the highly hydrated citrate phase causes salting out of the virus. To increase the hydrophobic driving force and attract more virus to the PEG-rich phase, equilibrium systems were determined and measured by tie lines. A strategy of an increasing relative hydrophobic interaction from the PEG-rich phase and salting out effect from the citrate-rich phase was adapted by choosing tie lines of different lengths. An increased recovery with an increasing tie line length was observed, with a maximum of 78% recovery. 2-3 fold increase from conventional recovery will help abate the cost and satisfy the demands of vaccines.

Controlling the Nano-surface Finish of Medical Implants

Derryl Poynor

Titanium nanotubes (TiNTs) have been shown to be an effective surface finish of medical implants through improved osseointegration, although lack a standardized manufacturing process to ensure a consistent and predictable nano-surface. Floating anodization, a novel anodization technique where unconnected Ti sample(s) were anodized by the electric field generated between two or more graphite electrodes, was able to affect the location and degree of nanotube formation by controlling the parameters influencing the electric field strength and direction. According to the results, the primary factor controlling the oxide layer is the amount of current exiting at a location upon the surface; no nanotube formation was present at nearly zero current densities or where current entered the sample. COMSOL models of the cell were developed to depict the current density field across the electrochemical cell and consequently, demonstrating their potential to predict nanotube formation by current density alone. Furthermore, the influence of temperature, time, and the differences between traditional and floating anodization were investigated in attempt to develop a robust anodization process.

Oral Presentation Abstracts

Novel Materials and Transport Phenomena

Assessment of nanoparticles dispersion in asphalt during bubble escaping and bursting: Nano hydrated lime modified foamed asphalt

Lingyun You, Zhanping You, Qingli Dai, Lifeng Zhang

Saving mixing energy by using bubble escaping and bursting during the production pro-cess of nanomaterial modified water-foamed asphalt is a novel preparation idea, which can be taken as one type of cleaner physical warm-mix asphalt technology. The objec-tive of this study was conducted to assess the dispersal of nano hydrated lime (NHL) par-ticles in the asphalt using a scanning electron microscopy (SEM) test, and to evaluate the physical properties of NHL modified water-foamed asphalt (NMFA). In this study, the NHL and sodium dodecylbenzene sulfonate (C12H25C6H4SO3Na) were added to the water to make suspensions, and the suspensions were mixed with asphalt to form NMFA. The X-ray diffraction (XRD) test was used in order to understand the NMFA's microstructure and dispersal of NHL in water-foamed asphalt. The dynamic shear rheometer (DSR) and the asphalt binder cracking device (ABCD) was also used to evaluate the high tempera-ture and low temperature performance of NMFAs, respectively. The SEM images show that the NHL particles were well dispersed in the water-foamed asphalt, the XRD test results confirmed it and demonstrated that the NMFAs may form an intercalated micro-structure. Furthermore, the NMFAs exhibited better high temperature and low temperature performance compared to the original asphalt.

Visualization of Evaporation/Condensation in Cryogenic Propellants

Kishan Bellur

Prediction and control of evaporation/condensation of cryogenic propellants is one of the key factors limiting long-term space missions. Modeling propellant behavior and predicting phase change rates require models that need to be calibrated with experimental data. However, no such data is available on controlled phase change of cryogenic propellants. In this work, neutron imaging is employed as a means to visualize the condensed propellant inside opaque metallic containers at temperatures as low as 17 K. These are first known images of cryogenic propellants. Evaporation/condensation tests were conducted using containers of different sizes, shapes and materials. Two different techniques to determine phase change rates are developed and compared. The results suggest that the evaporation rate is a strong function of (1) the liquid-vapor interface curvature in the vicinity of the contact line and (2) the surface chemistry of the container. The onset of condensation is investigated and the results show that liquid hydrogen is perfectly wetting to Al 6061 and SS 316. A new technique to probe length scales lower than the imaging resolution is developed and discussed.

Oral Presentation Abstracts

Biological Sciences

A Novel Plant Derived Lysin: A Potential Multi-Functional Tool for Biomedical Research

Jared Edwards, Christina Welch, Priyanka Kadav, Tarun K Dam

Lysins disrupt and disintegrate cell walls/membranes and occur in bacteria, viruses and plants. They are most commonly noted in phages where lysin activity cleaves peptidoglycan in cell walls. Our work has revealed a plant species producing a new hemolysin named HelyX (Hemolysin X). The lysin is functionally defensive and possibly catabolic in comparison to the more commonly discussed versions of lysin in organisms. Our data suggest that tissues of our target plant species, primarily storage tissue and flower, produce high concentrations of this newly discovered lysin. HelyX demonstrated an exceptional ability to completely lyse proportionately large volumes of both human and rabbit red blood cells. Experimentation with other cell types such as Escherichia Coli revealed the inability of HelyX to lyse through cell walls. While red blood cells have been confirmed targets for lysis from testing, currently we are testing the action of HelyX on white blood cells (WBC) and platelets. The ability to inhibit the vigorous lytic activity of HelyX was observed in varying degrees when introduced with specific ligands, most notably bovine Thyroglobulin, which can completely inhibit lower concentration HelyX samples at comparably low concentrations. Such inhibitors could be used for controlling the activity of HelyX when it is applied in vivo for therapeutic purposes. Our ongoing experiments will determine if the lytic activity of HelyX is a broad spectral lysin or specific to particular cell types. Resulting implications vary from HelyX's utility as an isolating reagent of WBC and platelets from whole blood and potentially a highly active reagent that can be manipulated into eliminating specific/harmful cell lines. Our research on HelyX focuses on characterization of its molecular structure and determining its range of targets as well as inhibiting ligands. Once fully characterized, HelyX could potentially be proved as a natural reagent with potential biomedical application.

The cancer-specific protein galectin-3 remains active even after substantial degradation by autolysis: Implications in biological functions

Priyanka Kadav, Christina Welch, Jared Edwards, Purnima Bandyopadhyay, Tarun K Dam

The cancer-specific protein galectin-3 remains active even after substantial degradation by autolysis: Implications in biological functions
Priyanka Kadav, Christina Welch, Jared Edwards, Purnima Bandyopadhyay, Tarun K Dam
Laboratory of Mechanistic Glycobiology, Department of Chemistry, Michigan Technological University
Proteins generally become inactive when they undergo structural degradation. We recently found that the tumor-associated protein galectin-3 (Gal-3) is an exception to this rule. Gal-3 plays important roles in cancer but its functions are not fully understood. Because of its tumor specific over-expression, Gal-3 is considered as an important biomarker for different types of cancers. Gal-3 is a chimeric protein that contains a C-terminal carbohydrate-recognition domain (CRD), which is linked

to the N-terminal tail. In our lab, recombinant Gal-3 is over-expressed in E. coli BL21 (DE3) strain and purified by affinity chromatography. We have found that the affinity purified Gal-3 undergoes enzyme-independent autolysis, when stored with lactose at 4°C for more than six weeks. Intact Gal-3 after autolysis produced a single protein band of 17 kDa. This molecular weight is similar to that of the CRD portion of Gal-3. Conventionally, the CRD is separated from intact Gal-3 by enzymatic digestion using collagenase. However, in the present case, Gal-3 apparently autolysed itself to produce the CRD without the catalytic action of collagenase. Our data indicate that autolysis of Gal-3 significantly degrades the protein but the CRD remains intact and functionally active. Our current observations suggest that Gal-3 under cellular stress may undergo autolysis and generate active CRDs without the assistance of any enzyme. In this way, Gal-3 may retain some of its functions even when it is substantially degraded in a challenging cellular environment. Thus the degraded Gal-3 can still carry out some of the functions of intact Gal-3 and can still serve as a cancer biomarker. Although the CRDs retain the binding property of its intact precursor (Gal-3), they lose the ability to cross-link cellular receptors. As a result, the CRDs generated through autolysis may influence cell signaling by competing with intact Gal-3 for the same receptors in cellular environment.

Examining Aspen Expansion in a Native Fescue Grassland Through Geo-spatial Techniques

Christopher L. Anderson

Native fescue (Fescue spp.) grasslands of the Intermountain West have become increasingly scarce due to agriculture, loss of First Nations land management, and bison (Bison bison) extirpation. This grassland is a biodiversity hot-spot, and home to several threatened species of flora and fauna endemic to the area. Our study site, on the Rocky Mountain Front in Waterton Lakes National Park, Alberta Canada, consists of 30 discrete aspen stands (Populous tremuloides) which are encroaching on this rare shortgrass prairie. Parks Canada is attempting to suppress aspen expansion and improve habitat through natural means of ecological restoration, such as fire and elk (Cervus elaphus) browse. Prescribed burns will decrease woody vegetation through adult stem mortality while stimulating regeneration, which is subsequently browsed by elk. The park is also home to several wolf packs (Canis lupus), which prey on the elk; thus, affecting aspen regeneration spatially. These dynamics give a natural laboratory for examining the interaction of fire, elk, wolves, and aspen. We measured the aspen stands at various levels of growth before and after fire to determine overall expansion. All pre-fire measurements were taken during the summer of 2016 with a Trimble mapping grade GPS unit. Post fire measurements were taken during the summer of 2017 with a Trimble UX5HP unmanned aerial system (UAS). Measurements were also taken of a subset of aspen stands in 2017 with the GPS to ground truth the aerial photography data. The result will be a series of polygons overlaid on one another, creating a map of how flora types occur. The two data collection techniques will also be compared to assess the usability of aerial photography as a replacement for the handheld GPS. Photogrammetry, spatial statistics and georeferencing are currently under analysis through Trimble Business Center, ERDAS Imagine and ArcGIS.

Graduate Research Colloquium Banquet

MUB Ballroom, Wednesday, February 28, 2018 at 6:00 PM

The graduate research colloquium is the largest event hosted by the Graduate Student Government. At this event, everyone involved with the GRC; both planning and participating, help the graduate student government congratulate the graduate students and faculty who receive awards. The awards given at the Graduate Research Colloquium include:

- Dean's Award for Outstanding Scholarship
- Outstanding Graduate Student Teaching Award
- Graduate Student Service Award
- Presentation Awards (1^{st}, 2^{nd}, 3^{rd} place)
- Poster Awards (1^{st}, 2^{nd}, 3^{rd} place)
- Exceptional Student Scholar Award
- Exceptional Student Leader Award
- Exceptional Graduate Mentor Award
- Exceptional Staff Member

Awards

Graduate School Awards

The graduate school sponsors three awards to honor students that have committed an extraordinary amount of time to their studies, instructing others or serving their graduate community. This awards include:

Dean's Award for Outstanding Scholarship
This award is given to one graduate student per department in recognition of their academic success in their chosen field.

Outstanding Graduate Student Teaching Award
This award is given to one graduate student per department in recognition of their exceptional ability as a teacher and excellent evaluations from students.

Graduate Student Service Award
This award is given to graduate students nominated by the GSG Executive Board for their outstanding contributions to graduate education at Michigan Tech.

Graduate Research Colloquium Awards

Graduate students participating in the GRC are judged by Michigan Tech faculty based upon the quality of their work and ability to present in a professional manner. The best three oral presentations and the best three posters are granted a certificate of recognition and a cash prize of $300 for 1st place, $200 for 2nd place or $100 for 3rd place.

Graduate Student Government Merit Awards

The GSG sponsors three awards to honor outstanding work by two graduate students and one faculty mentor. The recipients of these awards were nominated by their colleagues, peers and supervisors and reviewed by the GSG Executive Board.

Exceptional Student Scholar
One graduate student is awarded with a plaque and $300 for their excellence in academic pursuits, performance inside and outside the classroom, research achievements, publications and presentations, and exceptional work ethic.

Exceptional Student Leader
One graduate student is awarded with a plaque and $300 for their ability to work with others, participation in extra-curricular activities, contribution to their department and graduate student community, collegial attitude and demeanor, and integrity.

Exceptional Graduate Mentor
One faculty member is awarded with a plaque for their collegial and professional excellence, advocacy for graduate students, availability to graduate students, awareness to graduate student opportunities, inter-disciplinary collaboration, and creativity to avail new opportunities to graduate students.

Exceptional Staff Member

One Staff member is awarded with a plaque for their professional excellence and advocacy for graduate students, availability to help and encourage students, inter-departmental communication and creativity to avail new opportunities for students.

Acknowledgements

The Graduate Student Government would like to acknowledge the GSG Academic Committee, the GSG Executive Board and the Graduate School for planning, organizing, supporting and participating in the 2016 Graduate Research Colloquium (GRC), all the volunteers who helped make the event happen, the judges for volunteering their time and the presenters for their participation.