BIOSCIENCES

1. Support Vector Machine Based Test for Incongruence between Sets of Trees in Tree Space

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The increased use of multi-locus data sets for phylogenetic reconstruction has increased the need to determine whether loci under consideration have evolved under similar evolutionary processes (e.g. the neutral coalescent) or whether a gene tree or set of gene trees significantly deviate from the phylogenetic patterns of other genes. Such unusual gene trees may have been influenced by other evolutionary processes such as selection, gene duplication, or horizontal gene transfer. Motivated by this problem we propose a nonparametric goodness-of-fit test for two empirical distributions of gene trees, and we developed the software GeneOut to estimate a p-value for the test. Our approach maps trees into a multi-dimensional vector space and then applies support vector machines (SVMs) to measure the separation between two sets of trees. We use a permutation test to assess the significance of the SVM separation. To demonstrate the performance of GeneOut, we applied it to the comparison of gene trees simulated within different species trees across a range of species tree depths. When applied to DNA sequence data simulated from different sets of gene trees, results in the form of receiver operating characteristic (ROC) curves indicated that GeneOut performed well in the detection of differences between sets of trees with different distributions in a multi-dimensional space. Furthermore, it controlled false positive and false negative rates very well. The non-parametric nature of our statistical test makes it an applicable test for any scenario where evolutionary or other factors can lead to trees with different multi-dimensional distributions.

Keywords: phylogenetic trees, non-parametric hypothesis test, support vector machines, supervised clustering

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2. Preclinical Development of NEXT Tissue Revitalization Technology for Degenerative Disc Disease

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The demonstrated ability of certain non-toxic chemical agents to provide fast-acting, long lasting, and inexpensive repairs to load-supporting tissues like the intervertebral disc provides the opportunity for unique new therapeutic options. Genipin-based Nonsurgical EXogenous crosslink Therapy (NEXT) has been shown to address the core, underlying factors contributing to degenerative disc disease—nutritional deficiency and mechanical insufficiency of the disc—while also addressing known pain generators directly by reducing joint instability, reducing disc bulge under load, increasing tear resistance, and providing a level of adhesion of adjacent tissue layers to resist release of catabolic agents from degraded discs. NEXT has also been shown to dramatically and immediately improve tissue mechanical properties including strength, toughness, and fatigue resistance. Recent testing supported by the Kentucky SBIR Matching Funds has shown that NEXT has the ability to maintain disc hydration by increasing retention of water attracting molecules, a critically important function for pain-free load support. Other recent pre-clinical testing was directed at quantifying dose response including evaluating the effect of repeated treatments. In addition, worst-case neurotoxicity testing confirmed that there were no treatment related effects following epidural injections in rats. Newly formed strategic alliances with UK, Hagyard Equine Medical Institute, and Coldstream Laboratories have positioned Orthopeutics to launch a new entity, Equinext, to investigate and commercialize NEXT-based treatment options for

equine musculoskeletal health.

Keywords: collagen crosslinking, adhesive properties, glycosaminoglycan retention, dosing, neurotoxicity

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3. Polyadenylation of Stored mRNA During Seed Germination

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Seed germination is a critical control point in the plant life cycle, demarcating the transition from the stage most impervious to that most susceptible to the environment. Crop production, weed management, and the establishment and range of native- and invasive-species all depend upon whether and when seeds in a population complete germination and how quickly and uniformly they do so. Thus, mechanisms that regulate germination are of great importance. Germination is sensitive to inhibitors that affect cellular poly(A) polymerases, yet surprisingly insensitive to more general inhibitors of transcription by RNA polymerase II. In concert with this, seeds may accumulate a sizeable population of non-polyadenylated mRNAs. This body of work frames the hypothesis that is the subject of this project. This hypothesis holds that the polyadenylation of stored mRNAs is vital for seed development and germination. To test this hypothesis, polyadenylated and unadenylated RNAs that accumulate in the course of seed germination are being characterized. For this, a novel deep-sequencing approach has been developed. Using this approach, the 3′ ends of polyadenylated and unadenylated RNAs that are present in dry seed have been studied. The results confirm that populations of unadenylated RNAs do accumulate in the seed, and that high-throughput sequencing can be used to study unadenylated RNAs in the course of seed germination.

Keywords: unadenylated RNA, seed germination

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4. Exploiting Osmosis for Size-Based Separation of Blood Cells into Subpopulations Using Microfluidics

Vahidreza Parichehreh*, Srikanth Suresh Kumar, Kranthi Kumar Bhavanam , Rosendo Estrada, Palaniappan Sethu
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Blood leukocytes or white blood cells (WBCs) provide an ideal sample to monitor systemic changes and understand molecular signaling mechanisms involved in disease processes. Blood samples need to be processed to deplete contaminating erythrocytes or red blood cells (RBCs) and sorted into different WBC sub-populations prior to analysis. This is typically accomplished using immune-affinity protocols which result in undesirable activation. An alternative is size based sorting which by itself is unsuitable for WBCs sorting due to size overlap between different sub-populations. To overcome this limitation we investigated the possibility of using controlled osmotic exposure to deplete and/or create a differential size increase between WBC populations. RBCs and WBC sub-populations isolated using density gradient separation were studied using a microfluidic device and the size increase and lysis of blood cells following exposure to deionized (DI) water was monitored. Time lapse microscopy confirms depletion of RBCs within 15 seconds and creation of > 3 μm size difference between lymphocytes, monocytes and granulocytes. A flow through device was also used to expose different WBCs to DI water for 30, 60 and 90 seconds to quantify cell loss and activation. Results confirm preservation of ~100% of monocytes, granulocytes and loss of ~30% of lymphocytes (mostly CD_3+/CD_4+) with minimal activation. These results indicate feasibility of this approach for monocyte, granulocyte and lymphocyte (sub-populations) isolation based on size.

Keywords: osmosis, blood leukocytes, microfluidic

5. Elimination of Ergot Alkaloid Production in a Forage Grass through Genetic Manipulation of its Symbiotic Fungus

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Tall fescue is an agronomically important cool-season grass grown extensively across the United States. Stand longevity and high forage yields, along with good resistance to various stresses, depend in part on the presence of the symbiotic fungus, Neotyphodium coenophialum (endophyte). This mutualistic relationship, however, can have a detrimental effect on cattle performance due to the ergot alkaloids produced by N. coenophialum. Therefore, we are eliminating the ability of an N. coenophialum strain to produce ergot alkaloids by deleting dmaW, the gene for the first step of the ergot alkaloid-biosynthesis pathway. The endophyte has two copies of dmaW, and we have eliminated dmaW2 by replacing it with a foreign marker gene, which we then removed. We then attempted the same strategy to eliminate dmaW1, but were unsuccessful after screening more than 600 transformants. However, by sequencing the 95-Mb genome of N. coenophialum, we revealed that dmaW1 is part of a telomeric cluster of ergot-alkaloid biosynthesis (EAS1) genes. This result presented us with an alternative and more feasible approach to remove the entire EAS1 cluster. For this purpose we have designed a transformation vector to recombine with lpsA1, the 10-kb EAS gene on the centromeric side of the cluster, and by subsequent spontaneous or Cre-recombinase-mediated removal of the selectable marker, to leave a telomere-protected chromosome end. The resulting endophyte strain is expected to lack ergot alkaloids as well as the foreign marker genes used in its construction, making it suitable for introduction into tall fescue cultivars.

Keywords: forage grass, tall fescue toxicosis, alkaloid biosynthesis, symbiosis, endophyte

6. Mechanisms Involved in Retinal Surface Scar Formation

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Fibrotic diseases are often initiated by epithelial cell damage. Upon damage epithelial cells undergo epithelial-mesenchymal transition (EMT) to assume a migratory mesenchymal phenotype. In cases that result in fibrosis, such mesenchymal cells are known to further differentiate into myofibroblasts. Aberrant and persistent induction of myofibroblasts is believed to cause fibrotic diseases. Numerous studies have shown that transforming growth factor-beta (TGF-ß) plays a critical role in this fibrotic process. Within the eye, formation of fibrotic scarring on the surface of the retina involves EMT and myofibroblast transformation of retina pigment epithelial (RPE) cells. Similar to other fibrotic diseases, TGF-ß has strongly been implicated to play an important role in such retinal surface scarring. However, the precise mechanism is still not clear, and therefore, in this project, experiments were conducted to understand the mechanisms involved in this potentially blinding disease. An in vitro culture model using primary cultured RPE sheets were utilized to understand the changes that occur during EMT and myofibroblast transformation in the presence or absence of TGF-ß. Immunocyto/histochemical staining and western blot analyses was used to determine expression, localization and/or activation status of various proteins. Our data shows that cell-cell contact is the primary regulator of EMT, with TGF-ß failing to induce EMT in differentiated RPE cells maintaining intact cell-cell contact. Interestingly, however, TGF-ß plays an important secondary role downstream of EMT in inducing myofibroblast transformation.

Keywords: fibrosis, TGF-beta, retina

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7. Development of Hyperactive DNA Transposases by Directed Evolution

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Transposons are a proven, efficient and cost-effective technology for genome modification. Transposon technology has great commercial potential in areas such as gene therapy, therapeutic protein production, and transgenesis. However, in order for transposon technology to be commercially viable in these areas, it will be necessary to create "hyperactive" transposases, enzymes that can mobilize transposons with extreme efficiency. We propose to apply directed evolution (DE) technology to create hyperactive transposases. DE comprises two discrete components: first, genetic diversity is created through the production of a library of genetic variants, and second, the library is evaluated through genetic selection and/or high-throughput screens to identify variants with the desired function(s). DE differs from natural evolution in two key aspects: i) DE is performed under controlled selection pressure for predetermined functions and ii) in DE, "non-natural" functions of practical use may be derived through appropriate selection schemes. Therefore, DE is a powerful tool that is ideal for the creation of hyperactive transposases. For this proposed project we will engineer a newly characterized transponsase, PiggyBac (PB). One major advantage of using PB for transgenesis is that it can carry a very large cargo, able to easily deliver sequences in the 10-15 kB. High quality random or targeted mutant libraries will be generated and screened using flow cytometry-based transposition assays. Selected variants will serve as parents for subsequent rounds of evolution in which positive mutations will be recombined. This project promotes and capitalizes on interactions and collaborations between scientists from University of Kentucky and a Kentucky-based biotech company, Transposagen Biopharmaceuticals, Inc. One of the research focuses of the PI's is the DE of DNA-binding proteins, while Transposagen is a company commercializing mobile DNA technologies and a leader in the functional manipulation of transposons including PB. The breadth of interests of the collaborative team provides experience and expertise in areas including protein engineering by DE, high throughput screening, and functional characterization of hyperactive transposases.

Keywords: __

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8. Endothelial Targeting of Antioxidant Polymer Nanoparticles for the Suppression of Vascular Oxidative Stress

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Vascular oxidative stress is a key pathological process in a variety of disease states (e.g., ischemia – reperfusion injury, hypoxia, and acute lung or renal injury). Oxidative stress is characterized by the formation of a wide range of reactive oxygen species, which can cause severe DNA, protein, and lipid damage leading to cellular dysfunction and death. This type of injury results in a degenerative cycle of propagative damage. It is possible to suppress this injury through the addition of free radical scavengers, which can intercept oxidation of cellular components and thereby attenuate this damage. However, in order for this therapy to be effective, a therapeutic dosage of antioxidants must be delivered to the site of injury. We have previously demonstrated the use of an antioxidant polymer, poly(trolox), to suppress general vascular oxidative stress1. In this work, we evaluate the ability of cell adhesion molecules (PECAM-1) targeted poly(trolox) nanoparticles to suppress injury in a human umbilical vein endothelial cell (HUVEC) model. By incorporating targeting antibodies on the surface of these nanoparticles we

see significant attachment of polymeric carriers to endothelial cells as compared to untargeted polymer nanoparticles. This targeted delivery system also demonstrates the ability to suppress oxidative stress in a cellular model.

Keywords: biomaterials, targeted delivery, oxidative stress

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9. Isothermal Helicase-Dependent DNA Amplification Assays for Detection of Bacterial Pathogens of Horses

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Strangles caused by Streptococcus equi and abortion and uveitis caused by Leptospira interrogans are common diseases of horses in Kentucky. Control of these infections will be facilitated by development of rapid and sensitive assays performed beside the animal or in the veterinarian's office. Simple and portable assays for detection of S. equi and pathogenic leptospira have been developed based on detection of se18.9 (S. equi) and IS287 (L. interrogans) specific sequence using an isothermal helicase-dependent amplification (tHDA) reaction followed by visual detection of the amplicon in a disposable lateral flow cassette or in precast agarose gels using a portable E-Gel iBase Power System. Experimental kits have been produced and evaluated. The specificity and sensitivity of tHDA assays were similar to that of PCR when applied to specimens from horses. Tests require neither expensive equipment nor extensive training of personnel and provide a practical alternative to PCR assays for detection of S. equi and pathogenic leptospira in clinical samples.

Keywords: streptococcus, leptospira, horse, tHDA

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10. Cardiovascular Models of Simulated Moon and Mars Gravities: Head Up Tilt vs Lower Body Unweighting

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Introduction: Models of cardiovascular responses to postural changes in reduced gravity environments should be evaluated prior to exploration class space missions. We compare two models (head-up tilt, HUT, vs body un-weighting, LBPP) to simulate Moon, Mars and Earth gravities. We hypothesized that indexes of segmental (thorax (THX), abdomen (ABD), upper (UL) and lower (LL) leg) and cardiac output (CO) volume shifts, as well as regulatory (blood pressure (BP), heart rate (HR), vascular resistance (VR)) responses to standing would be similarly reduced by LBPP and HUT. Methods: Mean values of cardiac variables were recorded from 21 subjects during 20 minute sessions while supine (simulation of space flight), standing at 100% Body Weight (BW) (Earth), and in the Alter-G trainer (AG) at 40% (Mars) and 20% (Moon) BW. An additional test was conducted on a tilt table while supine and tilted at 80°, 20°, 10° HUT. Results (Mixed Model, $p<0.05$): Differences between the two models were found for SBP (higher in AG, 13 mmHg ± S.E.M.), DBP (higher in AG, 11 mmHg ± S.E.M), SV (lower in AG, 7 ml ± S.E.M.), VR (higher in AG), THX (higher in AG) and ABD Impedances (lower in AG). Conclusion: Body weight unloading via both LBPP and HUT resulted in cardiovascular changes similar to those anticipated in actual reduced gravity environments. The LBPP model (Alter-G) has the advantage of providing a study environment that allows dynamic activity at reduced body weight, however, significant increase in BP in Alter-G gives the HUT model an advantage.

Keywords: weightlessness simulations, blood pressure regulation

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11. Efficacy of Countermeasures to Cardiovascular Deconditioning in Men and Women During Simulated Moon and Mars Explorations

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Our goal has been to develop a countermeasure to mitigate cardiovascular consequences of adaptations to microgravity during space missions. In collaboration with NASA JSC, NASA Ames and Alter G Corp investigators, we conducted studies with the following results: A) Breast high compression garments prevent the increased incidence of orthostatic intolerance seen in the hypovolemia model of spaceflight. Mechanisms of action included better control of blood pressure through a return of more blood to the heart, requiring less need for activation of sympathetic neural reflexes. B) AlterG's "G Trainer" can be used to model cardiovascular responses to standing and walking in Mars and lunar gravities. Controlling lower body positive pressure in the G Trainer offered the opportunity to reduce body weight and return standing stroke volume to supine levels at lower levels of sympathetic activity. In an outreach study, we determined that C) Diabetics with autonomic neuropathy were identifiable using noninvasive measures we developed in previous EPSCoR studies. Those indices pinpoint a failure of cardiovagal reflex regulation of blood pressure in diabetic neuropathy. In the final year, the same consortium of investigators are assessing 1) design of the Alter G seal, 2) effects of Alter G activity in subjects who are cardiovascularly deconditioned, and 3) effects of a short exposure of deconditioned subjects to artificial gravity using NASA Ames' Human Performance Centrifuge. Supported by KYNASA EPSCoR WKU5612, NIH R01N539774 and UK GCRC USPHS # M01RR02602.

Keywords: weightlessness, blood pressure regulation, gravity

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12. Numerical Investigation of A Corrugated Dragonfly Airfoil

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Previous experimental studies on static, bio-inspired corrugated wings have shown that they produce favorable aerodynamic properties such as delayed stall compared to streamlined wings and flat plates at high Reynolds numbers (Re = 10^4). The majority of studies have been carried out with scaled models of dragonfly forewings from the Aeshna Cyanea in either wind tunnels or water channels. In this study, the aerodynamics of a corrugated airfoil was investigated using computational fluid dynamics at a low Reynolds numbers of 1000, with an investigation of the complex vortex structures that form in the corrugated airfoil valleys and around the airfoil. The study shows that at low Reynolds numbers the corrugation does not provide any aerodynamic benefit compared to a flat plate geometery. Instead, the corrugated airfoil generates more drag than the flat plates. A static structural analysis shows that the wing corrugation can increase the resistance to bending moments on the wing structure with reduced thickness and weight.

Keywords: dragonfly, MAV, low Reynolds, flight

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13. Signposts of Planets Around the T-Tauri Star GM Aur

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Circumstellar disks are not only a byproduct of star formation, but are also the place where planets form and migrate. The dominant gas-phase constituent of disks early in their evolution is H2, and its lifetime in the disk limits the time available for gas giant planet formation and migration. It has been suggested that the larger dust grains are confined to the outer disk if the gap or cavity hosts bodies with M > 1 MJ, but because accretion continues onto the star, they must be companions with M < 6 MJ (D'Angelo et al., 2006; Lubow and D'Angelo, 2006; Masset et al., 2006; Rice et al., 2006). Here we present our continued multi-wavelength investigation of GM Aur, a T-Tauri star which hosts a large disk with a central cavity of r = 20 AU. Gaps in transitional disks have been described as optically thin, however, this may not be the case should the disk host one or more planets that preferentially allow only small grains enter the cavity. A novel technique we have used to test this hypothesis has been PSF subtracted high resolution FUV imagery obtained with HST/ACS.

Keywords: circumstellar disks, transitional disks, exoplanets, planet formation, t-tauri stars

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14. Assessing Pollinator Food Sources and Phenology on Eastern Kentucky University's Campus

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Creating habitats for pollinators is a multifaceted and dynamic process. Pollinators need three season blooms cycles in order to survive winters and other harsh climactic events, such as drought. In order to create efficient, sustainable, and effective planting plans and guidelines to address the need for three season bloom cycles, an in-depth understanding of existing habitats is necessary. In my project, a survey of Eastern Kentucky University's existing pollinator friendly plant species was performed. This data was then transferred to GIS maps in order to create a visual database of existing pollinator habitats. Through these visuals, pollen deserts in late summer and early fall were identified. With the information collected from this project, campus officials and students may be able to work together to create a pollinator friendly landscape. This data may also be applied in updating forage maps, so that a greater understanding of climate change's effects on phenology is gained. In this process, pollinator support and advocacy becomes more effective as we gain an understanding of Kentucky's pollinator landscape with the ultimate goal of creating effective relationships between people, habitats, and pollinators.

Keywords: sustainability, ecology, pollinators

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15. Microfluidic Devices to Study the Effect of Atherogenic Flow Pattern on Cultured Endothelial Cells

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Atherosclerotic susceptible regions and the appearance of atherosclerotic lesions are found in

locations of disturbed flow, where arteries divide or curve sharply. Regions of disturbed flow in vivo are associated with high rates of endothelial cells proliferation, apoptosis, failure to align to the direction of the flow, and increased expression of inflammatory mediators. A number of studies have attempted to recreate the flow patterns in vitro that mimic vascular regions of disturbed flow. However, these studies have been done with the use of macroscale systems that provide non-homogeneous conditions and lack of sufficient throughput. In this work, we have fabricated microfluidic devices with grooves that recreate disturbed flow. Computational fluid dynamics simulation shows recirculation within the microgrooves and values of shear stress in the range to those found in atherosclerotic regions. Endothelial cells were seeded in channels with and without (control) microgrooves. Cells exposed to laminar shear stress (control) were elongated, aligned in the direction of the flow and the f-actin filaments oriented in the direction of the shear stress. In contrast, cells within the microgrooves exposed to the same inlet flow rate had cuboidal, cobblestone morphology, random orientation, disorganized f-actin filaments, and showed increased apoptosis. These results demonstrate the ability of these devices to mimic in vitro, the in vivo atherogenic flow pattern. Evaluation of additional atherosclerotic markers is in progress.

Keywords: atherogenic flow pattern, disturbed flow, endothelial cells, in vitro, microfluidic.

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16. Out-of-Planet Electrodes for Microfluidic Pumps

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This poster reports the fabrication process of a microfluidic tube lined with interdigitated electrodes. The entire inner wall becomes a surface for AC electroosmosis-driven pumping. Self folding is the technique used to fabricate the electrodes. This technique depends on the strain mismatch between the tensile stressed film (metal layer) and the compressive stress film (oxidized silicon layer). The electrodes roll up with a well defined radius of curvature in the range of 100-200 microns. The new development over our previous work is the ability to connect two different electrical signals to alternating electrodes using an insulating silicon nitride barrier that allows circuits to cross over each other without shorting. Electroosmotic (EO) micropumps are essential for low-cost, power-efficient microfluidic lab-on-a-chip devices used in diverse application such as analytical probes, drug delivery systems and surgical tools. EO pumps can use DC or AC electric field to drive the solutions through the microchannels. ACEO pumps have been developed since 1990s by several groups to address the drawbacks of the DCEO pumps such as the faradic reaction, gas bubbles and electrode dissolution. The original ACEO microfluidic pump was created with planar arrays of asymmetric electrodes at the bottom of the channel. This rolled-up tube design improves on the planar design by including the channel walls and ceiling in the active pumping surface area of the device.

Keywords: microfluidic, strain, ACEO, pump

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17. Cellular Morphology as a Response to Nutrients and Rapamycin in Ustilago Maydis

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A unique attribute of Ustilago maydis is its ability to form galls on maize. This ability requires that the fungus switches from a yeast-like budding form to a filamentous form. This switch also occurs in response to nutrient deprivation and other environmental cues. While the Target of Rapamycin (TOR) pathway plays an important role in nutrient sensing (as well as other celular processes) in some pathogenic fungi, its role in U. maydis currently remains unclear. This study investigates the role of the TOR pathway in the

dimorphic switch in response to nitrogen limitation. Two integral membrane proteins, Ump1 and Ump2, serve as ammonium transporters and Ump2, in particular, is normally required for U. maydis to switch to filamentous growth on low ammonium (SLAD). We show here that knock out or over-expression of ump2 in conjunction with TOR inhibition via rapamycin treatment, results in morphological changes at both the colony and cellular levels. While treatment of wild type or the ump2 mutant with rapamycin resulted in little or no morphological changes on rich or SLAD media, treatment of other mutant strains produced some dramatic changes in morphology. A strain overexpressing ump2 is filamentous even on rich media. Treatment of this strain with rapamycin led to misshapen or donut-shaped colonies, reminiscent of the "don" mutants associated with cell-separation defects. Additionally, TOR inhibition results in further morphological changes in the ump1-ump2-double mutant, generating a hyper-filamentous phenotype on SLAD; this is in contrast to the tangled short filaments normally produced by this strain. These findings allow us to propose a model for the role of TOR in ammonium sensing and the dimorphic switch to filamentous growth.

Keywords: ustilago maydis, rapamycin, TOR, ammonium transporter

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18. Light-Powered Nanoparticle-Mems Hybrid

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Light-actuated microelectromechanical (MEMS) bistable elements are built using a metal/oxide bilayer with a stress mismatch. In a hybrid design that uses gold nanoparticles for localized heating in response to infrared light, a nanoparticle solution is patterned onto the selected part of the device before releasing the structures from the planar substrate. We use two different printing methods to deposit solutions with pre-synthesized nanoparticles: inkjet-style deposition from a Dimatix material printer and parylene micro-stenciling. Finally, the silicon substrate is isotropically etched to release the MEMS structure, using XeF_2 etchant that is highly selective to silicon but has a little effect on organic materials. Integration of the infrared-resonant gold nanoparticles on bistable MEMS structures creates light-driven hybrid actuators that react to narrow-band infrared light by heating, causing the MEMS device to bend through controlled thermal expansion. The bilayer bistable structure is a strained rectangular frame with two local minimum and short-lived transition states and extremely rapid transition time ($<<0.1$ s) as observed during optical and scanning electron microscopy. Switching from those local minima is determined by thermal expansion from local heating of the printed nanoparticle film and depends on uniformity of distribution, absorbance at the infrared laser wavelength. Actuation at laser power and thermal limits compatible with physiological applications will enable microfluidic pumping elements and fundamental studies of tissue response to three-dimensional mechanical stimuli, artificial-muscle based pumps and other biomedical devices triggered by tissue-permeant infrared light. Cardiac muscle studies are the target application for these light-powered actuators.

Keywords: MEMS, nanoparticle, infrared

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19. Microfluidic Cell Arrays for High-Throughput Culture

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Microfluidic cell arrays (MCAs) offer an attractive platform for massively parallel integration of cell culture with multiple, complex inputs delivered

with in vivo–like temporal resolution. Variables like composition of culture medium, chemical and biological stimulus, and cellular interactions can be varied in a time dependent fashion within a single array. We developed a MCA platform that is applicable for any cell-based study regardless of cell type or evaluation technique. MCA trapped cells in a confined area of low shear stress and when necessary exposing them to the fluid flow for extraction. Types of cells that can be cultured within the array depend on the surface properties of the wells. Cell adherent surfaces ensure 2D monolayer culture whereas cell repellant surfaces are ideal for suspension cell culture or for the formation of spheroid bodies for 3D cultures. To ensure scalable inputs and delivery of complex stimuli, each array had an integrated gradient generator for dose response studies and a flow encoded switch for time dependent delivery of secondary stimulus. Automation of the gradient generator and fluid encoded switch was accomplished by using programmable syringe pumps and LabView. Computational fluid dynamics (CFD) was used to model fluid flow, visualize streamlines and estimate shear stress as well as to estimate diffusional and convectional transport of molecules into the wells. This MCA provides a universal platform for high-throughput studies compatible with any cell type or post-culture analysis technique without minimizing functional complexity attainable using microfluidics.

Keywords: MCAs, CDF, platform, cell arrays

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20. Endothelial Cell Processes at the Intracellular Level on PEG Hydrogels with VEGF

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Angiogenesis is a key biological response known to be involved in many physiological and pathophysiological situations. Three intracellular responses involved in the initial formation of new blood vessels, increases in endothelial cell proliferation, cell migration, and the survival of apoptotic stimuli, have been associated with vascular endothelial growth factor, isoform 165 (VEGF165). Current research in the areas of biomimetics and tissue engineering has focused on developing polyethylene glycol (PEG) based biomimetic systems capable of initiating and sustaining angiogenesis in vitro. However, an in depth understanding of how endothelial cells respond at the molecular level to VEGF165 incorporated into such systems has not been clearly established in the literature. The goal of the current study was to determine the up-regulation of pro-angiogenic proteins in human umbilical vein endothelial cells (hUVEC) and human microvascular endothelial cells (hMEC) seeded on PEG hydrogels containing grafted VEGF165 and adhesion peptides (RGDS). The data suggest that the covalent incorporation of VEGF165 into PEG hydrogels proficiently up-regulates the signaling proteins responsible for increases in endothelial cell proliferation, cell migration, and apoptosis survival.

Keywords: VEGF, angiogenesis, PEG hydrogels, endothelial

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21. Undertaking Behavior in Termites

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Undertaking behavior is an essential adaptation to social life and important for colony hygiene. Unlike Hymenoptera social insects such as ants, in which undertakers remove dead colony members and place the carcasses in a refusal pile away from the nest. This study, however, a lower termite, Reticulitermes flavipes, showed distinctively different undertaking behaviors toward dead termite workers from different origins. Specifically, dead termites from an alien species, R. virginicus, were buried onsite by R. flavipes undertakers while a group of R. flavipes soldiers guarding the burial site; whereas, dead termites from R. flavipes, regardless of their colony origins (KY or OH), were pulled back into the nest by R. flavipes undertakers with few soldiers guarding the entrance. The

genetic underpinnings governing the undertaking behaviors toward corpses from inter- and intra-species will be investigated using a brain chip customized from brain transcriptomes of three lower termite species including R. flavipes, R. virginicus, and Coptotermes formosanus. This study is a part of our efforts to gain a better understadning of the evolution of eusociality in termites using genes with social contents.

Keywords: undertaking behavior, colony hygiene, Reticulitermes flavipes, brain transcriptome, eusociality, termites

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22. Kentucky Initiative in Ecological Genomics

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The Kentucky Initiative in Ecological Genomics (KIEG) supports infrastructure and staff support for high-throughput sequencing at the University of Kentucky Advanced Genetic Technologies Center (UK-AGTC), as well as financial support for new faculty and their students working in the area of ecological genomics. This program has funded the purchase of a Roche/454 Titanium pyrosequencer and ancillary equipment, plus approximately $50,000 of computer hardware and $5,000 in software to handle data generated on the pyrosequencer, whole genome and whole transcriptome assemblies, a Chado database, and GBrowse sites for ongoing genomics projects. The grant supports two full-time graduate research assistants per year, a bioinformatician and the AGTC senior facilities manager. Supported research projects at regional universities include those of Patrick Calie at Eastern Kentucky University, working on native plant phylogenetics, and Hazel Barton at Northern Kentucky University, working on microbes of caves and other low-nutrient ecosystems. Since acquiring and installing the Roche/454 pyrosequencer the instrument has been employed to sequence 16 microbial genomes totaling more than 500 Mb. In addition, numerous transcriptome, phylogenomic and phylogeographical studies have been undertaken based on the capabilities of this instrument. Examples of sequenced genomes include the ergot fungi (Claviceps species) responsible for episodic human poisoning and implicated in the Salem Witch Trials, and the apicomplexan Sarcocystis neurona, a distant relative of the malaria pathogen and a cause of equine neuropathy. Other projects involve transcriptome sequencing of plants, insects, and insect-gut symbionts.

Keywords: ecology, evolution, genomics, infrastructure

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23. Clinical Mass Spectrometry to Quantify Therapeutic and Endogenous Cardenolides with Anti-Cancer Properties

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Digoxin is a plant-derived cardenolide used to treat cardiac arrhythmias, yet several studies indicate that some cancer patients treated with digoxin respond more favorably to cancer therapies. Our lab has shown that the endogenous mammalian cardenolide, digoxin-like immunoreactive factor (DLIF), can selectively kill cancer cells, but spares normal cells. Thus DLIFs may be novel functional indicators of the endogenous anti-tumor response. These endogenous compounds are very difficult to purify and are detected using anti-digoxin antibodies which are inherently neither specific nor sufficiently sensitive for measuring DLIF in serum. Mass spectrometry (MS) provides a reliable, sensitive, and specific alternative. The ultimate objective of this project is to develop a rapid and accurate clinical MS method for measuring endogenous DLIF concentrations in blood. This

abstract reports the initial stage of the project – the development of a clinically validated MS method to quantify digoxin as a surrogate for DLIF. With DLIF purification ongoing, we have utilized both a Fourier-transform ion cyclotron resonance mass spectrometer (FTICR-MS) and a triple stage quadrupole tandem mass spectrometer (TSQ) to begin development of the quantitative digoxin assay. Calibration of the instrument response was linear for both instruments ($r2 > 0.99$) and highly reproducible (CV <15% at the low end of the dynamic range). The TSQ was the more sensitive instrument with a lower limit of detection ~0.1 ng/mL. This work sets the stage for measurement of endogenous DLIF in serum using MS. Supported by Kentucky Science & Engineering Foundation Grant #148-502-10-263, NSF/EPSCoR Grant #EPS-044749, and NIEHS P30ES014443.

Keywords: digoxin, DLIF, cancer, mass spectrometry

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24. Numerical Simulation for the Hydrodynamic Focusing Effect in the Microfluidic Coulter Counter

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Micro fluidic Coulter counter is an electrical impedance-based device for counting and sizing particles and cells. When a non-conductive cell passes through the electrical field, it causes a signal spike. The number and size of cells can be obtained by analyzing the signal. The quality of the signal is largely affected by the width of the sample conductive stream. The best signal usually is obtained when the width of the sample stream is comparable to the cell diameter. In a Coulter counter, hydrodynamic focusing technology can be used to control the sample stream width through adjusting the sheath and sample stream flow ratio. The focus of this work is to use a numerical approach to understand the impact of the flow ratio on the width of the sample stream. One of the main tasks is simulating the correlation between the diffusion coefficients, velocity ratio and the sample distribution which can be useful to help researchers to get the better signal. Others including cells moving is simulated with considering the hydrodynamic focusing affect. An hourglass-shaped conductive stream is also simulated to help the experiment scientists adjust the velocity ratio to meet the desirable data.

Keywords: Coulter counter, hydrodynamic focusing, concentration

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25. Identification of Parameters to Quantitatively Assess Leukocyte Mechanosensitivity

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Fluid flow-derived shear stresses deactivate leukocytes by minimizing their pseudopod activity and surface expression of adhesive CD18 integrins under physiological conditions. Impairment of theses responses has been linked to a chronic inflammatory state prevalent in cardiovascular diseases (e.g., hypercholesterolemia). Fundamentally, such a link suggests that leukocyte mechanosensitivity is critical for circulatory homeostasis. Based on this, a goal of our lab is to identify potential measures of leukocyte shear sensitivity for use as indicators of the onset/progression of hypercholesterolemia-related pathologies. For this purpose, we explored the use of shear-induced pseudopod retraction and CD18 cleavage as potential parameters. Our results showed that, at the functional level, shear-induced pseudopod retraction by human leukocytes diminished and eventually reversed after incubation with increasing concentrations of membrane cholesterol-enhancing agents and highly correlated ($R2=0.96$; $p<0.0001$) with cholesterol-dependent membrane fluidity. At the

molecular level, fluid shear exposure time-dependently downregulated the surface expression of CD18 by neutrophils, monocytes and lymphocytes; notably, shear-induced reductions in cell-surface CD18 were receptor subtype-specific. Together, these results provided evidence that leukocyte mechanosensitivity depends on cell membrane fluidity and cell type contingent on their differential expression and cleavage of CD18 subtypes. In this regard, the degree of pseudopod retraction and CD18 downregulation by leukocytes in response to shear flow may be used as indicators of leukocyte-specific shear mechanosensitivity. As such, the results of our studies provided a basis for future efforts to develop micro-scale flow devices for use as diagnostic tools that employ quantitative leukocyte mechanosensitivity indices as indicators of cardiovascular health status.

Keywords: fluid shear stress, pseudopod retraction, CD18 cleavage

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26. Cuticle Plays an Important Role in Basal as well as Induced Defense Against Bacterial and Fungal Pathogens

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Systemic acquired resistance (SAR) is a phenomenon in plants that confers protective immunity in the distal tissues towards secondary infections by related or unrelated pathogens. SAR involves the generation of mobile signal (s) at the site of primary infection, which then translocates to, and activates defense responses in the distal tissues. Although several signals have been implicated to play a role in SAR, the signaling events leading to activation of SAR still remains unclear. Recently, we showed an intact cuticle is required for decoding of the mobile signal in the distal tissues. Genetic mutations leading to abnormal cuticle or physical damage of cuticle on the distal leaves compromised SAR. The requirement for intact cuticle was only relevant within the time frame of mobile signal generation and translocation to the distal tissues. Since most mutations affecting cuticle development also impair fatty acid (FA) and/or lipid biosynthesis, we studied a role for these in SAR. Our results show impaired biosynthesis of FAs or lipids do not contribute to SAR. we have uncovered several mutations that specifically alter cuticle without influencing FA or lipid biosynthesis and they were impaired in SAR. Besides SAR, most mutants with abnormal cuticle showed enhanced susceptibility to necrotrophic fungal pathogens and this phenotype did not correlate with cuticular permeability. The studies demonstrate an important role for cuticle in induced as well as basal defense responses.

Keywords: cuticle, systemic acquired resistance, Basal defense

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27. EDS1 and Salicylic Acid Act Redundantly to Regulate Oleic Acid-Mediated Defense Signaling

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Oleic acid (18:1) is one of the major monounsaturated fatty acids (FA) in plants and its biosynthesis is catalyzed by the SSI2 encoded soluble stearoyl-acyl-carrier-protein-desaturase (SACPD). We have previously shown that reduction in the 18:1 levels, via a mutation in ssi2 or silencing of SACPD genes, results in constitutive activation of plant defense pathways in Arabidopsis and soybean, respectively. More recently, we have provided evidence linking 18:1 levels with resistance (R) gene expression and pathogen resistance. Lowering the levels of 18:1, via genetic mutations in SSI2, or by exogenous application of glycerol, induces the expression of several R genes. Genome-wide analysis showed that at least 25 R genes (and R proteins) were upregulated in the ssi2 plants in a salicylic acid (SA)-independent manner. Detailed characterization showed that SA acts

redundantly with EDS1 (enhanced disease susceptibility 1) to regulate 18:1-mediated signaling. Notably, EDS1 function is also redundant between two isoforms and either of these can function in 18:1 regulated pathway. Detailed molecular and biochemical characterization of 18:1 regulated pathway will be presented.

Keywords: salicylic acid, EDS1, oleic acid, defense signaling

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28. Externally Directed AMF-Triggered Release of Doxorubicin from Magnetic Carriers

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Iron oxide nanoparticles (NPs) have attracted a great deal of attention recently as agents for nano-therapeutics. The magnetic properties as well as other inherent features, such as low cytotoxicity, ease of functionalization and colloidal stability, makes these NPs ideal for biomedical applications. Importantly, magnetic NPs generate heat when induced with an alternating magnetic field (AMF) via magnetic oscillations of their magnetic moments. This unique property has been well studied and applied in hyperthermia treatment where heat generated (ca. 42-45 ºC) kills tumor cells in the presence of healthy cells. Here we demonstrate an externally controlled AMF-triggered nano-magnetic drug delivery system in which custom drug-loaded iron oxide nanoparticles release cargo in response to the heat generated on AMF-induction. We have designed a nano-magnetic delivery system for the anti-cancer drug doxorubicin (Dox) by loading an oxime ether doxorubicin-conjugate onto iron oxide nanoparticles nanoparticles. A drug release study shows that ~70% of the Dox conjugate is released when exposed to an AMF for 15 min. A cytoxocity study using MCF-7 cells treated with the nanomagnetic Dox formulation revealed that cell death occurred only upon AMF-irradiation. This novel nano-magnetic carrier has potential to be a non-invasive and externally controlled drug delivery system for cancer therapeutics.

Keywords: doxorubicin, doxorubicin delivery, alternating magnetic field-induced drug delivery, hyperthermia, magnetic nanoparticle, oximation, oxime

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29. MG53 Mediated Muscle Membrane Repair

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Ischemic heart disease is the most common cause of death in most Western countries. Developing novel therapeutic approaches that can directly target the causes of cardiomyocyte death during Ischemia/reperfusion (IR) injury will have broad translational potential. One pathway with great potential as a therapeutic target in regenerative medicine is the process by which individual cells repair their plasma membrane following injury. We previously found that MG53 is a novel, muscle-specific member of the TRIM family of proteins (TRIM72), which contributes to the dynamic membrane repair process in skeletal muscle. However, the role of MG53 in myocardial protection remains unknown. Recently, we found that the mg53-/- hearts are vulnerable to ischemia-reperfusion injury and increased MG53 expression can protect cardiomyocytes from oxidative-stress induced cell death. And the acute injury of the cell membrane leads to exposure of a signal to the extracellular space that can be detected by MG53, allowing recombinant MG53 to repair membrane damage when provided in the extracellular space. Our data also showed that recombinant MG53 purified from E. coli retains efficient membrane repair function, supporting the therapeutic value of

targeting MG53 in heart injury and other human diseases. The results may provide novel insights into proof-of-principle studies to develop effective protein-based therapies for cardiac repair in patients with cardiovascular diseases.

Keywords: MG53, membrane repair, heart failure, ischemia/reperfusion

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30. Use of a Virus-Based Vector for Stable Protein Expression and Gene Function Studies in Soybean

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Plant virus-based vectors provide an attractive and cost effective means for stable protein expression and gene function studies in soybean. Soybean is the top oilseed crop in the world and presents an important multi-billion dollar, source of high quality protein. There is critical need at present for tools that allow for rapid evaluation of new traits involving expression of beneficial proteins. In the present study, we used the bean pod mottle virus (BPMV)-based vector to explore the expression of two important soybean defense-related genes SCaM4 and GmFAD3. SCaM4 encodes a specific isoform of the soybean protein calmodulin. Overexpression of SCaM4 in soybean resulted in increased resistance to the root and stem rot pathogen, Phytophthora sojae, the Alternaria leaf spot fungus, Alternaria tenuissima and the pod and stem blight fungus, Phomopsis longicolla. Silencing of SCaM4, on the other hand, resulted in enhanced susceptibility to these three pathogens. Furthermore, the SCaM4-overexpressing soybean plants exhibited increased tolerance to high salt conditions. In another set of experiments, silencing of three genes coding for microsomal isoforms of the omega-3 fatty acid desaturase (GmFAD3) increased levels of the hormone jasmonic acid (JA) and JA- responsive defense genes as well as enhanced resistance to Phytophthora sojae. Furthermore, GmFAD3-silenced plants produced seeds that were significantly larger in size and weight. Our results thus show that the GmFAD3 genes modulate diverse biological processes including seed development and defense signaling in soybean. We have also used the BPMV vector for rapid evaluation of proteins with known antifungal or anti-nematode activities.

Keywords: virus vectors, soybean, protein expression,disease resistance

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31. Progressive Rod Degeneration in Miniature Pig Model of Retinitis Pigmentosa

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PURPOSE: We have developed a model of retinitis pigmentosa (RP) using somatic cell nuclear transfer with the most common rhodopsin mutation in autosomal dominant RP (Pro23His) in an inbred miniature pig. The aim of this study is to characterize the progression of retinal degeneration in the P23H pig retina during the period of maximum photoreceptor degeneration; thus, contributing useful data for exploiting this novel pig eye model and providing a biomedical model that is ideal for therapeutic interventions involving cell transplantation and other therapies. METHODS: Pig eyes were examined and monitored using ophthalmoscopy, fundus photography, fluorescein angiography and OCT from postnatal day 1 (P1) to 18 months of age. Retinal degeneration was assessed by histology and immunocytochemistry of rod and cone photoreceptor markers. Photoreceptor cell apototosis was examined using TUNNEL staining. RESULTS: Photoreceptor cell death was evident at P1, and OCT demonstrated marked retinal thinning at 21 months; H&E staining of retinal sections demonstrated that only one row of photoreceptors

remained in the outer nuclear layer at this time. Immunostaining demonstrated a progressive loss of rod photoreceptors during the period between P1 and 18 months of age. And, by 21 months of age, cones comprised the single row of photoreceptors remaining. CONCLUSIONS: The P23H miniature pig displays progressive loss of rod photoreceptors mimicking what is observed in RP patients. Thus, these transgenic pigs represent a large animal model of rod photoreceptor loss which can be used in future studies of cell transplantation or other therapies for retinal repair.

Keywords: retinal degeneration, retinitis pigmentosa, pig model

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32. Spinal Posture and Gait-Related Vertebral Body Motion in Normal Older and Normal Younger Female Subjects

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Spontaneous vertebral fractures are a large and growing health care problem. Abnormal posture or gait-related motion may induce altered spinal kinematics that in turn increase the likelihood of these fractures. The goal of this research was to quantify spinal posture and gait-related spinal motion parameters in older and younger subjects to determine the effect of age. Static x-rays and a 3D optical method for measuring spinal motion during gait were employed to quantify spinal postural and motion parameters in 12 older (age:58.4±5.1years) and 12 younger subjects (age: 26.3 ± 3.7 years). Vertebral motion around 3 axes was measured at 4 levels (T7,T10,T12,L2) by using noninvasive retroreflective markers during treadmill gait at 3 speeds (0.5,0.7,0.9m/s). The average angular motion of all gait cycles at each speed was determined for each level. The tri-planar ranges of motion and the variability of motion were compared as a function of age. Older subjects had 31.7% larger (p=.036) frontal Cobb angles and up to 30.9% and 33.5% smaller (p=.005 and p=.001) ranges of spinal motion in the frontal and sagittal planes, respectively, compared to younger subjects. Variability of motion in the sagittal plane was up to 42.9% less in older subjects. Decreased ranges and variability of spinal motion observed in older subjects may imply that gait-related loads are not as uniformly distributed across the vertebrae in the elderly. If greater stresses result from the abnormal motion, the likelihood of fatigue fracture may increase. Simple and inexpensive countermeasures to prevent fractures by restoring more normal spinal motion may be possible.

Keywords: spinal kinematics, vertebral fracture, aging, skin markers, gait-related spinal motion

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33. Simple Modeling to Study Prediction and Prevention of Fragility Fractures of the Hip

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AIM: The objective of this project was to apply mechanical testing models and finite element analyses to determine the influence of bone quality, cortical thickness, and a novel implantable device on the fracture risk of the femoral neck loaded to simulate a fall to the side. METHODS: Mechanical testing of hip models and axisymmetric finite element analysis (FEA) simulated the compressive buckling fracture of the superolateral cortex of the femoral neck that often occurs in a fall to the side. In the FEA, the maximum von Mises stress in the femoral neck was determined for each model. RESULTS: The femoral neck "failed" when there was zero cortical thickness combined with low density cancellous bone and also when there was a thin (0.5 mm) cortex and no cancellous bone in the neck region. Both of these conditions were

protected from failure by the device. With 1.5 mm or greater cortex thickness, the risk of fracture was always less than 33%. CONCLUSIONS: Cortical wall thickness and cancellous bone distribution are much better predictors of femoral neck fracture risk than cancellous bone density in computational simulation of fragility hip fractures. A simple metallic implant device can decrease the risk of such fractures, particularly in the poorest quality bone.

Keywords: osteoporosis, fracture, hip, implant, bone

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34. Numerical Simulation for the Hydrodynamic Focusing Effect in the Microfluidic Coulter Counter

Muheng Zhang*(1), Yongsheng Lian(1), Cindy Harnett(2)
(1)University of Louisville Mechanical Department, (2)University of Louisville Electrical and Computer Engineering Department

Micro fluidic Coulter counter is an electrical impedance-based device for counting and sizing particles and cells. When a non-conductive cell passes through the electrical field, it causes a signal spike. The number and size of cells can be obtained by analyzing the signal. The quality of the signal is largely affected by the width of the sample conductive stream. The best signal usually is obtained when the width of the sample stream is comparable to the cell diameter. In a Coulter counter, hydrodynamic focusing technology can be used to control the sample stream width through adjusting the sheath and sample stream flow ratio. The focus of this work is to use a numerical approach to understand the impact of the flow ratio on the width of the sample stream. The correlation between the sample distribution and the diffusion coefficient can be useful to help researchers to adjust the sample concentration, so does the ratio of the velocities between the sample stream and the sheath streams. An approximate function is given to calculate the vertical position of the concentration peak. The displacement between the two cells can be increased in horizontal direction but decreased in the vertical direction by the hydrodynamic focusing affect. An hourglass-shaped conductive stream is simulated and this is can be helpful for experiment scientists to adjust the velocity ratio to meet the desirable data.

Keywords: Coulter counter, hydrodynamic focusing, concentration

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35. Search for Earth-Like Planets Outside Our Solar System Using Transit Timing Variations

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The discovery of more than 500 planets orbiting stars other than the Sun (exoplanets) over the past 15 years has confirmed that the Sun is not unique among stars in hosting planets. However, this discovery is only a starting point in the quest to determine if life exists beyond our solar system. Most of these planets have a mass similar to Jupiter in our solar system, but they orbit very near their host star (i.e. hot Jupiters). In this project, we study known hot Jupiter exoplanets using a technique called Transit Timing Variation (TTV), which is capable of detecting Earth-mass planets in the same exoplanetary system. An important technique used to find and observe exoplanets depends on the small geometric chance that an exoplanet's orbit passes directly through the line of sight from Earth to the exoplanet's host star. As the planet crosses in front of (i.e. transits) its star each orbit, it blocks a small amount of the star's light, causing it to appear to dim slightly. A time-series of precision measurements of the apparent dimming using photometry yields a wealth of information about the exoplanet. One characteristic that can be measured is the precise time that a planet passes in front of its star during each orbit. If no other planets are in the system, the known exoplanet will pass in front of its star at precisely the same interval for each orbit. However, if a second (unknown)

exoplanet is orbiting the same star, the interval between transit times of the known exoplanet will vary slightly due to gravitational interactions between the two planets. These TTVs can be measured by observing multiple transits of an exoplanet and determining the difference in the observed and predicted regular interval transit times. Using orbital dynamics models, probable masses and orbital periods can then be determined for a perturbing exoplanet. When two planets are in mean-motion resonant orbits, the TTV method is sensitive to even Earth-mass exoplanets. In this work we discuss our early results, including TTV measurements for exoplanet WASP-12b. We are conducting this research utilizing telescope facilities at Moore Observatory near Louisville, Kentucky and Mt. Kent Observatory near Toowoomba in Queensland, Australia.

Keywords: astronomy, planets, exoplanets, transit timing variations WASP-12b

HUMAN HEALTH AND DEVELOPMENT

36. Effects of Non-Oral Feeding on Infant Tongue Muscle Mass and Force

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Safe and efficient feeding is a critical milestone for infants in the Neonatal Intensive Care Unit (Pickler, 2004). The tongue is a driving force of the infant swallow (Wolf & Glass, 1992); understanding the impact of extended non-oral feeding on infant tongue muscle mass would broaden the understanding of factors that contribute to infant feeding and swallowing problems. The aim of this study was to develop and test reliable, noninvasive procedures for measuring and interpreting tongue muscle thickness and force in infants. Three groups of infants were recruited; healthy full term, healthy late-term, and preterm. Muscle mass was estimated from measures of tongue thickness using ultrasonography. Muscle force produced by the infant tongue during nutritive sucking and nonnutritive sucking was measured using biomechanical and engineering methods to instrument bottle nipples and pacifiers. Examination of muscle thickness suggests difference between infant groups; mean tongue thickness was greatest for full term infants. Examination of force data suggests differences in tongue force and rhythm between full term and preterm infants for both nutritive and nonnutritive sucking. These techniques hold promise for measuring infant tongue muscle thickness and force. These pilot data must be interpreted cautiously but suggest differences in tongue muscle characteristics for healthy versus preterm infants. Such measures may help to inform us regarding the impact of extended non oral feeding in special infant populations.

Keywords: infant, tongue, muscle mass, force

37. Cigarette Smoke Extract Enhanced Ambient Ultrafine Particle-Induced Oxidative Stress in Endothelial Cells

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Previous studies have shown that ambient ultrafine particles (UFPs) may pass from the lungs to the circulation because of their very small diameter, and induce lung oxidative stress with a resultant dysfunction of lung endothelial cells. A number of epidemiological studies have shown that cigarette smoke induces cardiovascular disease. However, no studies have addressed the potential combined effects of UFPs and cigarette smoke on vascular endothelial cells. We hypothesized that co-exposure to UFPs with cigarette smoke extract (CSE) may cause combined effects on activation of

endothelial cells and dysfunction of endothelium by oxidative stress through activation of NADPH oxidase. We determined the combined effects of UFPs with or without CSE on mouse pulmonary microvascular endothelial cells (MPMVEC) obtained from wild-type mice and gp91phox knock-out mice (gp91phox is one of the key components of NADPH oxidase, which is located in the cell membrane), respectively. Our results showed that exposure of MPMVEC from wide-type mice to UFPs, CSE or UFPs with CSE, at a non-toxic dose, induced reactive oxygen species (ROS) generation, increased phosphorylation of p38 and Erk1/2, and up-regulation of early growth response -1 (Egr-1) and IL-6 expression. Furthermore, exposure of MPMVEC from wide-type mice to UFPs with CSE caused significantly increased ROS generation compared to those exposed to UFPs or CSE alone. Our results also showed that there were combined effects of increased phosphorylation of p38 and Erk1/2, upregulation of Egr-1 and IL-6 expression when MPMVEC from wide-type mice were exposed to UFPs with CSE. However, exposure of MPMVEC from gp91phox knock-out mice did not induce the above effects. UFPs- and/or CSE-induced Egr-1 mRNA upregulation was attenuated significantly when cells were pre-treated with a p38 specific inhibitor, SB 203580, and Egr-1 siRNA treatment abolished UFPs- and/or CSE-induced overexpression of IL-6. Our results suggest that UFPs, CSE, and UFPs with CSE caused the activation of NADPH oxidase, resulting in ROS generation that led to activation of MAPKs through induced phosphorylation of p38 and ERK1/2 MAPKs and upregulation of Egr-1. Those effects may further result in endothelial dysfunction through production of cytokines such as IL-6. Our results suggest that co-exposure to UFPs and CSE causes combined injury to endothelial cells than exposure to UFPs or CSE along.

Keywords: ultrafine particles, cigarette smoke extract, reactive oxygen species, NADPH oxidase, gp91phox, MAPKs, Egr-1, IL-6.

38. Computer Modeling of Biomechanical Mechanisms of Orthostatic Intolerance

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A large fraction of astronauts returning to earth suffer dizziness and other symptoms of orthostatic intolerance. While a wide range of factors may contribute to this problem, the loss of circulating blood due to capillary filtration is one of few that can explain the gradual decline of arterial pressure during stand tests. Over the past decade, we have used a computer model to investigate the relative importance of these hemodynamic parameters as contributors to orthostatic intolerance. In our most recent simulations, orthostatic tolerance times were compared to previous experiments combining head up tilt (HUT) and lower body negative pressure (LBNP) graded orthostatic stress, which provided hemodynamic data that allowed subject-specific modeling of capillary transport. The seven-compartment cardiovascular system model used measured heart rate, stroke volume, total peripheral resistance, mean arterial pressure and hematocrit data for twelve subjects. Simulations were controlled by decreasing the total blood volume at the measured rates of capillary filtration until cerebral pressure dropped below a threshold for consciousness. For an Wilcoxon alpha level of 0.05, there was no statistical difference in modeled times to syncope and actual times to presyncope. Both arterial pressure and cardiac output were most sensitive to total blood volume and least sensitive to caudal compliance parameters. The feasibility of subject-specific simulations of cardiovascular response to orthostatic stress was demonstrated, providing stronger evidence that capillary filtration is a prominent mechanism in causing orthostatic intolerance.

Keywords: computer modeling, biomechanical mechanisms, orthostatic intolerance

39. Fluid Pressure Selectively Influences

Endothelial Cell-Related Tubulogenic Activity

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The United Network for Organ Sharing reported in 2010 that >100,000 patients (including ~700 in Kentucky) were on waiting lists for organ transplants. Limited availability of donor material points to a critical need for strategies to engineer synthetic tissues. A significant barrier to their success is inadequate transport of nutrients and gases to, and waste away from, cells deep within the constructs. Generation of microvessels by endothelial cells (EC) in engineered constructs is, therefore, essential for facilitating tissue survival by promoting in-vitro formation of microvascular networks, preimplantation, that integrate with host microvasculature and mimic the in-vivo transport scheme, postimplantation. Previously, we reported that pressure stimulates EC proliferation involving release of angiogenic molecule, vascular endothelial growth factor (VEGF)-C. Based on this, we hypothesized that fluid pressure is a selective modulator of tubulogenesis that may be used to enhance microvascularization of engineered tissues. To address this, we used a custom-made pressure system to expose two- or three-dimensional cultures of EC to static pressures of 0 (controls), 20, or 40 mmHg (representative of in-vivo microvascular pressures). Compared to controls, two-dimensional EC cultures exposed to 20, but not 40, mmHg for 3 days exhibited increases in cell densities that depended on VEGFR3, a receptor for VEGF-C. Moreover, preliminary results showed that EC on microbeads suspended in three-dimensional collagen gels under 20 mmHg displayed increased numbers of multicellular tube-like sprouts. Our results suggest that pressure influences EC tubulogenesis. These findings serve as a first step towards identifying mechanobiological conditions that promote vascularization of engineered tissues.

Keywords: hydrostatic pressure, endothelial, tubulogenesis

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40. Noninvasive Scoring of Mouse Sleep and Behavior

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Sleep and wake states are poorly understand at a mechanistic and functional level. Identification of genes that contribute to normal and abnormal sleep-wake behaviors would improve our understanding and suggest new pathways and approaches for the treatment of sleep disorders. Many genes play a role in determining sleep patterns and circadian rhythms. Genetic approaches such as mutagenesis, quantitative trait locus analysis and knockout mice can help identify these genes and their respective roles. The downside is that screening for genetic factors affecting sleep requires expensive and labor-intensive animal experimentation with EEG/EMG analysis, not just simple actigraphy (i.e., activity monitoring). This severely limits the scale of behavioral experimentation. We have developed a noninvasive system for phenotyping sleep in mice based on the signal generated by a pressure-sensitive piezoelectric platform. This "piezo" system can already discriminate sleep from wake and track changes in breathing when the animal is relatively inactive. Preliminary observations indicate that pressure changes associated with respiration may have signatures characteristic of different stages of sleep as well. In this study, we demonstrate that features of the piezo signal that reflect breathing regularity and motion can be used to distinguish states that bear a strong statistical resemblance to REM and non-REM stages of sleep as well as quiet and active wakefulness. The next step is to correlate these states with EEG-scored states of vigilance. Successful noninvasive scoring of sleep and behavior will open up new avenues for

high throughput analysis of sleep phenotypes and alleviate the need for EEG measurements.

Keywords: mouse, sleep, wake, REM, non-REM, genetic screening

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41. Automated Detection and Characterization of Hypoxia-Ischemia Induced Seizures in Neonatal Rats

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Neonatal seizures most commonly occur as a consequence of hypoxia-ischemia (HI). Treatment of this phenomenon remains controversial, owing to the difficulty of correctly identifying seizures, which may consist of abnormal EEG with or without behavior, and sometimes seizure-like behavior without EEG; these are labeled as clinical, electrographic, and behavioral seizures, respectively. We have used unilateral carotid ligation and hypoxia in neonatal rats as a model of hypoxic-ischemic encephalopathy (HIE), and simultaneously recorded EEG, EMG, and video to document the experimental seizure yield during and following HI. An objective tool for quantifying seizure outcome would help assess the effect of different experimental conditions and interventions. The goal was to develop an automated seizure detection algorithm (SDA), specifically for this neonatal model of HIE, that can identify clinical, electrographic, and behavioral seizures from their EEG and EMG patterns. We have designed a prototype SDA that filters EEG and EMG to correct for background variation and emphasize episodes of high amplitude spiking activity; a novel aspect is the use of EMG to detect behavioral correlates of seizures. Seizure activity is detected when the processed signals exceed a user-selected threshold. The optimal threshold is determined through a receiver operating characteristic analysis, using visually scored events as ground truth. The results suggest that accurate detection is feasible, but refinement is ongoing to optimize the SDA's sensitivity and specificity. Future work will involve correlation of seizure yield with tissue damage 72h post-HI, with the goal of assessing long-term outcome for neonates with HI-induced seizures.

Keywords: hypoxia, ischemia, EEG, seizure detection, neonatal, stroke

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ENVIRONMENTAL AND ENERGY TECHNOLOGIES

42. Quartz Crystal Microbalance Investigation of Cellulase Binding, Activity and Inhibition on Model Cellulose Films

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Soluble sugars produced from the hydrolysis of cellulose are promising feedstocks for production of fuels and commodity chemicals from renewable plant-based resources. The recalcitrance of cellulose to degradation is well documented and attributed to multiple sources, including high cellulose crystallinity and the heterogeneity of biomass (dependent on pretreatment and presence of lignin). Cellulase is a cellulytic enzyme that possesses a catalytic domain capable of hydrolyzing the beta-1,4-glycosidic bonds in cellulose. However, during biomass conversion to soluble sugars, its hydrolytic efficiency is limited by nonproductive binding to hydrophobic components or inhibition by hydrolysis products. To study these factors, the changes in mass and surface properties of model cellulose thin films are measured using a Quartz Crystal Microbalance with Dissipation (QCM-D). The cellulose thin films are synthesized by thermochemically dissolution followed by coating onto a quartz crystal resonator. The mass

of the spin-coated cellulose film is determined by the change in the resonance frequency, and the cellulose surface coverage is observed by atomic force microscopy (AFM). Cellulase adsorption, activity, and inhibition on model cellulose thin films as are measured directly as changes to the piezoelectric properties of the cellulose thin films by QCM-D. Here, we will report observations of (1) inhibition by cellobiose of cellulase derived from T. reesei, (2) the effects of bound inhibited enzyme on reducing subsequent cellulose hydrolysis, and (3) evidence that excessive enzyme coverage decreases activity, leading to an optimal enzyme concentration for sacharification. Plans to investigate effects of surface chemistry on cellulase binding will be discussed.

Keywords: biofuels, biomass, cellulose, saccharification, hydrolysis

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43. Use of Photobleaching Technique to Understand the Effect of Photovoltage on the Stability and Efficiency of Organic Solar Cells

Buddika K. Abeyweera*, Hemant Shah, Bruce W. Alphenaar
Department of Electrical and Computer Engineering

Due to rising fuel costs, solar cells have recently gained much attention as a possible clean alternative energy source. Organic polymer solar cells are of particular interest because of their relatively low manufacturing cost and flexibility. Here, we describe a straightforward and low cost preparation technique to reproduce bulk heterojunction organic polymer solar cells with high yield using poly[2-methoxy-5-(3,7-dimethyloctyloxy)]-1,4-phenylenevinylene (MDMO-PPV) and [6,6]-phenyl-C61-butyric acid methyl ester (PCBM) with the active area of 0.25cm2. Since the efficiency of these solar cells is low compared to conventional silicon solar cells, a novel approach is needed to enhance efficiency of Photovoltaics. In this project, we used photobleaching technique of organic solar cells to investigate the reduction of photovoltage by experimentally populating the excitonic states of electron accepting material: PCBM. Low power Xenon white light source is used for photobleaching experiments. In addition, capacitive photocurrent spectroscopy technique from white light source is described to show the huge charge dissociation from the exciton of PCBM with the main absorbance of organic semiconductor. In the current study, we suggest that filtering out the energy in white light, responsible for long-lived excitonic state of PCBM, will enhance the AC photovoltage. Ultimately this will lead to enhance the stability and the efficiency of the organic solar cell.

Keywords: photobleaching, photovoltage, organic solar cells

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44. Characterization and Activity of Mesoporous Titanosilicate Ccatalysts with Isolated Titanium Sites Generated by Surfactant Complexation

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Department of Chemical and Materials Engineering, University of Kentucky

Mesoporous titanosilicates with a homogenous distribution of tetra-coordinated Ti sites prepared by combined templating using a sugar surfactant (dodecyl maltoside) and a cationic surfactant (cetyltrimethylammonium bromide) are characterized to determine the presence and activity of isolated tetra-coordinated Ti sites. The primary characterization is performed using a model catalytic epoxidation reaction of styrene with aqueous peroxide. Surface acidity estimation is carried out by temperature-controlled in situ diffuse reflectance infrared spectroscopy (DRIFTS) studies of ammonia adsorption, combined with UV-visible absorption techniques to quantify the total acidity of the materials. Selectivity and activity of the reaction towards styrene oxide are enhanced by using catalytic systems with controlled surface acidities. A rational explanation for the correlation

of acidity of the corresponding catalysts including the nature and strength of the acidic sites with the observed activities is proposed. The results are compared with the TS-1 zeolite, the state of the art catalyst for epoxidation reactions. Based on similarities in acidity and epoxidation activity, the existence of isolated Ti sites in the mesoporous catalysts has been proved. The extent of Ti incorporated in each sample is estimated using inductively coupled plasma–optical emission spectroscopy (ICP-OES), which establishes increased Ti (IV) site incorporation in the mesoporous titanosilicates in comparison to TS-1. Mesoporous titanosilicate containing 1 mol% Ti (per metal) has approximately twice the activity per Ti as TS-1. However, mesoporous titanosilicates with higher Ti content exhibit less activity per site, which may be due to a combination of decreasing surface area and increasing acidity.

Keywords: mesoporous titanosilicates, isolated Ti content, acidity, epoxidation catalysis

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45. Fundamental Studies of Light Absorption in Vertical Nanowire Arrays

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(1)Department of Electrical Engineering, (2)Conn Center for Renewable Energy Research

In this project, we are investigating the light absorption within vertical nanowire arrays as a function of density, size and arrangement of nanowires compared to thin films. Recent studies showed that randomly ordered vertical nanowire arrays can absorb light efficiently compared to ordered arrays. Specifically, this was demonstrated with silicon wire arrays with enhanced near-infrared to exceed the ray-optics light-trapping absorption limit for an equivalent volume of randomly textured planar Si, over a broad range of incidence angles. In this project, the initial measurements were performed using Molybdenum Oxide nanowire arrays. The absorption measurements at different angles of incidence were measured for Molybdenum Oxide wire arrays grown on Silicon, quartz substrates showed that absorption was greater at angular incidence than at normal incidence of light. Ultimate objective of the project is to study synthesis and optical characterization of vertical arrays of Indium Nitride nanowires.

Keywords: light absorption, vertical nanowire arrays

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46. Titania/Bucky Paper Composites for Photocatalytic Dye Degradation and Photoelectrochemical Water Splitting

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Department of Chemical and Materials Engineering, University of Kentucky

The titania/carbon nanotube (CNT) composite system has been shown in several recent studies [reviewed by K. Woan et al., Adv. Mater. 2009, 21, 2233] to have high photoconversion activity because the CNTs facilitate photoinduced charge separation and limit recombination by transporting electrons away from the carrier generation site. In the current work, titania/bucky paper (self-supporting films of multiwalled CNTs) composites were fabricated by the sol-gel method with a surfactant (Pluronic-123) additive, or by dip-coating buck paper with commercial TiO_2 (Degussa P25) powder. The composites are characterized by x-ray diffraction, N_2 adsorption-desorption isotherms, thermogravimetric analysis, UV-Visible diffuse reflectance spectroscopy, and electron microscopy. A uniform coating of anatase titania on bucky paper (with 44 % TiO_2 in the composite) has been achieved by sol-gel coating. The photoconversion efficiency of the composites is determined by photocatalytic degradation of methylene blue and photoelectrochemical water splitting in KOH solution under UV light. The results reveal a positive role of CNT in the photoconversion efficiency of the composites, most notably for the P25/buckypaper, which shows a photoconversion efficiency of 7.3% for hydrogen generation by water

splitting. The uniform coatings of TiO_2 on buckypaper show that the texture of the titania (film vs. particle) plays a major role in photoconversion efficiency, and that it may be desirable to have some fraction of the CNTs exposed to aid in reactant adsorption and photocatalytic reactant generation.

Keywords: titania, carbon nanotubes CNT, bucky paper, sol-gel, photoelectrochemical, water-splitting, hydrogen generation, photocatalysis, methylene blue degradation, energy conversion

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47. Shape and Vibration Control of Membrane Structures under Servo-Constraints

T. Michael Seigler and Amir. H. Ghasemi*
Department of Mechanical Engineering, University of Kentucky

The objective of this research is to develop a control approach for the active shaping of large membrane structures using active materials. Membrane mirrors are thin, flexible optical surfaces for satellite lenses that are lightweight and can be stored compactly. These types of mirrors are expected to enhance inflatable space technology by providing quality optical imaging while reducing current weight and storage requirements. Membrane mirrors, however, require active surface control for proper imaging and are subject to various disturbances (including large thermal gradients and internally induced excitation) that can lead to degraded performance. Active materials, such as piezoceramics, have been proposed as a means of providing disturbance rejection via distributed actuation; the idea is to attach a number of actuators along the outer rim of the optic and actively control them to produce a desired motion. However, unlike typical piezoelectrically actuated structures, due to the properties of the membrane, the introduction of the piezoceramic significantly alters the dynamic behavior of the membrane structure. Here we propose a novel method of simultaneous shape and vibration control based on the dynamical theory of partly specified motion. The basic idea behind this method is to solve for the open-loop control input from the membrane-actuator model that achieves the approximate desired shape. The open-loop control is then augmented by a feedback loop that accounts for uncertainties due to modeling errors and external vibration disturbances. This proposed controller is tested through numerical simulations. Analytical results will demonstrate the effectiveness and feasibility of the proposed controller.

Keywords: shape control, vibration control, membrane structures, servo-constraints

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48. Kentucky Institute for Aerospace Education: Creating the Pipeline to Further Student STEM Opportunities

Tim Smith*
Kentucky Institute for Aerospace Education and Frankfort High School Aviation Academy

The Kentucky Institute for Aerospace Education (KIAE) is a 501(c)(3) organization that supports a STEM network of 12 high schools in Kentucky. Schools in the KIAE network have been provided with an aerospace

Keywords: STEM, aviation, aerospace, engineering, flight, aircraft maintenance

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49. Autonomous Robot Design Competition

Aleck W. Leedy
Department of Engineering and Physics, Murray State

The purpose of this poster is to highlight the autonomous robot that was designed by the Murray State University Hardware (Robot) Team that competed in the IEEE SoutheastCon 2011 Student Hardware Competition April 2, 2011 in Nashville, TN. The theme of the 2011 competition was natural disasters. The focus was the use of autonomous robots to safely evaluate the situation,

and relay vital information to emergency response teams. The objective of the competition was to locate the victims trapped in a building, determine their status, sense hazards, and report this information to the emergency responders. The Murray State team built a completely autonomous robot that is capable of locating victims, sensing hazards, avoiding obstacles, and recording its exact position at all times. The 2011 IEEE SoutheastCon Hardware Competition aligned well with NASA's Exploration Systems Mission Directorate (ESMD) that manages the development of capabilities of robotic exploration. The design of the robot required the Murray State team members to have a background / expertise in the following areas: electrical engineering, mechanical engineering, and computer science. The team members were required to have knowledge of electromagnetics, sensors, circuit building, computer programming, modeling and simulation software packages, and troubleshooting. Presented in this poster are the details of the robot system design that includes a system block diagram, circuit diagrams, graphical analysis, and a list of the major components of the system.

Keywords: autonomous, robot, sensors

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50. Preferential Hydrogen Bonding in the Superoxide-Water Radical Complex

Ziyou Tang and Wafaa Fawzy*
Department of Chemistry, Murray State University

Previous computational investigations on the ground electronic state of the superoxide-water complex showed that there are two local minima of C2v and Cs symmetries. On the other hand, a photofragmentation experimental study identified a minimum energy structure of Cs symmetry with a single hydrogen bond. We explored the potential energy surface of the superoxide-water complex using the CCSD(T) level of theory with the aug-cc-pVDZ basis set. Our preliminary results show two equivalent minimum energy structures that correspond to a planar geometry of Cs symmetry. In this structure, one of the hydrogen atoms in the water molecule forms a strong hydrogen bond with an oxygen atom of the superoxide radical. The dissociation energy of the complex and the length of the hydrogen bond are estimated as 7540 cm-1 and 1.7 angstroms, respectively. The outcomes of our study will be presented and compared to results of the previous studies.

Keywords: computation, preferential, hydrogen boding, complex

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51. Ionic Hydrogen Bonding in the Superoxide-HF Radical Complex

Ychen Zhang and Wafaa Fawzy*
Department of Chemistry, Murray State University

The superoxide radical is one of the most important anions that play a major role in chemistry in the atmosphere and in biological systems. However, there have been few investigations on the nature of intermolecular interactions between the superoxide radical and other closed-shell molecules in the gas phase. It has been shown that characterization of the potential energy surface (PES) of binary gaseous complexes is essential for understanding intermolecular interactions between entities of the complex as well as dynamics of chemical reactions in which the binary complex present a minimum either at the entrance or at the exit channel of the PES of the reaction. Furthermore, determination of the PES of binary gaseous complex presents the first initial step toward understanding intermolecular interactions in the condensed phase. In this work, we carry out high level correlated ab initio study on the intermolecular PES of the superoxide—HF radical complex. This binary complex presents a prototype for an ion-dipole type of intermolecular interactions.

Keywords: ionic, superoxide radical, hydrogen bonding, computation

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52. Low-Cost Conductivity Sensor with Data Logging

T. M. Lucas*, C.K. Harnett
Department of Electrical and Computer Engineering, University of Louisville

A microcontroller-based sensor was developed to record water presence and conductivity for the Virtual Observatory and Ecological Informatics System (VOEIS) project. Integrated data logging and low power requirements make this device well-suited for data collection in remote locations around Kentucky. The conductivity information collected can give insight into pollution levels over time in natural water sources. The time-stamped water presence can be used to record flooding patterns in an area, which is valuable for planning agricultural and commercial development. The recorded measurements are calculated based on the inverse relationship between conductivity and resistivity. Electrodes are exposed to the environment to determine the resistance of the medium surrounding the sensor. A simple circuit provides analog input to an Arduino microcontroller for further processing. Calibration is performed by using KCL solutions with known concentrations to adjust for electrode spacing. The fitted conversion parameters are used by the Arduino to calculate the conductivity. Time-stamped measurements are taken periodically. Data is recorded to a microSD card by the open source data logger.

Keywords: conductivity, VOEIS, environmental

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53. Preferential Hydrogen Bonding in the Superoxide-Water Radical Complex

Ziyou Tang* and Wafaa Fawzy
Department of Chemistry, Murray State University

Previous computational investigations on the ground electronic state of the superoxide-water complex showed that there are two local minima of C2v and Cs symmetries. On the other hand, a photofragmentation experimental study identified a minimum energy structure of Cs symmetry with a single hydrogen bond. We explored the potential energy surface of the superoxide-water complex using the CCSD(T) level of theory with the aug-cc-pVDZ basis set. Our preliminary results show two equivalent minimum energy structures that correspond to a planar geometry of Cs symmetry. In this structure, one of the hydrogen atoms in the water molecule forms a strong hydrogen bond with an oxygen atom of the superoxide radical. The dissociation energy of the complex and the length of the hydrogen bond are estimated as 7540 cm-1 and 1.7 angstroms, respectively. The outcomes of our study will be presented and compared to results of the previous studies.

Keywords: computation, preferential, hydrogen bonding, complex

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54. Ionic Hydrogen Bonding in the Superoxide-HF Radical Complex

Yuchen Zhang* and Wafaa Fawzy
Department of Chemistry, Murray State University

The superoxide radical is one of the most important anions that play a major role in chemistry in the atmosphere and in biological systems. However, there have been few investigations on the nature of intermolecular interactions between the superoxide radical and other closed-shell molecules in the gas phase. It has been shown that characterization of the potential energy surface (PES) of binary gaseous complexes is essential for understanding intermolecular interactions between entities of the complex as well as dynamics of chemical reactions in which the binary complex present a minimum either at the entrance or at the exit channel of the PES of the reaction. Furthermore, determination of the PES of binary gaseous complex presents the first initial step toward understanding intermolecular interactions in the condensed phase. In this work, we carry out high level correlated ab initio study on the intermolecular PES of the superoxide—HF radical complex. This binary complex presents a prototype

for ion-dipole type of intermolecular interactions.

Keywords: ionic, superoxide radical, hydrogen bonding, computation

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55. Dynamic Data Extraction, Data Visualization and Customized Statistical Analysis with Application to the Kentucky Mesonet Data

Anoop Rao Paidipally*(1), Jonathan Quiton(1), Stuart Foster(2) and Guangming Xing(1)
(1)Department of Mathematics and Computer Science, Western Kentucky University, (2)Geography and Geology and the Kentucky Climate Center, Western Kentucky University

There is a need to integrate large-scale database, high-performance computing engines and geographical information system technologies (GIS) into a user-friendly web interface as a platform for data visualization and customized statistical analysis. In this poster, we present some concepts and design ideas regarding dynamic data storage and extraction and its link to open-source computing and mapping technologies. Finally, we would like to demonstrate our progress using the Kentucky Mesonet Data.

Keywords: large-scale database, high-performance computing, geographical information system, web-interface, Kentucky Mesonet

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56. Some Results in Modeling Single Household Daily Power Demand

Craig Dickson*(1), Jonathan Quiton(1), William Ray(2), Stuart Foster(3)
(1)Department of Mathematics and Computer Science, Western Kentucky University, (2)Glasgow Electric Plant Board, (3)Department of Geography and Geology and the Kentucky Climate Center

In the past, modeling aggregate power demand had been the more practical way to approach the problem of forecasting daily electricity demand for a region. It was not until recently that modeling single household power demand became a desirable and feasible approach due to advances in computing infrastructure and capabilities. We have examined some of the explanatory variables and models used to predict aggregate demand at the daily and hourly levels, and apply them to a single household setting. We demonstrate our predictive methods using the Glasgow Electric Plant Board household power data in conjunction with Kentucky Mesonet and National Weather Service temperature data.

Keywords: aggregate power demand, single-household prediction, weather data

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57. Predictive Models for Pollutant Source Identification Using DNA Biomarkers and PCR Readings

Kevin Andrew(1), Rick Fowler(2), Jonathan Quiton*(3,4) and Claire Rinehart(3,5)
(1)Gatton Academy of Mathematics and Science in Kentucky, (2)Waters Laboratory, (3)Bioinformatics and Information Science Center, (4)Department of Mathematics and Computer Science, (5)Department of Biology, Western Kentucky University

In this poster, we present three predictive models for pollutant sourcei dentification. These models use two sets of data: one is the 16S rDNA sequence data from which we derive the fragment sizes and the other is from the quantitative real-time PCR. We used the rDNA database to derive our coefficients for our models, and then use the PCR readings data as inputs to finding pollutant source probabilities. If one can mark fragment sizes from PCR outputs, then a multinomial logistic regression or a tree-based (decision tree) regression model can be used. Otherwise, we present a Bayesian approach where the client is required to enter his prior probabilities and the expert to interpret the PCR readings and identify regions for the fragment size. Our initial analysis helped us identify seven out of 16 possible enzymes having some discriminatory power. This set of seven enzymes

serves as our final set of predictors to use all our models. Current and future work are also discussed.

Keywords: pollutant source identification, rDNA sequence, preditive models, decision tree, Bayesian probabilities

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58. Investigation of the Relationship Between Freestream Turbulence and Klebenoff Modes

Mark A. Miller*, Sean C. C. Bailey
Department of Mechanical Engineering, University of Kentucky

Delaying the transition from laminar flow to turbulent flow in a boundary layer has many advantages for aerospace systems, the principal one being a significant reduction in wall shear stress and thereby skin friction drag. Traditionally, the study of laminar-turbulent transition has focused on the boundary layers forming along a nominally zero pressure gradient flat plat immersed in a disturbance-free flow. In such conditions, the transition process has been well understood and its initiation can be described using the linearized, unsteady, Navier-Stokes equations. In many engineering systems, the freestream is turbulent and therefore not disturbance free. Instead of following this well understood process, the boundary layer undergoes bypass transition. During bypass transition, laminar-turbulent transition occurs much earlier and the actual transition to turbulence is often preceded by the appearance of streamwise streaks of low momentum fluid within the boundary layer associated with spanwise distortion of the boundary layer thickness. Commonly referred to as ``Klebenoff modes", these structures are long in the streamwise direction and narrow in the spanwise direction (with a width on the order of the boundary layer thickness). The interrelationship between the low wavenumber motions of the freestream turbulence and the formation of the Klebenoff modes is the focus of the proposed research project. We will use simultaneous particle image velocimetry and hot-wire anemometry to investigate the link between the Klebanoff modes in a transitional boundary layer and the low wavenumber components of the free stream turbulence spectrum.

Keywords: fluid mechanics measurements, turbulence, bypass transition, boundary layers

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INFORMATION TECHNOLOGY AND COMMUNICATIONS

59. Ensemble Hidden Markov Model Classifiers for Detecting Explosive Devices

Hichem Frigui*, Anis Hamdi
CECS, University of Louisville

The performance of automated algorithms for buried mine and IED detection are strongly dependent upon a variety of factors that are correlated with device types, burial depths, and geographical and environmental conditions. It is typically the case that one sensor (or one feature) may perform well in one context and not so well in another context. The goal of the proposed research is to develop autonomous, robust, and efficient Hidden Markov Models (HMM) for detecting buried explosive objects, such as land mines and IEDs. Our approach strives to identify the different contexts, build and adapt models for each context, and develop fusion algorithms that can take advantage of the stronger sensors/ features for a given context without suffering from the effects of weaker sensors/features in the same context. The context identification and characterization would allow the algorithm to perform detection quickly and accurately in the presence of rapidly changing geographical and environmental conditions.

Keywords: landmine detection, ensemble HMM, model fusion

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60. Multiple Air Robotics Indoor Testbed (MARIT)

Yinan Cui*, Tamer Inanc
ECE, University of Louisville

An indoor testbed for controlling unmanned aerial vehicles (UAVs), Multiple Air Robotics Indoor Testbed (MARIT), is introduced. MARIT was established in Autonomous Robotics and Control Systems Lab (ARCS) at University of Louisville. It is instrumental to capture the 6 DOF (degree of freedom) dynamic position information of the small air robots fast and accurately in the 3D test domain. MARIT consists of 6 high-resolution digital cameras (Vicon motion capture system) with superior frame rates (120 frames per second), quadrotors (Dranganflyers) with reflective markers, and a workstation PC. It uses captured data (including the translation axis values and axis rotation values of the robots) to form a closed-loop control system, which provides accurate control of the robots within the testbed environment. Based on the software development kit provided by Vicon (Real-Time SDK), the user can develop his or her own controller applications for various flight missions. This testbed can be further used to study autonomous systems in which multiple agents cooperate with each other to perform assigned tasks.

Keywords: UAV, trajectory generation, control

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61. Autonomously Robotic Tour Guide

Luke Spicer, Ali Mahmoud*, Mike Miller, Aly Farag
Computer Vision and Image Processing Lab, Electrical and Computer Engineering, University of Louisville

The first part of this work is completing the hardware and software upgrades on the ATRV robot and ATRV-mini robot started this past year. The hardware portion of this task consists of installing new motherboards, memory, powers supplies and communication interfaces. The software portion of this project consists of installing Linux drivers, the Linux OS, Uploading Player Stage and debug/ testing all interfaces. The next task is writing programs to enable the ATRV-mini to give a guided tour of the CVIP lab. This guided tour portion of the project has two phases and will be the main focus of this project. Phase 1: Navigation through the CVIP Lab and Verbal Description of the lab's Demo's: In this phase the robot will navigate its way to each demo point in the CVIP Lab, instruction the audience to follow him. The robot will then describe each demo and outline the important facets of each demo. The Student will design algorithms to employ the camera, sonar, and Laser scanner sensors to allow the robot to move safely through the lab environment as it gives the tour. Phase 2: Wireless Interface to Computers Controlling Each Demo: In this Phase the robot will be equipped with wireless remotes to activate demo's, select proper demo programs, and run the entire tour without user intervention. Finally the student will help assist Graduate Students with the porting of our previous NASA applications as time allows in the coming year.

Keywords: autonmous robotics, player stage

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62. Earth-Based Calibration of the S-Band Synthetic Aperture Radar Onboard NASA's Lunar Reconnaissance Orbiter

Benjamin K. Malphrus*(1), Jeff Kruth(1), Michael Combs(1), Robert Kroll(1), Caleb Grimes(1), Ben Cahall(1), Ron Schulze(2), Darryl Royster(2), Scott
(1)Morehead State University Space Science Center, (2)Johns Hopkins University Applied Physics Laboratory

The Lunar Reconnaissance Orbiter (LRO) is a NASA Robotic Program mission whose intent is to create a comprehensive atlas of the Moon's features and resources. Among 6 science experiments on LRO is the Miniature Radio Frequency Technology Demonstration (Mini-RF), an advanced synthetic aperture radar that operates in both the X and S bands of the radio spectrum. It is used to image the polar regions and search for water ice. The mini-RF baseline modes include: two frequencies—S-band (13 cm) and X-band (4 cm); two resolutions—baseline (150 m/75-m pixels) and zoom (15 m/7.5-m pixels); and dual-polarization. In 2010 NASA, Johns

Hopkins Applied Physics Laboratory and MSU used the 21 M Space Tracking Antenna in an experiment involving calibration and end-to-end performance characterization of the spacecraft's X-Band system. In the Spring of 2011, the team undertook calibration of the S-Band system using the same technique. The 21 m system was configured with a transmitter (Tx) system designed and fabricated during this project, which transmitted a high power signal at 2,138 MHz with extreme polarization purity, which was beamed at LRO. A significant design effort was undertaken to support this calibration experiment. An S-band feed system was developed and implemented on the 21 M as well as a high power transmitter system and associated control systems. Undergraduate student researchers have been intimately involved in engineering, implementing, testing and calibrating the GSE instrumentation, in operating the system during calibration experiments, and in analyzing data produced. LRO has returned data important to the understanding of lunar resources, which will ultimately support future human exploration of our solar system.

Keywords: lunar topograhy, synthetic aperture radar, earth station technologies

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63. Archival Study of the X-ray Spectra of Blazars with the Chandra X-ray Observatory

Thomas G. Pannuti* , Benjamin J. Cahall, Caleb K. Grimes
Department of Earth and Space Sciences, Morehead State University

An analysis of the X-ray spectra of a sample of blazars that are candidates for long-term radio monitoring observations with the 21-meter Space Tracking Antenna at Morehead State University. These spectra were extracted from data obtained by pointed observations made with the Chandra X-ray Observatory and were fit with several different models, including a simple power law model and a thermal plasma model. The main goal of this work is to identify spectral variations in the X-ray spectra of blazars and determine if these variations correlate with other properties of the blazars. To illustrate this work, we present an analysis of two blazars, 1ES 2344+514 and 0235+164. Initial results will be presented and discussed.

Keywords: X-ray spectra, blazars, Chandra X-ray Observatory

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64. Thomas More Telescopes in the Classroom

Wes Ryle*
Thomas More College

Providing middle school and high school educators with explicit and detailed student projects in the STEM disciplines is an efficient method for increasing student interest at a young age. The ideal STEM projects involve hands-on student activities as well as a means for cooperation and feedback from the broader educational community. This proposal describes a two day instructor workshop in astronomy at Thomas More College and the subsequent follow-up activities. The workshop will concentrate on projects centered around the use of a simple telescope, namely the Galileoscopes popularized during the recent International Year of Astronomy. Participants will be provided with a telescope kit for personal use, along with an additional kit to be assembled and used in their classrooms. During the workshop, participants will be given instruction, and in some cases, participate in sample student oriented projects that involve repeated observations with a telescope. Even a series of simple observations, such as the phases of Venus or the position of the Galilean moons of Jupiter, can provide students with a detailed insight into the scientific method and a historical perspective on the birth of modern science. Additionally, Thomas More College will serve as a hub for observations collected by students from the classrooms of the workshop participants, providing a valuable resource for further instruction and fostering a partnership between local area schools.

Keywords: educational outreach, astronomy

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65. Visualization of Kentucky Lake

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Visualization plays a critical role in transforming data into information in understanding of the behavior of a system. An accurate usable visualization requires adequate investigation to include user requirements, design requirements, development of a model and a prototype development. According to this research in visualizing the Kentucky Lake a sensor network has been deployed that collects and stores large volumes of time-varying data to be analyzed. A visualization tool to handle the datasets requires adequate processing to produce quality graphical representations of information, otherwise not apparent through physical examination of data. Within this visualization application a prototype application is presented that demonstrates a small-scale graphical implementation of a smaller dataset. This work evaluated the use of Paraview software as a visualization engine, and demonstrated the visualization of dissolved oxygen and temperature. ParaView is an application utilizing Visualization Toolkit (VTK) as the data processing and rendering engine; VTK is a development package with a scripting language interface supporting the development of 3D computer graphics, image processing, and visualization. Due to lack of data collection points often interpolation needs to be done to generate a continuous visualization. The present visualization was done using linear interpolation. The visualization can be extended to accommodate parallel computing to handle larger dataset.

Keywords: visualization, kentucky lake, paraview, color mapping

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66. Cosmic X-Ray Background NanoSat (CXBN): An Improved Measurement of the Diffuse X-Ray Background

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The goal of this nanosatellite mission is to significantly increase the precision of measurements of the Cosmic X-Ray Background in the 30-50 keV range, thereby constraining models that attempt to explain the relative contribution of proposed sources lending insight into the underlying physics of the early universe. The mission addresses a fundamental science question that is central to our understanding of the structure, origin, and evolution of the universe by potentially lending insight into both the high energy background radiation and into the evolution of primordial galaxies. The X-Ray background flux measurements to be made during this campaign will utilize on a semiconductor detector based on a Cadmium zinc telluride, (CdZnTe or CZT) array. Advantages of this technology include high sensitivity to x-rays and gamma-rays, due to the high atomic numbers of Cd and Te, and better energy resolution than scintillator detectors. In ~1 year of operation the experiment will have collected 3 million seconds of data, reaching a broadband S/N ~250. The science mission requirements allow for the design of a relatively simple spacecraft and conops, making this mission ideal for the CubeSat form factor. The CXBN design utilizes innovative attitude determination and control systems (to keep the spacecraft sun pointing), unique communications systems at UHF and S-bands, innovative power systems with deployable solar arrays, 3-D printed (additive manufactured) components, and other innovations. CXBN is a CubeSat mission that is being developed

at low cost and on a highly constrained timeline, but with potentially significant science returns. The mission has been selected by NASA for flight in the 2nd Quarter of 2012.

Keywords: cosmic X-ray background, CZT detector, CubeSat

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67. Science Gateway-Mowic: Modern Web Interface for Clusters

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High performance computing (HPC) has become the third leg of science, along with theory and experimentation. It is important to create easy to use, adaptable, extensible interfaces to these systems to allow scientists to answer new questions in a timely manner. Such interfaces should provide mechanisms to run HPC code, convert and manipulate data and visualize that data. Creating a user interface layer to the cluster, not a specific application, would provide such an interface. Clusters require remote access, often done through ssh. Web interfaces provide expanded connection capabilities. The can be accessed from many types of and do not require the installation of the interface. Web interfaces include a wide variety of open-source, high-quality, end-to-end components. Such a web interface would also allow for others to verify or build upon the work from a distance. Mowic is a prototype cluster interface that uses Linux, Apache, PHP, MySQL, HTML, CSS, Javascript, and jQuery, all freely available, well established products. Mowic does leave the tool designer free to use any other web components in the creation of their custom tools. It allows for custom visualization tools to be installed within it to view or manipulate datasets. Mowic handles connections to the files and navigation of the system. Sample tools were created to view sparse matrices with the ability to zoom in and out. The system is able to run HPC code and then visualize the data.

Keywords: science gateway, user interface, web design, parallel program, cluster

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68. Multistep Sparse Matrix Strategies for Information Retrieval on Large Datasets

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One of the greatest challenges each person faces in everyday life is the ability to approach a limitless body of incoming information and filter from it what is useful and meaningful for his own purposes. In the world of computer processing, the individual developer is responsible for building complex algorithms capable of handling that information and delivering an output that consumes less memory and requires less computational time without compromising on its accuracy. The proposed multistep sparse matrix strategies have been applied to three small famous datasets, MED, CISI and CRAN, and the numerical experiments show the advantage of such an approach in terms of storage costs and query time compared with least-squares based approach while maintaining comparable retrieval quality. Building on that, we extend this method on large datasets, such as LISA and NPL which are highly dimensional. The testing result on the LISA dataset is highly encouraging. Considering the above approach, the K-Means computational algorithm is used to cluster the respective documents and construct a suitable concept matrix. Most of the currently generated sequential, parallel and GPU accelerated K-Means algorithms are intended for use with dense data structures and are thus excessively time consuming and inefficient for use with the processing of a sparse data matrix. Since most term-document datasets are excessively sparse, a GPU based K-Means clustering algorithm constructed for use with sparse matrix data sets and providing for text clustering capabilities is our focus.

Keywords: term-document matrix, concept decomposition matrix, multistep, sparse matrix approximation, K-Means, GPU

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69. Kentucky Nanonet: Connecting Kentucky's Micro/Nano Community

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The "KY nanoNET (KYNN) Initiative" is a five-year ~$1.4M proposal (~$900K from NSF) to develop a statewide infrastructure virtual network for the advancement of micro/nanotechnology in Kentucky and the many fields that utilize this pervasive and maturing technology. The KYNN contains three distinct efforts: 1) Development of a comprehensive, web-based regional network to integrate the micro/nano labs and resources scattered throughout the Commonwealth (similar to the NSF-sponsored, nationally targeted NNIN and nanoHUB initiatives), 2) development of a shared software program (i.e. KRUNCH - Kentucky Research Users of Nano CADtools Hub) to allow researchers across the state access to a variety of commercial TCAD tools for micro/nano/MEMS research/education, and 3) development of a centralized physical core facility (i.e. KORE - Kentucky Optical REsources) to fabricate custom photomasks, which will effectively serve the needs of all micro/nano researchers/educators in Kentucky. After two years, the KYNN has added 13 "hubs" to the network and supports over 100 internal and 50 external users of the shared software. The KY NanoNET website (kynanonet.org) has a monthly average of 974 page views (11,191 in the most recent 12 months), and has over 50 followers (Facebook, Twitter, etc). The KORE facility has written 211 masks (127 internal, 84 external) in the past 12 months, serving 9 different institutions (both industrial and academic organizations). Complementing the three strategic initiatives are outreach and economic development efforts, including tours of the UofL Micro/Nano Technology Center and participation in external events such as Nano Days sponsored by the Louisville Science Center.

Keywords: nanotechnology, microtechnology, software, photomasks, outreach, Kentucky, community

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70. Networked Cooperative Autonomous Mission Control

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Autonomous mission control with automated reconfiguration of missions is essential to adapt to the changing dynamics of an unknown environment. The possibility of adapting a mission to the status of the vehicle, the status of the surrounding vehicles, and the environment increases with the greater use of network centric operations. This research introduces a method to create a network centric testbed implemented for cooperative networked mission control. This research is focused on creating a usable framework for autonomous vehicles to work cooperatively to complete tasks. Specifically, this research is using two unmanned autonomous vehicles (AUVs) to complete a search and intercept mission. The AUVs use infrared sensors, and visual input as primary variables for navigating unknown environments searching for the specific object. The AUVs communicate with each other to maintain cooperative status and to better make decisions.

Keywords: autonomous mission control, automated reconfiguration, networked cooperative

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71. 3D Data Visualization of Bee Hive Cluster Using Sensor Net

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Scientists require tools to analyze large and complex data. Multidimensional data visualization is an efficient tool for better understanding of the behavior monitored. Remote accessibility of the visualization tool further strengthens the accomplishments of the research. This thesis is a proposed model for a Web Graphic User Interface for 2D and 3D data visualization to monitor internal condition of honey bee cluster temperature. A prototype is developed. It shows the integration of hardware and software for data acquisition, graphical transformation of data, and deployment in real time on the internet the data and information generated. Researchers, from apiculture arena in this case, can detect alarming conditions early enough to understand the issues with Bee death during winter season. Arduino, MATLAB, .NET software and parallel programming are used for sensing the interior temperature of beehive, transform the data graphically, and deploy it on Internet. Future work involves the parallel processing of the data to speed-up the real-time visualization.

Keywords: 3D, data visualization, sensoring, bee hive

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72. Vibration Monitoring and Analysis with Wireless Sensor Network (WSN) to Classify Vehicles Types

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On August 27 2006, Comair flight 5191 departing from Lexington, Kentucky crashed, killing all passengers and all but one crew member. The basic human error leading to the crash was the shorter runway that the Comair flight took off from. The present technology to deal with runway air traffic control is the manual monitoring done by air traffic controllers. For the Comair flight, the air traffic controller cleared the plane for takeoff from runway 22; the pilot then proceeded for further duties without checking which runway the flight was actually taking off from. Severe weather conditions, negligence or shortage of workers can also lead to delayed or undetected diagnosis of an error which can lead to an unfortunate loss of life. Runway mishaps occur due to the lack of real time monitoring and the time gap in alerting or diagnosing a severe condition. The event response time gap can be reduced by deploying automated technology to handle constant 24/7 monitoring, detection and alerting of severe conditions by transmitting a warning signal. One such idea using this technology is the deployment of wireless sensor network to detect errors/faults on the runway and transmit warning messages to the pilot and air traffic controller in real time. With wireless sensor network deployment, crashes like that of Comair 5191 could be avoided as the pilot would be instantly notified of the length of the runways based on the signals received from the sensors deployed on different runways in an airport. The wireless sensor network could also detect severe weather conditions which can go undetected by human beings thus preventing further loss of lives. This technology would be a commercially viable product as is discussed further in later sections.

Keywords: sensor network, vibration, data analysis, real time software

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MATERIALS SCIENCE AND ADVANCED MANUFACTURING

73. Adsorption of Chlorophyll a on to Hydrophobic and Hydrophilic Surfaces Using Broadband Spectroscopy with Single-Mode Integrated Optical Waveguides

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In this work, we experimentally investigated the effects of sodium chloride on the molar absorptivity and surface density of a submonolayer of chlorophyll *a* adsorbed onto hydrophilic and hydrophobic solid/liquid interfaces. Those investigations were made possible by a broadband spectroscopic platform based on single-mode, integrated optical waveguides which allows for extremely sensitive spectroscopic detection of analytes immobilized at submonolayer levels. Chlorophyll *a* with a constant bulk concentration (1.4 μM) was dissolved in phosphate buffer solutions (7 mM) of neutral pH, but with different sodium chloride concentrations. For a buffer solution of 1 mM of sodium chloride, the measured surface density of chlorophyll *a* was 0.209 pmol/cm^2 for a hydrophilic and 0.125 pmol/cm^2 for a hydrophobic surface. For a phosphate buffer solution of 10 mM of sodium chloride, the measured surface density of chlorophyll *a* was 0.528 pmol/cm^2 for a hydrophilic and 0.337 pmol/cm^2 for a hydrophobic surface. Additionally, a hypsochromic shift of the Soret band was observed for the adsorbed pigment in correlation with an increase in buffer ionic strength. The adsorption of chlorophyll *a* onto different surfaces can play an important role to elucidate several processes found in nature and provide a rationale for bio-inspired new material technologies.

Keywords: chlorophyll a, molecular surface adsorption, waveguide spectroscopy, atomic layer deposition, molecular vapor deposition PEG silane, perfluorodecyltrichlorosilane

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74. Self-Assembled Nanoelectromechanical System for Detecting Piconewton Forces

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Force detection from 0.1-1000 pN is of particular interest for nanomechanical measurements of cellular biomaterials. This range spans that of other probes that are widely used by the experimental cellular and macromolecular biophysics communities, including: magnetic traps (0.05–20 pN), laser traps (0.1–100 pN), and the low-end range of atomic force microscopes (5-10,000 pN). Herein we describe the self-assembly and nanomechanical properties of a structure that is sensitive to forces over this entire range. The bead-on-a-string (BOS) nano-electro-mechanical system (NEMS) is a composite polymer structure of magnetic nanorods in polyethylene oxide (PEO). At dimensions of 50-200 nm by 1 mm long the structure is so flexible that a 1 micron transverse displacement, corresponding to a 10 pN force, is easily observed visually under a light microscope. Even higher, sub-piconewton sensitivity (and in three dimensions) is possible by using scattering into a single quadrant-photodetector. Therefore, the BOS NEMS structure appears capable of sensing an extended range of forces, providing simpler access to the soft biological samples under test, and being more easily interfaced to the tight working space of biological optical microscopes. The fabrication of the structure is particularly appealing in that it can be made controllably and in parallel by simple hand brushing of polymer over a patterned array of micropillars. The weight fraction, molecular weight and brushing speed of the PEO solution determine whether one bead or a bead and satellites form. The relatively large bead volume (25 micron diameter) enables large deflection with modest magnetic field gradients.

Keywords: nanomechanics, directed self-assembly,

polymers, magnetics

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75. High-Resolution Pulsed-Field-Ionization Ion Spectroscopy of Transition-Metal-Oxide Clusters

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Transition metal oxides are widely used as both catalysts and catalyst supports in petroleum refining and other industrial processes. A catalyst is a substance that initiates a desirable chemical reaction or speeds up a reaction that would otherwise be too slow to be economical. However, catalyst development is still carried out by try and error, and the rational design of new catalysts with predictable properties is a long-term goal requiring both basic and applied research. This KSEF-sponsored project focuses on the fundamental aspects of the catalyst development. We use laser-assisted synthesis to prepare metal oxide clusters in gaseous supersonic jets, mass spectrometry to measure the oxide abundance and distribution, and high-resolution pulsed-field-ionization ion spectroscopy to search for electronic-vibrational spectra. The outputs of this research include accurate ionization and vibrational energies, electronic states, and geometric structures. The project expands our research program in a new direction, stimulates additional research in cluster science, and increases the basic knowledge about the size-dependent properties of the transition metal oxide clusters. This work opens up new area for high-resolution ion spectroscopic applications to transition metal clusters and enhances Kentucky's emerging international reputation in this field. With the preliminary results from this grant, we have already been awarded a research grant of $445,560 from the National Science Foundation and a grant of $100,000 from the Petroleum Research Fund of the American Chemical Society and presented several papers at national and international meetings. With this grant, we are training several graduate and postdoctoral students in modern physical chemistry and chemical physics.

Keywords: pulsed-field Ionization, high-resolution ion spectroscopy, and transition metal oxide clusters

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76. Novel Lead-Free Piezoelectric Ceramics in the Solid Solution $BiFeO_3$-$BaTiO_3$

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Piezoelectric materials are widely used in many areas of science and technology due to their electromechanical properties. The transformation of mechanical energy into electrical signals and vice versa based on the piezoelectric effect has led to the development of a variety of sensor devices and piezoelectric actuators. The most technologically important piezoelectric material is lead zirconate titanate $PbZrO_3$-$PbTiO_3$ (PZT), however, the commercial manufacture and application of PZT as a lead-based material represent serious health hazards. The need to reduce environmental contamination by lead-based substances has created the current drive to develop alternative lead-free piezoelectric materials. The present work describes investigation of the novel lead-free piezoelectric ceramics in a solid solution of $BiFeO_3$-$BaTiO_3$ (BFBT). BFBT ceramics were prepared via the solid-state route with addition of manganese oxide in order to increase the DC resistance. Piezoelectric d_{33} coefficients of 116 pC/N (low-field, Berlincourt) and 326 pC/N (high-field) are reported. Piezoelectric measurements using the Rayleigh law under applied large DC electric field indicated an increased low-field piezoelectric d_{33} coefficient to 150 pC/N. The DC bias is believed to stabilize the ferroelectric domain structure leading to stronger intrinsic and extrinsic contributions to the piezoelectric response in BFBT. Bright field TEM imaging confirmed formation of macroscopic domains following high field poling from initially frustrated domain state indicating the ability to induce long-range polarization order in BFBT

ceramics. It is believed that the results of this work will contribute to the development of a family of lead-free piezoelectric materials based on $BiFeO_3$-$BaTiO_3$ system.

Keywords: bismuth ferrite, barium titanate, lead-free, piezoelectric ceramics, crystal structure

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77. Nanoscale Bubble Valves on CNT Membranes for Chemical Energy Storage

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Chemical energy requires stable electrodes with low over-potential, fast mass transport, and a valve system to stop diffusion while in the storage mode. Carbon nanotube membranes [1] are an exciting platform for energy storage since the mass transport through CNT cores is a thousand fold faster than pores of conventional materials, graphite is highly conductive and stable, and CNT surfaces can be functionalized with catalyst metals or complexes for a low over potential [2-3]. However an effective valve to turn off the membrane during storage time needs to be developed. Nano-scale bubbles have the potential to be nearly ideal valves to completely cover the pore entrance and reversibly turn off the membranes. Nanoscale bubbles have been observed to have unexpected stability, with internal pressures of only 1 atm, on hydrophobic surface due to the formation of a small contact angle [4]. Nano-scale bubbles are prone to form inside of the nanochannels and the growth of hydrogen nanoscale bubble can be controlled by electrochemical current dosing. Presented here is a novel electrochemical method to generate nm-scale bubbles at the tips of CNTs that can temporarily block the membrane. 92% blocking efficiency is achieved when the bubbles are stabilized in a 30-60 nm diameter 'wells' at the tips of CNTs. The nanoscale bubbles can be removed with 0.004 atm applied pressure on the feed solution to recover the transport through the CNTs membrane, allowing for a switchable membrane valve.

Keywords: energy storage, membrane, nano fluidics

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78. Tuning the Pore Structure of Surfactant-Templated Mesoporous Titania Films

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We describe methods to tune the synthesis of well ordered mesoporous titania thin films (MTTFs) fabricated by Evaporate-Induced-Self-Assembly with Pluronic surfactant template P123. Because P123 has average structure $(PEO)_{20}(PPO)_{70}(PEO)_{20}$ [where PEO = poly(ethylene oxide) and (PPO) = poly(propylene oxide)], the concentrations of polar and nonpolar additives can be adjusted to tune wall thickness, pore size and mesophase of the final products. For instance, the wall thickness of MTTFs can be tuned from 5 nm to 7 nm by adjusting the molar ratio of titanium precursor to P123 due to cooperative assembly of Ti species with PEO blocks. Alternatively, organic species can be introduced to interact with PPO blocks for pore tuning. When poly(propylene glycol) (PPG) is added to films aged at a temperature where PPG exhibits hydrophobic behavior, the mesopore size of the films increases up to as much as 6.4 nm and secondary pores ~2.4 nm in diameter are introduced due to partitioning of PPG between the polar titania-rich phase and the P123 micelles. On the other hand, aging the PPG-containing films at a temperature where PPG exhibits hydrophilic behavior leads to a hierarchical structure composed of voids >200 nm in diameter and ordered <12 nm pores. As one more example, adding 1-butanol gives transparent MTTFs with distorted 3D hexagonal (space group R-3m) symmetry. Grazing incidence small angle x-ray scattering, electron microscopy and simulated scattering confirm that the butanol-containing

films are composed of ordered arrays of cage-like cavities of tunable size.

Keywords: mesopore, titania thin film, wall thickness, pore size, hierarchial pore, 3D hexagonal mesopore, PPG, butanol

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79. Thermomechanical Characterization of Environmentally Conditioned Shape Memory Polymers

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Most air vehicles today are designed to obtain certain performance capabilities at the cost of operational flexibility. The ability to have a vehicle capable of adapting for numerous mission elements would be very advantageous. The design of the reconfigurable material systems to be used in a multifunctional air vehicle varies greatly. Shape memory polymers (SMPs) are novel class of active polymers that have been considered for the development of reconfigurable air vehicles. However, the durability of the SMPs has not been fully investigated to ensure they function properly in relevant environments. In this project, epoxy-based SMPs were conditioned separately in simulated service environments designed to be reflective of anticipated performance requirements. The shape recovery ability and mechanical properties of the conditioned SMPs were evaluated. Results show that environmentally conditioned SMPs generally exhibit decreased glass transition temperatures and higher moduli and strain rate sensitivities in comparison to an unconditioned one. Environmental conditioning also affects the shape recovery abilities of the SMPs if the recovery temperatures are set low.

Keywords: shape memory polymer, environmental conditioning, durability, reconfigurable material

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80. Novel Shape Memory Materials for Aerospace and Biomedical Applications

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Shape memory materials are an important class of smart materials with the ability to recover mechanically induced strain with a change in temperature or magnetic field and tunable material properties (e.g. Young's modulus, damping properties). They have the ability to sense the changes in environment and respond accordingly. They simplify products, add features, improve performance, and increase reliability with relatively little mechanical complexity. Shape memory alloys have remarkable material properties such as they can produce very high actuation strain (4-10%), stress (~100-400 MPa) and work output (~10 MJ/m3) as a result of reversible martensitic phase transformations. Shape Memory Polymers are polymeric smart material that have the ability to return from a deformed state (~100%) to their original (permanent) shape induced by an external stimulus (trigger), such as electric, temperature, magnetic field, light or solution. In this poster, results from the thermomechanical characterization of the high temperature and high strength shape memory and shape memory polymers for aerospace and biomedical applications will be presented.

Keywords: shape memory alloys, shape memory polymers, phase transformation, aerospace, biomedical

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81. High Temperature Polymer Matrix Composites for Aerospace and Space Applications

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Polymer matrix composites (PMCs) have been increasingly used for high temperature applications in aerospace industries. The matrix systems in the high temperature PMCs are predominantly thermoset polymers. One of the major concerns in using polymer matrix composites at high temperature environments is the thermo-oxidative degradations of the polymer matrix and the matrix-fiber interphases. Exposed to elevated temperature, the free surfaces of PMCs are susceptible to oxidation. When exposed to thermo-mechanical loading, the result is accelerated degradation and ply cracking which in turn introduces new free surfaces. Ultimately, the thermo-oxidative degradation reduces the life and durability of the composite system. The present project studied the thermo-oxidative degradation and resultant mechanical properties of the PMCs through experimental testing and numerical simulations.

Keywords: polymer matrix composites, thermo-oxidative aging, interphase, finite element modeling

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82. Hematite Nanowire Arrays for Photoelectrochemical Water Splitting

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Properties of hematite a- Fe_2O_3 nanowire arrays for photoactive water splitting on the electrode are shown. The nanowire arrays are synthesized by thermal and plasma oxidation of commercial steel samples. In comparison, the Fe_2O_3 nanowire arrays grown using thermal oxidation of iron foils exhibited no photoactivity due to the presence of a thick (approx. 30 micron) interfacial layer and non-hematite phases. The photoactivity of plasma grown iron oxide NW arrays is supreme to other growth methods yielding a significant photoactivity of 0.255 mA/cm2 at 0.3 V SCE in 1M KOH . If the photocurrent is inhibited by the presence of a thin amorphous oxide sheath on the surface of the nanowires due to exothermic reactions on the surface, it can be easily removed by diluted hydrofluoric acid which restores photoactivity of the electrode.

Keywords: a-Fe_2O_3, hematite, iron oxide, nanowires, plasma synthesis, photochemical activity, water splitting, hydrogen manufacturing, solar cell

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83. Advanced MEMS Grayscale Lithography Mask Generation Software

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Grayscale lithography is a technique used to expose different areas of a photosensitive substrate to various intensities of light. By controlling the amount of light each region of the substrate is exposed to, the depth at which photoresist is developed can be carefully controlled. This process can result in the creation of complex 3D structures in photoresist simply from using a single exposure lithographic technique. While it provides an extremely versatile tool for Micro-Electro-Mechanical Systems (MEMS) fabrication, grayscale lithography is a relatively underutilized process.

The main drawback of grayscale lithography involves the time-intensive creation of mask files required to generate complex 3D structures. Therefore, the University of Louisville Micro/Nano Technology Center (MNTC) team designed a process to simplify the task of generating mask files. Custom software was written which automatically converts SolidWorks parts into grayscale mask files accepted by a Laser Pattern Generator. By allowing parts designed within SolidWorks to be directly fabricated into MEMS structures, a large preexisting pool of engineering professionals are now able to take advantage of the ability to participate in MEMS design with no additional training required.

Keywords: grayscale lithography, SolidWorks, solid models, MEMS, microfluidics, photolithography

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84. Solar Thermal Powered Knudsen Gas Pump

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This paper reports on a Knudsen gas pump that may be operated using solar radiation. The pump may be considered environmentally friendly as it requires no external power supply. The Knudsen pump presented here features no moving parts, is thermally driven, has a simple design, has no need for batteries or other power supplies, and it is relatively simple to fabricate. Two Knudsen gas pumps were designed and fabricated. Both pumps utilize the same basic design: a nanoporous material, an inlet tube, a heat sink, and a method of heating the exposed portion of the nanoporous material. Gas will flow through the nanoporous material when a temperature gradient is applied due to the thermal transpiration effect. The velocity of a drop of water in the inlet tube was measured to obtain the flow rate of each pump. The gas flows from the cold to the hot side of the nanoporous material. When solar energy heated the metal of either pump, the drop would start moving out of the tube. Flow velocities exceeding 1 mm/s were obtained for an open tube, and a pressure difference greater than 1 kPa was obtained in a closed container.

Keywords: gas pump, solar power

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85. Angle-Multiplexed Waveguide-Resonance Sensor of High Sensitivity and Nano-Second Time Resolution

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We report here the experimental results of an optical sensor based on a waveguide resonance with a high quality factor formed by a dielectric film (Al_2O_3) deposited over a noble metal material (Ag, Au). Based on a judicious design of the layer thicknesses and a fabrication process that delivers a highly transparent dielectric film over a metal surface, we demonstrate a device that is 39 times better than conventional surface plasmon resonance sensor for probing refractive-index changes. In addition, we have created an optical experimental setup based on diffraction-limited lenses that is able to collect the full angular spectrum and resolve the sharp waveguide resonance. Such configuration has enabled us to reach nanosecond time resolution and experimental evidence is provided by the luminescent signal of a sub-monolayer of a ruthenium complex adsorbed to the sensor surface. The highly sensitive and fast detection technique demonstrated here is expected to find useful applications in studies of the fast-dynamics of surface adsorbed molecules

Keywords: waveguide resonance, surface plasmon resonance, biosensor, time-resolved detection, nano-second time resolution

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86. Hybrid Organic-Inorganic Polyoxometalate Materials

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Self-assembly of the robust Keggin clusters and metal-organic coordination complex building blocks under hydrothermal conditions gives a number of new organic-inorganic hybrid solid compounds. These compounds were studied by Single crystal X-ray, UV–Vis, IR spectroscopy and Thermogravimetric analysis.

Keywords: hybrid organic-inorganic, polyoxometalate materials

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87. Amino-Functionalized SAPO-34 Membranes for CO_2 Separation

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SAPO-34 seeds and membranes were functionalized with several organic amino cations such as ethylenediamine, hexylamine and octylamine. The successful incorporation of the amino groups in the SAPO-34 framework was confirmed by FTIR and XPS. The resultant SAPO-34 membranes were evaluated for the separation of CO_2/CH_4 and CO_2/N_2 gas mixtures. CO_2/CH_4 selectivities as high as 245 with CO_2 permeances of ~ 5 x10-7 mol/m2 s Pa at 295 K and 138 KPa, were observed for an optimum ethylenediamine functionalized membrane, which corresponded to a ~ 40% increase in separation index as compared to the nonfunctionalized SAPO-34 membrane. Similarly, CO_2/N_2 separation performance was highly improved with the incorporation of ethylenediamine. CO_2/N_2 selectivities as high as 39 with CO_2 permeances of ~ 2.1 x10-7 mol/m2 s Pa at 295 K and 138 KPa, were observed for an optimum ethylenediamine functionalized membrane, which corresponded to a ~ 167% increase in separation index as compared to the nonfunctionalized SAPO-34 membrane.

Keywords: zeolite membranes, amino groups, CO_2 separation

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88. Matrix Isolation Spectroscopy of Copper-Naphthalene

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The interaction of transition metals with p-electrons is central to organometallic chemistry and constitutes a significant body of work in this field, yet surprisingly little is known about the bonding and geometry of transition metal-polycyclic aromatic hydrocarbon (M-PAH) complexes. Additionally these M-PAHs are suspected to exist in the interstellar medium (ISM), and may contribute to the unidentified interstellar infrared emission bands. This poster will present the matrix isolated infrared absorption spectrum and theoretical characterization of the Cu-Naphthalene complex. To produce this complex, laser ablated copper is co-deposited with a 1-3% argon/naphthalene mixture on a barium fluoride window cooled to approximately 10 K by a closed cycle helium cryostat. The trapped species are then probed with FTIR spectroscopy. Vibrational frequencies and electronic energies for both the eta-2 and eta-6 binding mode of Cu-Naphthalene were computed at the of B3LYP/6-311+G(d,p) level of theory. And through comparison of the observed and computed vibrational frequencies, the gross geometry of complex and the binding mode of copper to the p system are deduced. This work allows for a better understanding of metal-PAH interactions, the chemical and physical properties of the complexes, and their roles in the ISM.

Keywords: polycyclic aromatic hydrocarbons, PAH, interstellar medium, ISM, infrared, IR, transition metals

89. Passive, Non-Contact Remote Sensing of Displacement Using High Dynamic Range Optical Sensors

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University of Louisville

The ability to measure small changes in position accurately in real time has many practical applications. Conventional methods are costly and require physical contact or close proximity to the target. We have developed an inexpensive, non-contact, passive technology capable of remotely sensing spatial displacements smaller than a micron using high dynamic range optical sensors, low-noise electronics, and in some cases standard video equipment. In biomedical applications, the technology provides a reliable respiration monitor, and a non-invasive tool to assess the cardiovascular system. In civil engineering, it provides remote sensing of the structural integrity of bridges. Through analyses that identify principal resonant frequencies and displacements of the bridge under load, we identify key aspects of bridge dynamics and relate them to its structural health. The current best practice to visually inspect bridges is slow, costly, and potentially dangerous. Our approach surveys the structure at a distance in natural daylight quickly and easily without the need to be present on the bridge. Our technology may also identify structural deterioration hidden from view, since it senses and interprets the response of known components to normal load dynamics due to traffic, wind and background seismic noise. This offers an affordable method to monitor a bridge's health routinely, as well as to provide a prompt large scale assessment of the stability and health of critical infrastructure in the event an earthquake leaves damage over a large area.

Keywords: displacement, structural health, bridges, non-contact, remote sensing, passive, biomedical

90. Fabrication of Nanoporous Nickel as an Alternative to Raney Nickel

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Raney nickel is an important industrial catalyst but is also highly pyrophoric and must be protected from air exposure or stabilized by mild heating. An alternative form of nanostructured nickel (nanoporous nickel, or np-Ni) was developed as a thin film in this research project, and this material was found to avoid the pyrophoric problem. High purity (100% Ni content) np-Ni thin films were fabricated by dealloying NiMg precursor films. The nanoporous structure exhibited ligaments with a size of 7 nm, comparable to that of Raney nickel. Several precursor systems (NiCu, NiAl, NiFe and NiMg) were investigated as precursors for fabrication of np-Ni, and NiMg yielded the most consistent, open-porosity structure. Details of the fabrication method, structural characterization and chemical analysis, as well as electrochemical and mechanical performance of np-Ni will be presented.

Keywords: Np-nickel, thin film, thermal cycle, dealloying, CV, XPS, relative density

91. Selectively Stimulated Self-Assembly of Polymer Thin Films into Nanoscale Suspended Structures

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The fabrication and selective laser patterning of polymer thin films into arrays of nanofiber air-bridges is reported. Fiber formation is initiated by using a focused laser beam to thermally nucleate holes in a 20-1000 nm thick polymer film that is supported on top of an array of micropillars. Then heating above the glass transition temperature produces hole growth through controlled

dewetting, leading to the formation of fiber bridges. Using a rapid laser scanner or controlled motion stage, a custom array of holes is laser-written, and then, following thermal annealing a custom array of fibers forms to complete the lithographic process. The structures fabricated with this laser annealing technique have potential for use in devices that require regular diameters, structure, and orientation, in specific two and three-dimensional architectures with point-to-point connections; e.g., in nanoelectronics, microelectromechanical systems (MEMS), microfluidics, optical sensors, and nano-optics. Several studies have been performed using films that are linearly tapered in thickness. In one of these studies, the scaling relationship between laser energy and nucleated hole diameter is established and reported. In addition to the ability to custom pattern arrays of fibers, the major new outcome of this study has been that fibers formed with prenucleated holes are much more uniform in diameter than previous studies that only depended on random nucleation. This study was funded by a KSEF award.

Keywords: nanolithography, directed self-assembly, polymers, rheology

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92. Characterization and Catalytic Properties of Pd and PdAg Monolayer Protected Clusters

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We successfully synthesized Pd monolayer-protected clusters (MPCs) coated with octylamines (C8NH2), hexanethiolates (C6S), mixed monolayers of C8NH2/C6S ligands, and PdAg (10:1) stabilized with C8NH2. These nanoparticles exhibit significantly different reactivities with hydrogen gas and different stabilities against H2-induced aggregation depending on the ligand and metal composition of the MPCs as determined by UV-vis spectroscopy and electronic measurements in solution and as solid state films, respectively. The MPCs were characterized by 1H NMR, Fourier transform infrared (FTIR) spectroscopy, transmission electron microscopy (TEM), energy dispersive X-ray (EDX) analysis, X-ray photoelectron spectroscopy (XPS) and thermogravimetric analysis (TGA) to determine the size, metal composition, and ligand composition. The catalytic activity of the synthesized Pd and PdAg MPCs was examined using allyl alcohol as a substrate. Gas chromatography (GC) and NMR results show that C8NH2-PdAg 10:1 MPCs are more efficient catalysts for the hydrogenation of allyl alcohol to propanol while C8NH2-Pd MPCs are 50% and C6S-Pd MPCs favor the isomerization of allyl alcohol to propanal. Differences in the catalytic activities among the various monolayer coatings for Pd(C8NH2)177-x(C6S)x, where we varied x to be 10, 16, and 32, are attributed to the poisoning effect of the C6S ligands. The turnover frequencies (TOFs) of the Pd and PdAg MPCs catalysts ranged from 0 to 61 mol H2/ (mol Pd * h) and 28 to 94 mol H2/ (mol Pd * h) for the hydrogenation and isomerization of allyl alcohol, respectively.

Keywords: monolayer protected clusters, catalysis, palladium, silver, hydrogenation, allyl alcohol

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93. Electron-Beam-Induced Deposition of Metal Nanostructures from Liquid Precursors

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Focused electron-beam-induced deposition using bulk liquid precursors (LP-EBID) provides a new approach to nanoscale direct patterning. LP-EBID replaces the gas-phase precursors typically used for electron-beam induced deposition with aqueous solutions. This novel approach has shown greatly increased material purity compared to EBID using metalorganic and trifluorophosphine gaseous precursors. In addition, liquid precursors are readily available, inexpensive, easily handled, dissipate charge from insulating substrates, and can greatly increased deposition rates. Because of its versatility

and higher purity, LP-EBID appears promising for rapid device prototyping and lithographic mask repair. Here we report our recent studies concerning the deposition of multiple metals (Pt, Au, Ag, Ni, and Cr) as well as two different alloys (Au-Ag, Au-Pt) using LP-EBID. We find that the noble metals deposit with higher purity (typically >90at.%) while Ni and Cr incorporate greater contamination from the precursor. Resolutions as small as 20-nm half pitch have been obtained, but vary based on material, precursor, and precursor concentrations. In addition, we show that the alloy composition can be controlled based on the ratio of precursor ions in solution. Finally, we demonstrate deposition on multiple surfaces (polyimide and silicon nitride) as well as on a separate Si substrate.

Keywords: e-beam, deposition, nanotechnology, patterning, alloy

TECHNOLOGY DISPLAYS

94. 3D Imaging Dental Probe for Orthodontic Treatment

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Due to the difficulties of setting up a data acquisition system inside the mouth, we use an intra-oral camera to capture a sequence of calibrated images. The objective of our research is to construct a complete 3D model of the human jaw using the surface and teeth database models. The surface model produced by our methods gives the crown part of each tooth which is matched to 3D models in a teeth-database. Our surface model then replaces any conflicting information of the crown information of the match 3D model of the database, and the root structure of the 3D model is morphed to best match the known root structure based on any available x-rays, producing a complete 3D tooth structure of the subject for each tooth. The complete 3D model of the human jaw has great importance in the research of dentistry surgical simulation. Therefore our work has five parts: 1. The Surface Model: Designing and Developing algorithms to create a 3D model of the surface of the teeth form 2D video images. 2. The 3D Teeth Library: The 3D model library of real extracted human teeth. 3. Matching the Library: The Matching and Morphing process of each tooth. 4. Fusion: Fusing and Morphing partial info from the Surface Model, the Library model and the available x-rays to create the complete 3D Model of the Human Jaw. 5. A new intra-oral camera: The development of new automatic intra-oral camera conceptual prototype.

Keywords: dental mold, 3D teeth imaging

95. Certified Reference Standards and Stable Isotope Internal Standards for Equine Medication Regulation

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The regulation of equine competitive events requires defined regulatory thresholds for residues of therapeutic medications, thereby requiring accurate forensic quantification of these residues. This creates a need for certified reference standards and stable isotope internal standards for use in medication analysis. Our research group has synthesized about 40 reference standards and has provided at least 20 unique certified standards and/or their appropriate stable isotope internal standards to racing chemists world-wide. There is an ongoing need for reference standards and internal standards to fulfill world-wide requirement to scientifically regulate equine therapeutic

medication use in equine competitive events.

Keywords: equine forensic chemistry, medication regulation, quantitative analysis, regulatory analytes, certified reference standards, stable isotope internal standards, chemical synthesis

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96. Functional Analysis Of Genes Involved In The Caste Differentiation In Termites

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There are over 2,700 species of termites on this planet. Because of their cryptic nature and unique capability of digesting woody materials, termites represent a tremendous challenge to the human society, and are considered by many as one of the most destructive insect pests in the world. The combined damages and control costs exceeds $30 billion annually. Termites have been controlled predominantly by the synthetic chemicals. The persistency and highly toxic nature of termiticides, however, post a serious threat to our surrounding environment and human health. To reduce our reliance on broad-spectrum termiticides, we developed a RNA interference (RNAi)-based control alternative using the termites own gene against them. In this study, a group of genes involved in the worker to soldier caste differentiation process have been cloned and functionally characterized. By suppressing the expression of these genes, the developmental process of termites was disrupted and the colony fitness was compromised. In addition, at higher dosage challenged termites exhibited molting defects and high mortality. Results indicate genes involved in the termite development are viable target sites for the RNAi-based genetic controls.

Keywords: RNA interference, Reticulitermes flavipes, termite control, caste differentiation, functional characterization

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97. Wireless Temperature Sensing System for Children

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Four engineers with the University of Louisville's (UofL) Electrical and Computer Engineering (ECE) department have teamed with two pediatric physicians from UofL to develop and validate a system to remotely monitor the body temperature in young children. This team of engineers and doctors has also engaged two business and marketing experts to help commercialize the technology through a start-up company called Simon Sounds LLC. The purpose of this novel and potentially patentable device is to allow parents to monitor in real-time the temperature of their young children and alert them if the temperature has exceeded a predetermined threshold. This technology alerts the parents to a rapid change in body temperature, which can increase the risk of neurologic events (seizures). A prototype of the wireless transmitter and receiver to continually monitor temperature remotely will be demonstrated. In addition to showing temperature and sounding an alarm locally, this system will also demonstrate the use of a smart cell phone application to communicate to the parent or caregiver anywhere.

Keywords: wireless, febrile seizure, temperature monitoring

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98. Exosomal RNA and Protein Expressions Differentiate Pregnancies Destined to Deliver Preterm

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Background: While preterm births account for 12.7% of live births in the US, more than 60% of

neonatal mortality results from births occurring prior to 30 weeks gestation. Since miRNA and protein profiling of placental biopsies may be useful in diagnosing preterm birth, our hypothesis is that specific miRNAs and proteins associated with circulating exosomes will exhibit the same utility, in a non-invasive manner, allowing its use in screening asymptomatic populations. Methods: This study utilized sera from pregnant women at 14-16 weeks gestation, subsequently delivering at term (>37 weeks, n=21) or preterm (24-35 weeks, n=21). These were matched for age, race and BMI. Exosomes were isolated and exosomal proteins and total RNA were extracted. miRNAs were isolated and profiled using qRT-PCR arrays for 88 specific miRNAs. Exosomal proteins were profiled and defined using 2D-DIGE and ion trap mass spectrometry. Results: Of 88 specific miRNAs, circulating exosomes from preterm pregnancies expressed elevated levels of 18 (>2-fold), while 13 miRNAs exhibited diminished levels (>2-fold) versus term pregnancies. Proteomic analyses of exosomes identified 194 proteins. Of these, 134 were shared by exosomes from term and preterm pregnancies, 21 appeared to be unique to pregnancies delivering at term and 39 were linked with preterm deliveries. Conclusions: Differences in protein and miRNA associated with circulating exosomes can be identified in preterm versus term delivering pregnancies. Proteins linked with preterm-derived exosomes are associated with organ injury/cell compromise and cell-mediated immunity. Profiling of exosomal miRNA and protein circulating in pregnant women provides early markers predicting preterm birth.

Keywords: preterm, early detection

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99. Peaklet Analysis: Software for Fast, Accurate, and Automated Analysis of Spectrum Data

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Based on market research provided by the Kentucky Commercialization Fund grant COMMFUND-1280-RFP-011, the PI and the WKU Research Foundation have entered into a joint venture with HitCents, Inc. to produce commercial software that utilizes the patent-pending wavelet-based algorithm developed by the PI in part during the course of the research in the KSEF R&D Excellence grant KSEF-1653-RDE-011. This algorithm uses a wavelet basis developed by the PI during a previous KSEF R&D Excellence grant KSEF-324-RDE- 003 and EPSCoR Research Enhancement Grant UKRF 4-65752-04-360. The software allows the user to input the location and width of various peaks in the user's collected spectra (PFTNA, XRF, etc.) that are indicative of the presence of elements in their test material, and uses wavelet technology to eliminate background distortions and provide an accurate count for each peak. The software also allows the user to search an input substance library to help identify the test material. This poster will touch lightly on the steps taken by the algorithm, with references to more elaborate descriptions, and will show screen-shots taken of the software in use. Contact information will be given for individuals and companies wishing to license the use of the software. The software will be available starting in June 2011 for a free trial before purchase via internet download from peakletanalysis.com.

Keywords: wavelets, spectrum analysis, elemental detection, multiwavelets, HitCents

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100. Broadcast Methods for the Elimination of Random Anomalous Peak Loads

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A problem faces around the globe is that of increasing power consumption. Population growth combined with increased demand from industry lead to a geometric progression of power consumption. The intermittent nature of these heavy demands results in peak power loads on the

grid especially during times of excessive heat. In order to help control these random anomalous peak loads, we have developed a system which will give electrical utility providers the ability to control AC units on both residential and commercial units. Using wireless communication systems already in place, an integrated switching unit on the AC unit and algorithms to model multiple environmental conditions, our system is able to shift and reshape peak electrical loads on the power grid. The distribution strategy is targeted primarily to power producers. Incentives by the large power production companies could be passed along to sub-users of the system to increase interest in the system. Our system uses resources available through various OEMs and mature switching technology which reduces overall risk, however, the combination of these resources with new algorithms to predict peak load occurrences produces a system which is state-of-the-art. This same switching technology has been integrated into a smart thermostat which allows for marketing to not only power utilities and producers, but home owners wishing to decrease their energy cost.

Keywords: smart switch, smart thermostat, AC cycling, peak load reduction

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101. Closed System Container Wireless Monitoring

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Wireless sensor technology (WST) involves a collection of specialized sensors designed to remotely monitor and collect information on an important product or material found in a specific location or space. For example, WST may be employed for monitoring any "closed system" container of liquid (with or without free headspace), like the contents of a barrel of fermenting bourbon. The use of WST allows for immediate (real-time) monitoring of important physical parameters (pressure, temperature, humidity, etc.) in the container as well as the automated remote sampling of the container's content and/or free headspace. The collected data can be analyzed to perform real-time monitoring of important industrial processes, like the rate of alcohol fermentation. The development of an integrated, wireless sensor system for the real-time monitoring of a container's content is central to the implementation of an automated response system. We plan to develop an automated response system using WST in order to monitor the contents of closed containers stored for long periods of time. This innovative WST monitoring system will save the distillery industry the expensive and often unsafe manual monitoring practice currently in use.

Keywords: sensors, networks, monitoring, closed system container, wireless monitoring

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102. Mass Production of Metal Oxide Nanowires

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Nanowires are beginning to find applications in several fields, such as lithium-ion batteries and dye-sensitized solar cells. In all of these applications nanowires have shown improved properties over the currently used industrial materials. However, many of these applications require large quantities of nanowire powders with specific properties. Therefore, bulk synthesis with controlled composition and morphology is a prerequisite for the commercialization of nanowire-based technologies. Various methods have already been discovered to synthesize nanowires; however, due to substrate limitations most are limited to producing only a few milligrams per batch. The ideal method of large-scale nanowire synthesis is in the gas-phase, wherein the reacted species are quickly swept away from the reaction zone and there is no substrate limitation on the quantity of material produced. We recently designed, built,

and tested a reactor of such a design, which can be easily modified and adjusted to synthesize nanowires of numerous metal oxide systems. The gas-phase method of metal oxide nanowire synthesis using this reactor has already been demonstrated with 4 different metal systems: tin oxide (SnO_2), zinc oxide (ZnO), alumina (Al_2O_3), Titania (TiO_2). A production rate of 1 gram of zinc oxide nanowires every 5 minutes was also demonstrated using the reactor. This corresponds to a production rate in the range of 100 grams of nanowires per day on a continuous basis. Thus the results of this study are unique and promising for both the research and commercialization of nanowire-based materials.

Keywords: nanowire, nanowires, nano, solar, lithium, lithium-ion, materials, mass production, bulk

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103. Strengthening Steel Beams with Ultra High Modulus CFRP Laminates

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Research on the application of fiber reinforced polymer (FRP) composites to steel structures has been limited. Utilizing FRP material for the repair and rehabilitation of steel members has numerous benefits over the traditional methods of bolting or welding of steel plates. Carbon FRPs (CFRPs) have been preferred over other FRP material for strengthening of steel structures since CFRPs tend to posses higher stiffness. The emergence of high modulus CFRP plates, with an elastic modulus higher than that of steel, enables researchers to achieve substantial load transfer in steel beams before the steel yields. This research analytically and experimentally investigates the bond characteristics between ultra high modulus CFRP strengthened steel members and the flexural behavior of these members. A series of double strap joint tests, using both ultra high modulus and normal modulus CFRP laminates, are carried out to evaluate the development length of the bond. Flexural tests are carried out under 4-point bending on several small scale wide flange beams. The study also introduces the novel ultra high modulus CFRP strip panels for strengthening of steel bridge girders. The strip panels eliminate the requirement for a splice plate while also increasing the load causing yield in the steel beam.

Keywords: composites, polymers, strengthening, steel beams

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104. Novel Reaction Purification Cartridges and Nanopalladium Pellets for the Chemical and Pharmaceutical Industries

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The overarching goals of our research are to reduce time/labor-consuming practices in chemical synthesis, and spur new concepts in chemoselectivity using green materials, and recyclable catalysts. To this effect we have devised a porous polymer supported organic phase that functions as a 'rigid solvent' framework that eliminates tedious liquid-liquid extraction practices and provides universal reaction clean-up. This 'rigid solvent' can also host metal nanoparticles that will catalyze a reaction with more efficiency and with less waste than current technologies.

Keywords: energy efficiency, chemical reactions, catalysis

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105. Sustaining Our Seafood: Video on Reuse Technology for Fish Production

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Sustaining Our Seafood video provides information on the need for aquaculture in the United States to use sustainable practices to be competitive in the global markets. Imports of cheaper fish products

have been increasing into the US partly because of higher costs of domestic fish production. Capital expenditures for land, ponds and tanks or other facilities are some of the reasons for the higher costs in the US and directly affect the overall market prices for food fish. Novel and cost-saving practices need to be incorporated to remain competitive. Reuse of existing facilities that can be retrofitted for aquaculture, such as decommissioned wastewater treatment plants, could be an option. Many are being needlessly demolished, when reusing them as fish hatcheries could save the community demolition costs, create new jobs and generate revenue. These old urban facilities could provide a reliable system for intensive fish culture and provide ready access to markets and lower transportation cost. Reuse of old wastewater facilities is a growing idea to use existing tanks, processed water effluent and other infrastructure components to raise fish as stockers for aquaculture production. Fish have been extensively analyzed for heavy metals, pesticides and other contaminants to provide assurance to the public of its food safety.

Keywords: aquaculture, reuse technology, paddlefish

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106. Implantable Intraocular Pressure Sensor

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107. Targeted Therapy for Cancer Treatment

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