Poster Symposium & Innovation showcase

GUIDEBOOK

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ABSTRACTS (1-3)

1 Curriculum Modules for the Internet of Things

AUTHORS: Hal Evensen, Molly Gribb, Adel Nasiri (UW-Milwaukee)
SCHOOL: UW-Platteville

ABSTRACT: The ongoing fourth industrial revolution, driven by the Internet of Things (IoT), is having profound impacts on industries of all kinds, especially manufacturers. Further, the increasing ability to collect and analyze large amounts of data has impacts beyond manufacturing. Given the critical role that engineering educators play in supplying the engineering workforce for the nation—and the critical role of our schools in other areas impacted by IoT—development and distribution of state-of-the-art undergraduate curriculum that enhances graduates' knowledge and skills in the IoT space is important. Therefore, UW-Platteville hosted an Internet of Things Curriculum Workshop in January 2019. The purpose of this workshop was to support faculty members from across our state to work together, to collaboratively develop and share IoT course modules to enhance educational outcomes for engineering and other programs state-wide. This workshop was designed to enable faculty to 1) learn about the need for curriculum directly from industry collaborators at a round-table discussion; 2) learn about existing IoT curriculum development efforts at sister institutions; 3) begin the collaborative development of new "two-week" course modules to enhance existing, and potentially new courses in a wide range of engineering and related disciplines. The modules have recently been completed and are being presented in a working session at WSTS 2019, to gather feedback from industry and academic participants. All are invited! The modules are to be broadly accessible across our state and will serve as a first step toward broader dissemination of IoT-related topics in engineering curricula.

2 Synthesis of (R)- and (S)-2-Methylproline

AUTHORS: Jason Lopez
SCHOOL: UW Oshkosh

ABSTRACT: 2-methylproline is a modified version of the important amino acid, Proline. It has medical applications within peptide therapeutics, but methods for synthesis are privately owned under patent. This research describes a method for the synthesis of (R)- and (S)-2-methylproline. Alkylation of dimethyl methylmalonate with 3-Bromopropionaldehyde ethylene acetal, followed by selective monohydrolysis of the diester with Pig Liver Esterase, should give an isomerically pure acid. The isomers can be easily interconverted by standard protecting group manipulations as long as the solution is isomerically pure. A Curtius rearrangement/hydrolysis followed by a reductive amination/hydrolysis should give the products (R)- and (S)-2-methylproline.

FACULTY ADVISOR: Dr. Brant Kedrowski

3 Electronic Health Records (EHR) User Interface Framework Derived from Health and Human (HHS) Services Web Usability Guidelines

AUTHORS: Lucas Frey
SCHOOL: UW-Platteville

ABSTRACT: Emergency departments are unique, unpredictable, and dynamic environments. These environments are prone to frequent interruptions. Throughout these interruptions, patient-physician documentation and communication suffers and emergency physicians cannot complete charting in an efficient and accurate manner due to poor user interface design. Therefore, due to the inability of emergency physicians to carefully complete Electronic Health Records (EHR's), EHR's become inaccurate. This can lead to misdiagnosis of the patient and subsequently litigation or the potential death of a patient. Users will be most comfortable and efficient with layouts they are familiar with. This study identified usability guidelines that helped emergency medical professionals interact with EHR Software more efficiently. We found that users prefer traditionally sized, colored, and spaced text, standard radio

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buttons or checkboxes for questions, and traditionally located navigation buttons in the middle side pane of the window. This study developed an understanding and measure of the optimal ergonomic and cognitive information presentation for healthcare providers to navigate electronic medical records efficiently. The study focused on three integral portions of the user experience with respect to EHR's: data visualization (textboxes, font size, font color, etc.), data entry (radio buttons, check boxes, buttons, etc.), and navigation (location, size, and color of navigation buttons).
FACULTY ADVISOR: Dr. Suboh Alkhushayni

4 Visualization of Algebraic Surfaces Using Python and Bertini_real

AUTHORS: Foong Min Wong, Dan Hessler
SCHOOL: UW-Eau Claire

ABSTRACT: There are several modern tools that can render algebraic surfaces, allowing us to visualize their important geometric properties and mathematical concepts. Bertini_real is one of the opensource numerical software for decomposing real algebraic curves and surfaces in any number of variables. The software has been using MATLAB for the visualization of smooth algebraic surfaces and exporting surfaces as stereolithographic (STL) files for 3D printing. Our research aims to extend the software's functionality by adding a Python-based Bertini_real visualization suite, for free educational access for students. We use the Python library Glumpy to plot the sampled decomposed surfaces and the library Trimesh to export raw and smooth 3D STL surfaces. Students who do not have a MATLAB license will now be able to use the graphical interface of Bertini_real to visualize algebraic surfaces freely.
FACULTY ADVISOR: Dr. Danielle Amethyst Brake

5 Molecular Analysis of 5'-3' Exoribonuclease (Xrn) Mutants, Including One That Tolerates Low Nitrogen, in the Green Alga Chlamydomonas reinhardtii

AUTHORS: Johnathan Tuttle, Julia R. Williams, Megan M. Augustine, Dr. David C. Higgs
SCHOOL: UW-Parkside

ABSTRACT: Organisms regulate the expression of genes in response to developmental and environmental changes. In eukaryotes, 5'-3' exoribonucleases (Xrns) help control mRNA stability that in turn can influence abundance of encoded protein and can help regulate gene expression. Sequence analysis predicts four Xrn genes in the nuclear genome of the single celled green alga C. reinhardtii, a model organism commonly used to study photosynthesis. Two of the Xrns appear to encode Type I Xrn proteins, typically targeted to the cytoplasm, while the other two appear to encode Type II Xrn proteins, typically targeted to the nucleus. Ten mutant strains with a predicted DNA insertion into one of the Xrn genes were obtained from the Indexed, Mapped Mutant Library in C. reinhardtii (Li et al., 2016, Plant Cell, Vol 28: 367-287). Growth tests confirmed that the mutants contain a selectable antibiotic marker, and PCR and DNA sequencing has confirmed the location of the insertion within the Xrn genes for three of the mutants. To test phenotypes of the mutant strains, growth curves were performed with nutrient rich (TAP) media and nutrient-limiting media such as nitrogen and phosphate starvation and lack of acetate, a carbon and energy source utilized for facultative heterotrophy. On nitrogen-depleted media, one of the mutants grows to a higher cell density compared to wild type. This is of interest because nitrogen is a critical and common limiting nutrient for plant growth. Despite having found that the tolerant to low nitrogen phenotype is unlinked to the Xrn inserts via test crosses, an analogous genetic variant may be possible to engineer in crop plants so as to overcome this nitrogen limitation, potentially allowing for the reduction of nitrogen fertilization. Genetic analysis and impact on molecular and cellular processes in these mutants will be presented.
FACULTY ADVISOR: Dr. David C. Higgs

6 Post-Synthetic Modification of Metal Organic Frameworks (MOFs) for Application in Toxic Metal Removal

AUTHORS: Riley Sasse, Jamison R Wallace, Jalynn C Schuh, Hyeong Cheol Yoo
SCHOOL: UW-Platteville

ABSTRACT: Unavailability of clean drinking water is a serious issue and an estimated 2 billion people do not have access to clean drinking water according to the World Health Organization. Heavy metal ions are one of the critical sources for water contamination. In this research, we aim to develop a material which will effectively remove heavy metal ions, for example cadmium ion, from water. The material we have synthesized is called metal-organic framework (MOF). This is highly porous with a surface area of around 1600 m2 /g. MOF can remove the cadmium ions from water in the ppm level. In order to enhance the removal efficiency, MOF surface was functionalized with specific functional groups which have high affinity for heavy metal ions.

FACULTY ADVISOR: Dr. Mohammad Rabbani

7 Mechanically Integrated Wind Power Generation System

AUTHORS: Adam Jensen, Dr. Md Maruf Hossain
SCHOOL: UW-Green Bay

ABSTRACT: Wind-powered energy generation currently lacks optimized energy output due to the constraints of the need for a 1-to-1 wind turbine-to-single electrical generator. This research proposes a system of mechanically integrated vertical axis wind turbines (VAWTs) that will connect to a single unit generator and electronic interface to more efficiently and cost-effectively produce electricity. Such a system has utility for both residential and commercial electric power consumers. The applications of the proposed system can also be expanded to include pumping water, grinding grains etc. Energy generation efficiency and operational cost-savings will be realized through (1) the network of wind turbines being powered by one single generator (reducing electrical/mechanical infrastructure), and (2) the VAWT system being connected to a single drive train from a single remote generator allowing for a reduction in the size and weight of each turbine (needing less wind to operate, and increasing opportunities for a wider geographic use). This research will have a transformative impact on the current understanding of wind power generation from VAWTs that will lend itself to overcoming the problem of high production costs for wind-powered energy generation. When each single VAWT no longer relies on a dedicated single generator and power electronics interface, the end result will be increased capacity for electricity generation from the wind, lower installation and maintenance costs, and greater wind-powered energy generation abilities.

FACULTY ADVISOR: Dr. Md Maruf Hossain

8 Wireless Mailbox Notifier

AUTHORS: Jerad DeVries
SCHOOL: UW-Superior

ABSTRACT: Often times mailboxes in the country cannot be seen from the house. Instead of checking for the mail manually by walking out there, we set out to design a system that will notify someone from inside their house. Building on the ideas of Michael Jenssen and Sergei Bezrukov we designed a wireless mailbox notifier that solves this problem.

9 Discovery of Antibiotic-Producing Soil Bacteria with Broad-Spectrum Activity

AUTHORS: Halee Behrens, Katlyn Tappy, Brian Merkel
SCHOOL: UW-Green Bay

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ABSTRACT: The emergence of antibiotic-resistant bacteria has developed into a worldwide health crisis. Initiatives have been taken recently to search for soil bacteria that produce novel antibiotics. A soil sample was obtained from a site located at 44°42'43"N, 88°06'26"W and was serially diluted in water. The bacteria were then plated on Luria broth (LB) agar plates containing 25 µg/mL of cycloheximide and incubated at 28°C for seven days. The Colony Forming Units for the collected soil sample was calculated to be 1.6 x 10^9 CFU/g. Morphologically distinct bacterial colonies were picked and patched on potato dextrose agar and 10% trypticase soy agar to create "master plates." Isolates were tested for antibiotic-producing activity against a representative Gram-positive bacterium, Staphylococcus aureus (S. aureus), and a representative Gram-negative organism, Escherichia coli (E. coli). Four soil isolates displayed broad spectrum activity against both S. aureus and E. coli. Two isolates are Gram-positive bacilli and two isolates are Gram- negative bacilli. BLAST analysis of the DNA sequence for the PCR-amplified 16S rRNA gene for each isolate and biochemical testing suggest that the Gram-positive isolates and Gram-negative isolates belong to the genera Bacillus and Pseudomonas, respectively.
FACULTY ADVISOR: Dr. Brian Merkel

10 Molecularly Imprinted Polyaniline in Glucose Detection

AUTHORS: Cody DeHamer
SCHOOL: UW Oshkosh
ABSTRACT: Molecularly-imprinted polyaniline was fabricated by polymerizing 3-aminophenylboronic acid on the surface of a glassy carbon electrode in the presence of glucose. The trapped glucose molecules were "knocked out" from polymer network by washing with sulfuric acid. The resulted molecularly-imprinted polyaniline enhanced the signal strength of an amperometric glucose sensor. This finding can be applied to improve the sensitivity and accuracy of glucose detection devices.
FACULTY ADVISOR: Dr. Yijun Tang

11 Assessment of Activated Carbon's Ability to Absorb Common Water Contaminants

AUTHORS: Philip Margarit, Dr. Jill Coleman Wasik
SCHOOL: UW-River Falls
ABSTRACT: Nitrates and phosphates are common water contaminants that come from fertilizers used in conventional agricultural practices. These contaminants are able to enter surface and groundwater through runoff, as precipitation and snow melt carries these contaminants from agricultural fields into watersheds. Phosphate causes eutrophication in surface water and nitrate is a threat to public health when it contaminates drinking water. Activated carbon is an organic absorbent material that has shown viability to act as a water filter. In the manufacturing process of activated carbon, a large amount of surface area is created. This is created in the form of micropores, which gives the substance a surface area of about 32,000 square feet per gram. This research investigated the viability of activated carbon as a material that could mitigate agricultural contamination. Filters were constructed by placing 125g of hydrated activated carbon into a funnel. Then nitrate and phosphate solutions of environmentally relevant concentrations were created (8 ppm and 1 ppm, respectively). A mixed nitrate/phosphate solution was also created to test for competitive effects. A solution was passed through a filter five times to measure filter effectiveness and potential to store the contaminants. This process was repeated 3 times for each solution. Activated carbon was able to effectively filter both phosphate and nitrate out of the solution, reducing nitrate concentrations by an average of 97.67% and phosphate concentrations by an average of 88.62%. In the solution with both contaminants combined, the filter preferentially filtered the nitrates over the phosphates, but was still effective for both. These results demonstrate the viability of this material to treat ground water affected by nitrates, and surface waters affected by point source phosphate pollution. Further research will be conducted on its ability to treat chloride contamination, and phosphate and

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nitrate contamination in water that contains other molecular compounds and ions.
FACULTY ADVISOR: Dr. Jill Coleman Wasik

12 Producing Polymer-quantum Dot Composite Materials Through Direct Ligand Reaction

AUTHORS: Kimberly Mackiel, Cordell Shrank, Aaron Evans
SCHOOL: UW-River Falls
ABSTRACT: Quantum dots are semiconducting particles with diameters of 1-20 nm which are efficient emitters and absorbers of light. The color of light absorbed or emitted depends on the average particle size. These properties have caused quantum dots to be incorporated into consumer electronics such as televisions. This has driven growth of the quantum dot market value to $5.04 billion by 2020. To build a flat panel display, quantum dots are formulated into a polymer composite, which is produced by weaving quantum dots between large polymer strands or by producing a polymer with quantum dot binding sites. These methods could result in quantum dot aggregation which can reduce device efficiency. In order to reduce aggregation, the quantum dot surfactants can be linked together directly using olefin metathesis. The distance between quantum dots is controlled by using surfactants of varying lengths. This could serve to improve device performance and efficiency. A drawback to this method is that amines on the surfactant decompose the olefin metathesis catalyst. This could be avoided by exchanging the amine surfactant for carboxylic acid.
FACULTY ADVISOR: Dr. Samuel Alvarado

13 Different Impacts of Deicing and Anti-icing on Concrete Durability

AUTHORS: Paige Bailey, Zebedee Kielar
SCHOOL: UW-Platteville
ABSTRACT: Winter driving conditions are greatly improved with the use of deicing chemicals such as salt. Applying salt after a winter event has been the most common method for many years. Recently, the application of a salt solution prior to snow or ice, known as anti-icing, is becoming more accepted due to cost and effectiveness. There is not enough research yet to identify the different impacts of these deicing and anti-icing chemicals. To study the varying effects, concrete samples were created and subjected to freeze thaw cycles either with deicing or anti-icing chemical application. Rock salt in solid format is used for deicing and a salt brine is applied for anti-icing. The loss of mass and durability of these samples throughout the cycles were recorded and analyzed. It was initially hypothesized that anti-icing chemicals would penetrate concrete easier because of the dry condition of the concrete. Hence, anti-icing would cause more damage to concrete than deicing does. However, initial results from this study show that the anti-icing concrete samples performed better than the deicing samples. The application of a salt brine prior to a winter event can be more environmentally friendly, effective, safe, and cost less than traditional road salt.
FACULTY ADVISOR: Dr. Danny Xiao

14 Investigating the role of ROP GTPases in plant-microbe Symbiotic Signaling

AUTHORS: Garrett Larsen, Charles Peterson, Muthu Venkateshwaran, Jean-Michel Ane (UW-Madison)
SCHOOL: UW-Platteville
ABSTRACT: Majority of land plants associate with arbuscular mycorrhizal (AM) fungi to meet their phosphorus and other nutrients requirements. In addition to AM symbiosis, legume plants associate with rhizobial bacteria to meet their nitrogen demand. During the symbiotic association between legumes and rhizobia, legumes form root nodules to accommodate their rhizobial symbionts inside which the

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rhizobia fixes atmospheric nitrogen and supplies it to the plants in usable forms. These processes are mediated by several genes and sophisticated signaling pathways in both plants and microbes. However, our knowledge on the molecular mechanisms mediating these plant-microbe symbiotic signaling is rudimentary. ROP GTPases are small regulatory proteins that play a role in many developmental processes in plants and their responses to biotic and abiotic stimuli. They are shown to play a role in root hair growth and plant defense against pathogens. However, their role in plant-microbe symbiosis is not very well established. We hypothesize that ROP GTPases play a role in early symbiotic signaling. Utilizing reverse genetic strategies, we characterized three different ROP GTPases, (ROP3, ROP6 and ROP7) for their role in legume nodulation and arbuscular mycorrhization. Specifically, we over-expressed two modified alleles for each gene that are either dominant negative (D121A) or constitutively active (C15V) in a wild-type genetic background of the model legume Medicago truncatula for functional characterization of ROP GTPases.
FACULTY ADVISOR: Dr. Muthu Venkateshwaran

15 Fabrication of YBCO Superconductor and Ga doped PBCO Insulator Polycrystalline Powders and High-Density Discs

AUTHORS: Nathan Arndt, Michael Connolly
SCHOOL: UW-Parkside
ABSTRACT: The high-temperature superconductor (S), Yttrium- Barium-Copper-Oxide (YBCO), and an insulator (I), Ga-doped Praseodymium-Barium-Copper-Oxide (PBCGO), are novel materials for the nanofabrication of S-I-S tunneling Josephson junction devices. Josephson junctions are used in superconductor quantum interference devices (SQUID), quantum computing, and terahertz frequency detectors. YBCO based Josephson junctions offer many advantages over the conventional low-temperature superconductor-based Josephson junctions in cost, cryogenic system simplicity, and IcRn value (with Ic the junction critical current and Rn the normal resistance).
We have synthesized single phase YBCO and PBCGO polycrystalline powder materials using the solid-state reaction method and subsequently, have fabricated high-density discs for the thin film deposition of YBCO/PBCGO superlattices (thin film multilayers). Here, we discuss the synthesis process of the polycrystalline powders, fabrication of high-density discs (greater than 90% of the theoretical value), and x-ray diffraction and electrical transport studies.
FACULTY ADVISOR: Dr. Hom Kandel

16 Directed Differentiation of Human Embryonic Stem Cells into Functional Cardiomyocytes

AUTHORS: Colton Lysaker
SCHOOL: UW-Platteville
ABSTRACT: Human embryonic stem cells (hESCs) have become a leading tool for disease modeling and translational research. What makes these stem cells so appealing in biomedical science is their pluripotent nature, meaning they can develop into any cell type in the body. Cardiovascular disease is the leading cause of death in the United States, accounting for 1 in every 4 deaths. And while the heart does not regenerate its own cells, it may be possible to supply replacement cells developed in the laboratory. Stem cell-derived cardiomyocytes are tools of the biotechnology and pharmaceutical industries in their search for cardiac therapies. To produce cardiomyocytes from stem cells, scientists must consider a wide range of factors. Here, we analyze how Bone Morphogenetic Protein 4 (BMP4), Activin A, and cell density affect stem cell differentiation into functional cardiomyocytes. By monitoring this differentiation, cell populations can be analyzed through molecular analysis and the appearance of cardiac-specific factors.
FACULTY ADVISOR: Dr. Mark Levenstein

17 Synthesis and Application of Smart Polymers in Architectural Coatings

AUTHORS: Colton Carney, Cole Castel, Henry Liautaud
SCHOOL: UW-Eau Claire

ABSTRACT: The focus of this research has been on the use of smart copolymers for application in architectural coatings. Smart polymers respond to stimuli in their environment such as temperature and pH by undergoing physical and chemical changes. Poly(2-dimethylaminoethyl methacrylate) (PDMAEMA) has varied water solubility when exposed to changes in these conditions. These stimuli-responsive polymers are ideal for architectural coatings such as paints, primers, and stains because they act as improved dispersants and surfactants. Dispersants are molecules that assist in preventing the aggregation of particle suspensions, while surfactants are molecules that affect the surface tension between liquids. The optimal dispersion of titanium dioxide particles reduces the cost while increasing the quality of coatings. Copolymers of PDMAEMA with polyethylene glycol (PEG) were prepared using activator regenerated by electron transfer atom transfer radical polymerization (ARGET ATRP). Both PEG-PDMAEMA diblock and PDMAEMA-PEG-PDMAEMA triblock copolymers were synthesized using controlled polymerization to ensure proper chain growth. Characterization of polymers was performed using proton nuclear magnetic resonance (NMR) spectroscopy and gel permeation chromatography (GPC) to verify if target molecular weights were achieved. The smart properties that were analyzed include interfacial tension and dispersion capability using pH and temperature testing series. Pendant drop tensiometry (PDT) was used to test the interfacial tension between buffered polymer solutions and toluene. This data shows how diblock and triblock copolymers are effective surfactants. Dynamic light scattering (DLS) was used to detect the dispersion of titanium dioxide particles in solutions with and without copolymers, to understand the dispersive properties as functions of pH and temperature. Essentially, PEG-PDMAEMA copolymers were tested to evaluate their performance as both titanium dioxide dispersants and smart surfactants in architectural coating applications.

FACULTY ADVISOR: Dr. Elizabeth Glogowski

18 The Effect of Intramolecular Acid Strength on CO2 Reduction Catalysts

AUTHORS: Kara Gillette, Grace Robertson, Lucienna Wolf (DePaul University), Kyle Grice (DePaul University)
SCHOOL: UW Oshkosh

ABSTRACT: Carbon dioxide (CO2) is produced from many modern processes involved in industry and transportation but has few practical uses that encourage producers to capture CO2 emissions. Converting CO2 into the more reactive carbon monoxide (CO) for use in synthesizing fuels, plastics, and other carbon-based products would create a way to recycle CO2 and the economic incentive to do so. However, without the assistance of a catalyst, the reaction used to convert CO2 to CO is not efficient enough for practical use. Several classes of complexes capable of catalyzing the conversion of CO2 to CO have been found, including one with the general structure MnBr(R-bpy)(CO)3, where R-bpy is bipyridine or a bipyridyl derivative. The conversion of CO2 to CO requires the protonation of CO2, and an earlier study showed that the addition of an intramolecular proton donor to the catalyst in the form of a pendent phenol increased the catalytic rate. The study presented here focused on determining the effect of the strength of the intramolecular proton donor on catalytic performance; that is the rate, selectivity and stability with which the catalyst converts CO2 to CO. To this end, three catalysts with pendant phenols of varying proton donor ability were synthesized and characterized. Their catalytic performance has been investigated, and the preliminary results will be discussed here. Additionally, a procedure to measure the relative strengths of the intramolecular proton donors is being developed, and the preliminary results from these measurements will be presented.

FACULTY ADVISOR: Dr. Sheri Lense

ABSTRACTS (19-23)

19 Recovering DNA From Beyond This World

AUTHORS: Caitlyn Guldenpfennig
SCHOOL: UW-Platteville

ABSTRACT: Developed at UW-Platteville, First Contact™ Polymer is a cleaning agent of choice for NASA and other astronomers/physicists working at the cutting-edge of research. After applying the polymer to telescopes and sophisticated lenses, it adheres to and clears contamination as it is removed, restoring the surface to factory specifications. Once removed, the polymer is often discarded along with the adhered materials. We have determined that First Contact™ possesses the ability to remove nanoscale molecules from multiple surfaces. This study aims to determine if those "nanomolecules", specifically DNA, can be recovered from the polymer. Multiple assays are under development to capture the DNA from First Contact™ Polymer and its solvent components. DNA recovered from the polymer may prove useful for many applications. It could hold the potential to aid in DNA collection for forensic investigations or even isolate molecules from beyond this world.

FACULTY ADVISOR: Dr. James Hamilton, Dr. Mark Levenstein

20 Applications of Linear Algebra in Calculus

AUTHORS: Zachary Cunningham
SCHOOL: UW-Platteville

ABSTRACT: We examined the relationship of matrix representations and linear transformations on finite-dimensional vector spaces in the hope of finding useful applications. We reviewed the work of Jack W. Rogers. Rogers' paper (Rogers, 1997) gives us a template for the use of matrix representations on the linear transformations of differentiation and antidifferentiation. We applied this concept to linear applications such as integration by parts and differential equations. Findings indicate we can use identity matrices to solve complex problems such as power reductions or multiple integration by parts problems. This simplified process allows us to reduce the time and effort needed to complete these problems.

FACULTY ADVISOR: Dr. Miyeon Kwon

21 Synthesis of Block Copolymers Containing the Smart Polymer PDMAEMA and Characterization using UV-Vis and DLS

AUTHORS: Sorfina Suzali, Karl Bauman
SCHOOL: UW-Eau Claire

ABSTRACT: Polymers which exhibit reversible properties depending on their environment are called smart polymers. The smart polymer poly((2-dimethylamino) ethyl methacrylate) (PDMAEMA) responds to changes in the environment by switching between insoluble and soluble, which promotes or inhibits the formation of aggregates and micelles. This unique property depends on pH and temperature, as well as buffer concentration, polymer concentration, and polymer composition. Activator ReGenerated Electron Transfer-Atom Transfer Radical Polymerization (ARGET ATRP) was used for the synthesis of PDMAEMA - Polyethylene Glycol (PEG) - PDMAEMA triblock copolymers. Compared to the original ATRP process, the use of a reducing agent with a Cu(II) catalyst allows for a less oxygen sensitive reaction. Additionally, a reduced amount of catalyst is needed which results in lower costs and environmental benefits.
To determine successful synthesis, molar ratios are determined by Nuclear Magnetic Resonance (NMR) spectroscopy. Additionally, dispersity and relative molecular weights are determined by Gel Permeation Chromatography (GPC). Once the target ratio and a low dispersity are obtained, the triblock is characterized by UltraViolet-Visible Spectroscopy, which determines the temperature at which the polymer becomes insoluble, or the cloud point. The polymer is also characterized by Dynamic Light Scattering (DLS) which determines the presence of free polymers as well as the radius of micelles and aggregates. The data is then compared to the linear diblock PDMAEMA-PEG. Currently there is a lack of

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literature on the linear triblock PDMAEMA-PEG-PDMAEMA, despite their possible applications in areas such as drug delivery and enhanced oil recovery.
FACULTY ADVISOR: Dr. Elizabeth Glogowski

22 Wire Positioning and Degradation in Superconducting Cables Subjected to Electromagnetic Cycling

AUTHORS: Benjamin Thronson, Tony Doan, Jack Swanson
SCHOOL: UW-Eau Claire
ABSTRACT: The goal of this research is to use image analysis techniques to quantify the mechanical impact of electromagnetic cycles on cable-in-conduit conductors, containing the brittle Nb3Sn superconducting filament used in fusion reactors. In order to quantify the data, virgin (heat-treated) conductors that have not gone through any electromagnetic testing are compared to conductors that have been tested at the full electric current and field of the ITER fusion reactor's toroidal field magnet system. These conductors are further deconstructed, imaged, and analyzed to observe the extent of movements and deformation of individual Nb3Sn wires within the magnet cable. There are two main tasks that make up this process: task one is to mechanically disassemble the conductors to inspect wires containing visible evidence of exterior deformation along with superconducting filaments cracks within the wires, and task two is to look for wire movement within the conductor during testing by doing image analysis on transverse cross-sections of the conductor. In order to complete the tasks, the wires are investigated by an overall areal density of the groups of wires in a cross-section relative to the Lorentz force, an investigation of the fraction of wires in contact with other wires, and the extent of plastic deformation of the wires. Additionally, the individual wires are observed by regions based on expected cracked filament locations. When comparing the circularity of the untested vs tested wires, the circularity decreased after testing. When comparing the aspect ratio across the cross-section of the tested cable, the aspect ratio increased on the opposite side of the Lorentz force (the low-pressure side). This demonstrates wire movement and pinching during testing. By quantifying the impact of the electromagnetic testing, it can then be determined what are the ideal operating condition for the superconductor, to minimize the mechanical damage that leads to electrical performance degradation.
FACULTY ADVISOR: Dr. Matthew Jewell

23 Strengthening Methods of Polymer Parts Made Using Extrusion-Based 3D Printing

AUTHORS: Nickolas Barnes, Andrew Wessels
SCHOOL: UW-Platteville
ABSTRACT: Polymer parts fabricated using extrusion-based 3D printing methods are characteristically porous. The level of porosity depends of the machine used and fabrication parameters. In these processes, intra-layer and inter-layer strengths are dependent on the amount of residual heat available in extruded material for bonding to the substrate or previously deposited materials. Because the residual heat is low and is insufficient to melt previously deposited material at the contacting surfaces, low bonding strengths results. The low bonding strengths coupled with inherent porosities limits the usefulness of parts fabricated. This work explores a post-processing method involving coating and thermal application on test samples. Results of mechanical testing on samples show improved strengths. This low-cost method has the potential to expand the application of polymer parts fabricated using extrusion-based methods.
FACULTY ADVISOR: Dr. John Obielodan

ABSTRACTS (24-28)

24 Synthesis and Viscoelastic Characterization of Smart Polymer PDMAEMA

AUTHORS: Aaron Ellefson, Victoria Fosler
SCHOOL: UW-Eau Claire

ABSTRACT: Stimuli-responsive polymers, also known as smart polymers, altered their properties when exposed to environmental changes of pH and temperature. A series of stimuli-responsive block copolymers based on poly(ethylene glycol) (PEG) and poly((2-dimethylamino) ethyl methacrylate) (PDMAEMA) were synthesized in lab via activator regenerated by electron transfer atom transfer radical polymerization (ARGET ATRP). This synthesis required less copper catalyst, was tolerant to oxygen, and has been shown to be more environmentally benign compared to ATRP. Nuclear magnetic resonance spectroscopy (NMR) and gel permeation chromatography (GPC) confirmed successful synthesis of the smart polymers. Alteration of the block ratio changed the polymer structure and was expected to cause unique rheological properties by affecting how it responded to environmental stimuli. The polymer samples underwent rheological tests to characterize yield stress and gel point. The rheometer applied stress/strain to determine viscoelastic characteristics. Viscoelastic materials have both viscous (liquid-like) and elastic (solid-like) properties. Storage and loss moduli were determined as a function of polymer composition, polymer concentration, pH, and temperature for PEG-PDMAEMA diblock and triblock copolymers. Oscillation temperature ramps determined the gel point by an abrupt increase in the storage modulus of the polymer solution. Understanding characteristic differences for the smart polymer under modified environments creates an index that can be used to predict properties from structural changes. These smart polymers reacted to changes in the environment such as pH and temperature, which means some intended future applications include use as viscosifiers, controlled release drug delivery, smart coatings, and polymer membranes.

FACULTY ADVISOR: Dr. Elizabeth Glogowski

25 Anxiety and Ethical Behavior

AUTHORS: Madison Schony
SCHOOL: UW-Platteville

ABSTRACT: Previous research indicates that anxiety causes individuals to feel more likely to engage in unethical behaviors than individuals not experiencing anxiety (Kouchaki and Desai, 2015; Lu, Lee, Gino, & Galinsky, 2018). Reducing anxiety levels could reduce unethical behaviors and promote safer, healthier environments. We examined the effect of anxiety on ethical decision-making and confidence levels. mTurk workers (N = 151) between the ages of 22 and 55 years participated in this research. Individuals in the anxiety condition wrote about a situation that made them anxious. Those in the neutral condition wrote about a commonplace occurrence. Participants answered questions about their mood, likelihood and confidence of engaging in unethical behaviors, and state anxiety levels. Induced anxiety did not affect likelihood of engaging in unethical behavior. However, higher levels of self-reported cognitive anxiety levels correlated with likelihood of engaging in unethical behaviors. Higher levels of cognitive and somatic anxiety levels correlated with lower confidence. Thus, anxiety and confidence levels may correlate with individuals' abilities to make ethical decisions; further evidence may point toward a causational relationship influencing how we manage anxiety levels and confidence to promote a more ethical society.

FACULTY ADVISOR: Dr. Kameko Halfmann

26 Sustainable Conversion of Contaminated Water into Potable Water

AUTHORS: Akanksha Gurtu, Dr. Georgette Heyrman
SCHOOL: UW-Green Bay

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ABSTRACT: Magnetic nanoparticles (NPs) belong to a unique class of nanomaterials with enormous interesting applications in environmental sustainability and in health care. Iron oxide NPs are the most common and widely studied nanomaterials. They are much easy to synthesize at low cost and mainly exist as α-Fe2O3 and Fe3O4 known as hematite and magnetite, respectively. Hydrothermal synthesis is the most common route to synthesize iron oxide NPs. To achieve successful applications, NPs should exist independently in the aqueous phase to provide maximum surface area. This can be achieved by producing "surface active magnetic NPs" which is a relatively new class of nanomaterials with little information available in the literature. Surface activity helps the NPs to exploit their applications at immiscible interfaces such as that of the bacterium cell membrane in an aqueous medium. "Surface active NPs" can be chemically modified to interact with the bacterium cell membrane and hence, they can be employed to remove bacterial contaminations from freshwater simply by applying the external magnetic field. The aim of the present study is to design sustainable biotechnology by using "surface active magnetic NPs" for removing bacterial contaminations at low cost with high efficiency.
FACULTY ADVISOR: Dr. Mandeep Bakshi

27 Investigation of Microstructural Defects in REBCO Superconducting Tape

AUTHORS: William Hartnett, Jack Swanson
SCHOOL: UW-Eau Claire
ABSTRACT: Fusion reactors are a future renewable energy source that require superconductors (materials that can conduct electricity without resistance) to produce strong magnetic fields. Rare-earth barium-copper-oxide (REBCO) superconductors are high-field superconductors fabricated in a tape geometry that are being explored for fusion applications. Internal delamination is one cause of mechanical failure in REBCO tapes. Since the tape is composed of many layers of material, we seek to understand which layers are the weakest mechanically and how the layers interact together to form cracks that cause delamination. In this study we investigate cracking in industrially slit samples and delamination behavior in peel tested samples using various etchants, scanning electron microscopy, laser confocal microscopy, auger electron spectroscopy and digital image analysis. Our results indicate that the oxide buffer layers adjacent to the REBCO can be a primary location for the initiation of cracking. With a better understanding of the crack propagation exhibited by the REBCO tape, the fabrication process can be improved to provide a more mechanically stable and cost-effective superconductor.
FACULTY ADVISOR: Dr. Matthew Jewell

28 The Impact of Powder Source on the Processing Uniformity of Bi2Sr2CaCu2O8-x (Bi-2212) Superconducting Wire Using Digital Image Analysis

AUTHORS: August Mantey, Timothy J. Lui
SCHOOL: UW-Eau Claire
ABSTRACT: This study focuses on analyzing the qualitative and quantitative geometric features of Bi2Sr2CaCu2O8-x (Bi-2212) superconducting filaments in a composite Ag-sheathed wire. Starting with wires that include powder from different vendors, the wires are transversely cut, mounted, and formed into metallographic pucks to be polished. High resolution images are obtained using a scanning electron microscope (SEM) and are digitally analyzed using a program called ImageJ. For the analysis process, a thresholded image is used for quantitative parameters such as filament size, roughness, circularity, fill factor, and nearest edge distance between filaments. The results of quantitative data from ImageJ show notable differences in filament size, roughness, and circularity from each powder source. Powder from three vendors, as well as the effect of wire drawing, are examined. Visual comparisons in powder uniformity and quantitative analysis of filament uniformity helps characterize each manufacturer's powder and establish a process that will produce the most uniform and high-current wire for superconducting

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magnet applications.
FACULTY ADVISOR: Dr. Matthew Jewell

29 Studies of Common Household Small Molecules That Can Inhibit Xanthine Oxidase Activity

AUTHORS: Chee Vang
SCHOOL: UW-Eau Claire

ABSTRACT: Xanthine Oxidase (XO) is an enzyme that catalyzes the last steps of the degradation of purines. It catalyzes the hydroxylation of hypoxanthine to xanthine, then xanthine to uric acid. Increased XO activity raises the level of uric acid in the fluids of tissues. High level of uric acid in the form of sodium urate can form crystals at the joints, which is known to cause painful arthritis, gout. To date there are only three compounds (allopurinol, febuxostat and topiroxostat) that are approved to use as drugs to treat gout. Hence, there remains opportunity to develop and design more compounds that can inhibit XO. We study the XO inhibition and binding of common household small molecules, such as saccharin, steviol, caffeine and imidazole related compounds. Kinetic results from fluorescence quenching, UV/VIS spectrophotometry and Saturation Transferred Difference NMR (STD NMR) will be presented. Our results indicate that saccharin inhibits XO activity weakly compare to known inhibitors (KM0=31.2 μM vs. KMi=38.4 μM) allopurinol and quercetin. The physical, chemical and functional group properties of the variety of inhibitor compounds in combination with computer modeling (ligand docking) should help guide to the design of more potent XO inhibitors.
FACULTY ADVISOR: Dr. Thao Yang

30 Computational Modeling of Small Molecule Inhibitors Binding to Xanthine Oxidase

AUTHORS: Eric Colwitz
SCHOOL: UW-Eau Claire

ABSTRACT: We study the function and structure of xanthine oxidase; how its structure differs from the transition of the 'Oxidase' form to the 'Dehydrogenase' form. Xanthine oxidase (XO) is an enzyme found in the human serum and lungs. It catalyzes the oxidation of hypoxanthine to xanthine and xanthine to urate. The disease gout is caused by formation of high level of urate in the blood. The major structural differences between xanthine oxidase and xanthine dehydrogenase involve disulfide bonds that are formed between cys-535 and cys-992, the loss of an amino acid cluster that is found in the dehydrogenase form at the FAD cavity that is made up of Arg-335, Trp-336, Arg-427, and Phe-549, as well as a change in conformation by an active site group, Gln-423 to Lys-433, which forms a loop over the NAD binding site and blocks NAD from reaching the FAD in the oxidase form. We use the software Autodock (freely available from the internet) to study the binding of small molecules that may have inhibitory effects on the XO activity. The binding of potential inhibitors is modeled after the known crystal structures of XO-bound inhibitors, such as allopurinol, quercetin, and its substrates (xanthine and urate). We first carried out the docking of known inhibitors and substrates (allopurinol, quercetin, urate) to XO and compared these binding modes and interactions to those of the known crystal structures. We have carried out the docking of saccharin binding to XO. Results showed that saccharin can bind at the urate binding site, and the hydrogen bondings and aromatic interactions from the side chains to saccharin are similar to those that occurred for the uric acid bound at the XO active site. Several molecules containing the scaffolds of quercetin, pyrazole, imidazole and sulfonamide groups will be designed by computer and their XO binding ability will be tested. Results for these molecules will be presented.
FACULTY ADVISOR: Dr. Thao Yang

31 Nanoscale Silicon Membranes, an Invention in MEMS Pressure Sensing Technology

AUTHORS: Adam Brockman, Lee Farina, Hannah Ihlenfeldt, Jacob Sina, Dr. Gokul Gopalakrishnan
SCHOOL: UW-Platteville

ABSTRACT: Silicon nanomembranes are an innovation in semiconductor technology and deliver several advantages over the significantly thicker membranes currently used in a number of devices, from microscopic pressure sensors with promising energy savings in GPS applications. Nanomembranes promise much smaller device footprints and better performance, but have been difficult to produce economically. We have developed an inexpensive method to fabricate nanomembranes. Our process includes chemical etches, pattern transfer by photolithography, surface activation and thermal annealing produces flat, ultrathin membranes that are robust and suitable for implementing in micro-electromechanical systems (MEMS) and microfluidic devices. A critical step in the ability to make flat membranes opposes conventional protocol for dealing with a phenomenon known as stiction. While stiction is carefully avoided in traditional MEMS fabrication, our process embraces it. In this presentation, we describe the fabrication steps, as well as the testing and numerical modeling of nanomembranes when subjected to pressure differences.

FACULTY ADVISOR: Dr. Gokul Gopalakrishnan

32 Microplastics and Polycyclic Aromatic Hydrocarbons: A Dangerous Combination

AUTHORS: Daniela Leon
SCHOOL: UW-Superior

ABSTRACT: Superior, Wisconsin was affected by an accidental explosion at Husky Energy Superior Refinery on April 26, 2018. This explosion produced an uncontrollable amount of chemical reactions that left potentially toxic compounds in the air and water. Polycyclic aromatic hydrocarbons (PAHs) are a clear example of chemicals left behind after this event. PAHs are also produced when coal, oil, gas, wood, garbage, and tobacco are burned. PAHs are classified as toxic compounds and can be adsorbed on natural and synthetic debris. The presence of microplastic (MP) debris in Newton Creek, St. Louis River Estuary (SLRE) and Lake Superior has become a reality. Due to their small size, MPs have a great surface area that increases their ability to absorb and concentrate these PAHs. Taking into consideration that synthetic particles (MPs) represent a medium to transfer toxic compounds to organisms that can be transferred to organisms when they are ingested, resulting in unknown ecotoxicological effects, we hypothesize that MPs can concentrate PAH compounds in higher quantities and faster than natural debris. The objective of this research is to investigate and compare the PAH concentrations in natural debris vs synthetic debris collected from Newton Creek and SLRE after the Husky Energy Superior Refinery explosion. We presented preliminary results from an ongoing assessment of the temporal variability of PAHs adsorbed by MPs and natural debris. Samples have been collected since June 2018 and will continue to be collected during 2019 at five different sites in Newton Creek and five sites at SLRE. MPs were separated from natural debris by sieving and analyzing each portion of the sample under dissection microscope. Synthetic debris was counted, classified and identified by using FTIR-ATR spectrophotometer. MPs were detected in 60% of the samples collected from Newton Creek and in 90% from SLRE samples. Fibers were the most abundant MPs in Newton Creek (86%) and in SLRE (83%) where the main synthetic polymers were polyethylene (6%), polypropylene (4%), and the most abundant was the semisynthetic polymer, cellophane (74%). Cotton (9%) was detected as a natural fiber in some samples. Among MP fragments found the most abundant synthetic polymer was polyethylene (66%).

FACULTY ADVISOR: Dr. Lorena Rios Mendoza

ABSTRACTS (33-37)

33 Generation of Novel Dipolar Cycloadditions between Coumarin and Diazo Compounds

AUTHORS: Taylor Hackel
SCHOOL: UW-La Crosse

ABSTRACT: Bioorthogonal chemistry is a rapidly developing field in that it emphasizes the key components of click chemistry—high selectivity, product yield, and reaction kinetics—while utilizing reagents and conditions that do not hinder cellular activity. Bioorthogonal reactions find broad applications within cellular biological research as its pivotal focus is the study of intracellular pathways and biomolecules through fluorescent labeling of cellular components. Coumarins are promising compounds as they exhibit fluorescent properties, or color production, that can be modified through the addition of either electron donating or withdrawing substituents. The potential of coumarin cycloaddition reactivity, a mechanism in which two molecules are conjugated in one step without byproduct formation, with diazo compounds, a functional group comprising of two nitrogens, will be explored in the context of biological applications. Organic synthesis of a variety of diazo and coumarin starting materials will be conducted, followed by reacting possible combinations of these starting materials in several solvents to seek a successful reactant pair. Products of the reactions will be characterized using H NMR spectroscopy. The successful generation of such a reaction will provide an innocuous, unprecedented means for chemists and biologists to study cellular processes in vivo.

FACULTY ADVISOR: Dr. Nicholas McGrath

34 Viscosity of Smart Block Copolymers for Titanium Dioxide Dispersion in Architectural Coatings

AUTHORS: Hunter Koltunski, Lauren Weidenheim
SCHOOL: UW-Eau Claire

ABSTRACT: Smart polymers are polymers with tunable properties that alter their characteristics due to a change of environment, i.e. pH or temperature. The smart polymer poly(2-(dimethylamino)ethyl methacrylate) (PDMAEMA) is the polymer of interest because of its ability to change chemical properties due to pH and temperature change. The block copolymers of poly(ethylene glycol) (PEG) and PDMAEMA were synthesized using activator regenerated by electron transfer atom transfer radical polymerization (ARGET ATRP). ARGET ATRP was chosen instead of ATRP due to cost efficiency, reduction of procedure set-up time, and reduced reactivity to air. To make sure that the synthesis had the desired ratio of PEG and PDMAEMA, Nuclear Magnetic Resonance (NMR) spectroscopy was used. Gel Permeation Chromatography (GPC) was also used to identify the average molecular weight of the polymer. The best smart polymer candidates are being characterized based on their differing viscosities, a fluid's resistance to flow, to assess their possible future usage in dispersing titanium dioxide in architectural coatings. To characterize the smart properties of the polymer, a Discovery HR-2 Rheometer was used. This rheometer can measure viscosity at different temperatures and is used to determine a viscosity difference based on pH, buffer concentration, and polymer concentration. These polymers may be able to be applied to architectural coatings as a titanium dioxide dispersant.

FACULTY ADVISOR: Dr. Elizabeth Glogowski

35 Wind Energy Harvesting Through Coupled Oscillators

AUTHORS: Daniel Allaire
SCHOOL: UW-Platteville

ABSTRACT: The purpose of this project is to optimize wind energy harvesting through piezoelectric materials. A piezoelectric material accumulates electric charge when it is exposed to stress, such as

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compression or tension. To take advantage of these properties, different configurations will be tested to determine which produces the most power. These configurations include adding an extension to the material to capture more wind energy and placing a post in the path of the wind-flow to generate more turbulence in the air flow. Initial test results showed that the Piezoelectric material was able to produce an electric potential of approximately 0.3 Volts. After adding an extension to the material and placing a post in the path of the air flow, the Piezoelectric material produced an electric potential of 7.5 Volts. Based on these data measurements, it can be concluded that with the proper modifications, piezoelectric materials would make excellent tools for harvesting wind energy. Future studies will be dedicated to optimizing the shape of the post in front of the piezoelectric beam and of the extension as well as mechanically couple two or more beams.
FACULTY ADVISOR: Dr. Edoardo Rubino

36 New Family of Vertex Isoperimetric Graph

AUTHORS: Jounglag Lim
SCHOOL: UW-Superior
ABSTRACT: We present research towards finding all (simple connected non-oriented) graphs on five to 17 vertices, all whose Cartesian powers admit an isoperimetric order. We were able to find a graph which is promising to be “strongly isoperimetric”, for all its Cartesian products. It is defined by a new graphs operation, $\tilde{\times}$,namely the tilde product.
FACULTY ADVISOR: Dr. Sergei Bezroukov

37 Mechanical and Optical Characterization of Polyvinylchloride Elastomers

AUTHORS: Jacob Bakich
SCHOOL: UW-Platteville
ABSTRACT: The objective of this research is to obtain a full mechanical and optical characterization of polyvinylchloride (PVC) based elastomers. These elastomers can be used to design and develop optical sensors for the detection of various physical quantities such a temperature, pressure, wall shear stress, and electromagnetic fields, among others. The optical sensors are based on the deformation of the elastomer; therefore, an exact mechanical and optical characterization is crucial to obtain a precise estimation of the performances of the sensor. To experimentally determine the index of refraction, a relatively thick sample of the polymer was made in an oven. A laser was pointed through the sample beam at predetermined entrance angles, the laser was then traced as it moved through and exited the sample, and then angles of refraction were measured with respect to the direction normal to the entrance surface. After the above process was completed, Snell’s law was used to calculate the index of refraction when the laser entered and exited the polymer. This process was performed with three different beams. After the calculation, the indices of refraction were averaged across four trials for each beam. The average index of refraction is 1.46041. The mechanical property investigated so far is the Poisson ratio. To determine the Poisson ratio, a beam was subjected to axial elongation, the strain in the axial and transversal directions was measured, and the ratio between these two quantities was measured. Preliminary results showed that the Poisson ratio is equal to 0.43. Future development of this project consists in determining Young’s modulus through the tensile test as well as investigate the influence of the temperature on the mechanical and optical properties. Also, magnetically polarizable microparticles will be embedded in the elastomer to create a PVC based magnetorheological composite materials sensitive to magnetic fields. Moreover, other agents such as a softener or a hardener will be added to determine their influence on the mechanical properties.
FACULTY ADVISOR: Dr. Edoardo Rubino

ABSTRACTS (38-42)

38 Development of Extruded Plant-Protein Rich Cereals using Soy Protein and Rice Flour Blend

AUTHORS: Binu Acharya, Dr. Ayub Hossain, Dr. Eun Joo Lee, Dr. Pranabendu Mitra
SCHOOL: UW-Stout

ABSTRACT: Now-a-days there is a growing demand for plant-based protein rich cereals, which have many health benefits. However, because the mechanism of protein extrusion for expanded products is still unclear, carbohydrate-based cereal products are the majority in the market. Therefore, the main objective of this study was to develop soy protein and rice flour blend extruded cereal-like products by optimizing formulations based on physicochemical properties of extrudates. Five formulations, in the ratio of 30:70, 45:55, 60:40, 75:25, and 90:10 of soy flour: rice flour, were blended. The blended formulations were extruded using a single screw extruder with a 40% feed moisture content at 150º C and 300 rpm screw speed. Physicochemical properties (radial expansion, hardness, crispness, solid density, piece density, porosity, moisture content, total color difference, L-value, and water solubility index) of the extrudates were determined and compared to optimize the best quality product formulations. The ANOVA ($p<0.05$) showed that soy flour and rice flour contents in the formulations affected the quality of the extrudates significantly. Radial expansion increased significantly on increasing soy flour content from 30 to 60% and decreased significantly upon further addition. Piece density was lowest (0.59 g/cm3) for formulation (45:55) and was highest (0.716 g/cm3) for formulation (90:10). Formulation (45:55) was most porous (30% porosity) in structure and was most favorable product with improved color, hardness, crispness, and water solubility index. The extrudates were rehydrated until attaining their equilibrium moisture contents, and the data were used to model the rehydration kinetics and determine the diffusivity values (5x10-10 to 9.96x10-10 m2/s) using the Fick's law to characterize the crunchiness of extrudates. The overall findings of this study indicated that the physicochemical characteristics of extrudates containing 45-60% soy flour can be successfully used to produce ready-to-eat protein rich cereals commercially.

FACULTY ADVISOR: Dr. Pranabendu Mitra

39 Characterization of Silica Colloid Thin Films

AUTHORS: Grace Baker, Tristin King, Karen Knoke, Dr. Doug Dunham, Yana Astter (Carthage College), Matthew Koviekis (Carthage College), Spencer Bingham (Carthage College), Dr. John Kirk (Carthage College)
SCHOOL: UW-Eau Claire

ABSTRACT: Silica colloid films are technologically important as they can serve as the matrix to hold nanoparticles for fabrication of thin film sensors. Thin film sensors need to be durable to function in a variety of environments. Nanoindentation tests were performed to determine the hardness and reduced modulus of silica colloid thin films that were prepared using a variety of methods: evaporated, sintered at temperatures ranging from 800º C to 1100º C, and spin coated with varying layers. Gold nanoparticles were introduced within the silica which was then spin coated onto glass slides and characterized to compare properties. The thin films were prepared by undergraduate research students with the direction of Dr. John Kirk at Carthage College. Our findings indicate that the evaporated samples sintered at higher temperatures had a higher hardness but were too close to the melting point of gold to be used. Further, the hardness of the spin coated samples decreased with the number of layers deposited.

FACULTY ADVISOR: Dr. Doug Dunham

40 Anti-Schur Numbers

AUTHORS: Kean Fallon
SCHOOL: UW-La Crosse

ABSTRACT: Schur numbers, denoted S(x), are named after the Russian mathematician Issai Schur.

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Since their discovery in 1916, only five of them have been computed. Due to the intractability of computing more Schur numbers, we decided to create and investigate anti-Schur numbers, denoted aS(x). To understand aS(x), one must first consider the counting numbers [1, 2, ..., x]. If four of these counting numbers satisfy the equation a+b+c = d then we say they form a sum. For example, {1, 3, 5, 9} is a sum since 1 + 3 + 5 = 9. Now we assign a color to each counting number in our set. A sum is then called a rainbow sum if each number is colored distinctly. We define aS(x) to be the smallest number of colors needed to color the set [1, 2, ..., x] such that a rainbow sum is guaranteed to exist in the set. Using case analysis, logic, and number theory, we have achieved results in both of the equations a+b=c and a+b+c=d.
FACULTY ADVISOR: Dr. Nathan Warnberg

41 Role of Bacterial Volatiles in Plant Defense Signaling and Disease Resistance

AUTHORS: Shannon Lamb, Brett Pluemer, Ryan Larsen, Garrett Larsen, Michael Campbell, Raja Annamalai
SCHOOL: UW-Platteville
ABSTRACT: Chemical control of plant diseases is the most popular management strategy in many crop production regimes. In sustainable agriculture, utilizing host plant resistance is considered as an important component of plant disease management. Volatile Organic Compounds (VOCs) isolated from plant growth promoting rhizobacteria (PGPR) have been shown to confer resistance in plants to a variety of pathogens, leading to reduced disease incidence and severity. However, the molecular mechanisms of VOC-mediated plant defense responses are rudimentary. We hypothesized that the bacterial VOCs act as elicitors of defense signaling by triggering the expression of an array of defense-related genes in plants that play a role in either salicylic acid (SA)- or jasmonic acid (JA)-mediated defense signaling pathways. The role of VOCs as elicitors of defense signaling was investigated through gene expression studies (reverse transcriptase-PCR and promoter-GUS assays). To analyze VOC-mediated defense signaling, we used Arabidopsis thaliana, Medicago truncatula (dicots) and rice (a monocot) as model systems. Ten different bacterial VOCs were tested for their role as elicitors of defense signaling. The expression profile of genes that are known to be involved in the SA- or JA-mediated defense signaling pathway were monitored in each model plant system. In addition, we used A. thaliana seedlings stably transformed with the promoter of defense-related genes fused to the coding sequence of beta-glucoronidase (GUS) to monitor the expression of VOC-induced defense genes using colorimetric assays. Using plant morphometric analyses and gene expression studies, we have identified a set of promising VOCs that can be used as elicitors of plant defense. Using nanoparticles of poly-lactic-co-glycolic acid (PLGA) encapsulated with 2-octanone, we explored the scope of using biopolymers for the controlled delivery of VOCs to induce plant defense against pathogens.
FACULTY ADVISOR: Dr. Muthu Venkateshwaran

42 Electrospinning Route to Making ZnO Nanofibers: Challenges and Potential Applications

AUTHORS: Daniel Isaacs, Patrick McManus
SCHOOL: UW Oshkosh
ABSTRACT: Electrospinning is an old and relatively inexpensive method for making polymer-based fibers. However, in the last twenty years this method has shown great promise for making metal-oxide and composite metal-oxide nanofibers from polymer solutions. Some of the advantages of using the fiberous form of nanomaterials are their relatively large surface-to-volume ratio and excellent mechanical properties. Additionally, by changing experimental parameters such as (voltage, pumping speed, humidity, concentrations, etc.) nanofibers with different properties can be produced. In this study, the

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physical properties of hybrid (polymer-ZnO) and annealed ZnO nanofibers are investigated using various analytical methods. Structural properties of the nanofibers were studied using powder X-rays diffraction (XRD) whereas surface morphology was monitored using scanning electron microscopy (SEM). Various challenges and potential applications of these nanostructures are discussed.
FACULTY ADVISOR: Dr. Neenad Stojilovic

43 Focus on Flavor: Helping Small Brewers Make Big Decisions

AUTHORS: Anna Meier, Lindsay Coonen, Anthony Gajeski
SCHOOL: UW-Eau Claire

ABSTRACT: As the popularity of microbreweries grows in Wisconsin, young breweries are encountering obstacles not faced by larger, more established facilities. Chemical analysis of volatile flavor compounds greatly improves a brewer's ability to characterize and fine-tune their product, but the instrumentation required for this task tends to be highly specific, expensive, and requiring of expertise in both assembly and methodology. Using costly commercial laboratories for analysis is not an option for many small brewers. In our research, we have developed a novel approach to solid phase microextraction (SPME) as a cost-effective method to prepare beer samples for analysis using standard gas chromatography and mass spectrometry (GC/MS) techniques. To collect volatile compounds contributing to flavor, we simply float a Monotrap® monolithic disk in the sample. The disc adsorbs compounds found in the headspace as well as less volatile compounds in solution that may also contribute to flavor. This collection disk is then extracted into a standard GC/MS solvent and run through the standard instrument to be semi-quantitatively or quantitatively analyzed for target compounds of interest to the brewer. Our process removes the need for additional headspace and sample preconcentration attachments often used in beer analysis. We have succeeded in quantitative analysis in ppb range and qualitatively have identified dozens of flavor volatiles. As an added benefit, this method requires a smaller sample volume than conventional headspace methods, making multiple analyses with varying parameters possible with a single sample. Our collaboration with local microbreweries has enabled analyses from every stage of the brewing process: brew style comparison, yeast strain comparison, effect of storage conditions, and monitoring the levels of off flavors throughout the fermentation process. This optimized technique has produced promising results allowing local microbreweries with modest resources to make informed choices to improve and innovate their product based on chemical analysis of volatile flavors in addition to the finely tuned palate of the brewer.
FACULTY ADVISOR: Dr. Scott Bailey-Hartsel

44 Effect of Roasting on the Physicochemical Properties of Five Varieties of Honduras Grown Coffee Beans and Comparing with Commercial Coffee Beans

AUTHORS: Johana Avila
SCHOOL: UW-Stout

ABSTRACT: There is a growing interest to develop high quality coffee by roasting different varieties coffee beans to meet the present consumers' demands. The assessment of physicochemical properties of coffee beans before and after roasting and comparing those properties with commercially available samples are essential to develop high quality coffee. The main objectives of this study were to characterize the physicochemical properties of the five varieties of roasted coffee beans (Pacamara, Parainema, Lempira, Obata Marsellesa) with seven different growing altitudes(1100-1600 msnm) from Honduras and compare those properties with two commercially available samples to justify the commercial potential of these five variety coffee beans. The dried green coffee beans were roasted at 200 degrees Celsius for 45 minutes using a conventional oven. The physicochemical properties of coffee beans were determined before and after roasting and the roasted physicochemical properties of the coffee beans were compared with

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commercial light roasted and dark roasted coffee. The ANOVA showed that the roasting process affected the quality of coffee beans significantly ($p<0.05$). The moisture content (8-9%) and water activity (0.3-0.4) of roasted beans improved the shelf-life as self-stable coffee. The L-value (23.19-29.61), rehydration ratio (11.51-22.82%), bulk density (0.33-0.55 g/mL), piece density (0.54-0.63 g/mL) and true density (0.90-0.93 g/mL) of roasted beans were comparable with the tested two commercial samples. However, the color analysis revealed that Marsella at 1150 msnm and Parainema at 1300 msnm were matched with a commercial light roasted coffee. The darkness of the roasted coffee beans can be improved by increasing the roasting time. The physicochemical properties of roasted Honduras grown coffee beans indicated that they can be used for manufacturing of high-quality desired coffee commercially.
FACULTY ADVISOR: Dr. Pranabendu Mitra

45 A Day in the Life of an Ambush Predator: Quantifying Behavior of the Timber Rattlesnake

AUTHORS: Alexander Matuszak
SCHOOL: UW-Eau Claire
ABSTRACT: Timber Rattlesnakes (Crotalus horridus) are ambush predators that “sit-and-wait” for opportunities to strike their prey, subsequently using multiple sensory systems to forage for their fallen prey. This foraging strategy is characteristic of low-metabolite, energy-conserving reptiles. When encountered, rattlesnakes are typically observed either standing their ground in a defensive posture while rattling their tail or staying completely motionless. It is currently unclear whether they modify their behavior in the presence of humans and few studies have been successful at observing them in natural, undisturbed states. In this study, we sought to quantify natural rattlesnake behaviors by direct video observation in the absence of human presence. Three radio-transmitted individuals of C. horridus were recorded via Sony Hi8mm Video Camcorders on tripods in June 2004 for ca. four hours during mid-day. We found that rattlesnakes are more active in an undisturbed state, spending much more time sensing and engaging their environment than previously thought—probing, body shifting, and even responding to irritation from crawling insects. This is in sharp contrast when a human was present during set-up and takedown of cameras where the snakes remained motionless. Although we did find more activity than expected, these ambush foragers still spent the vast majority of their time in a foraging position. Low activity like this likely correlates with prime basking time and low prey locomotion. This study demonstrates the importance of finding ways to study natural behaviors absent of human interference.
FACULTY ADVISOR: Dr. Robert C. Jadin

46 Dopamine and Utilitarian Moral Judgment

AUTHORS: Dana Mueller
SCHOOL: UW-Platteville
ABSTRACT: Human social interaction is critically intertwined with morality. Previous research connects dopaminergic pathways to emotional and cognitive processes in decision making, such as moral judgments. Utilitarian moral judgments occur when a specific action is based on the outcome rather than its consistency with moral norms. We expect to find that 1) individuals with higher levels of dopamine will tend to make more utilitarian (i.e., cognitively-driven) decisions and less emotionally based decisions, 2) individuals who express greater religiosity will make more emotionally based decisions and 3) individuals with low levels of dopamine and a high religiosity score will make the most emotionally based judgments. We measured dopamine using spontaneous eye blink rate, an indirect measure associated with dopaminergic transmission. Participants completed a utilitarian moral judgment task where they made decisions regarding nonmoral, impersonal, personal-low conflict, and personal-high conflict moral dilemmas. Then, participants completed a questionnaire related to religiosity. Preliminary results

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indicate that participants were most utilitarian for nonmoral scenarios followed by impersonal moral scenarios. Participants were least utilitarian for personal, low conflict scenarios. Understanding whether dopamine levels predict morality will be beneficial when applied to use for psychiatric disorders and other environmental variables. If dopamine is in fact related to shaping our moral decisions, then the increases or decreases of dopamine could affect our social lives or help individuals with a disorder better adapt to social scenarios.
FACULTY ADVISOR: Dr. Kameko Halfmann

47 Mechanical Characterization of REBCO Superconductor Using Nanoindentation

AUTHORS: Lucas Barry
SCHOOL: UW-Eau Claire

ABSTRACT: Rare-earth cuprate-based (REBCO) superconductors are a family of high-field, high-temperature superconductors fabricated in a tape geometry. While there are several layers of this REBCO tape, the focus of this study was on the mechanical behavior of the superconducting layer (the REBCO layer), and the oxide buffer layers that allow the REBCO to grow in an epitaxial fashion. The method used to explore the mechanical properties of these samples was nanoindentation, which allows for low loads to be applied to a material through a small hard tip. The goal is to understand if nanoindentation can be used to detect changes to the processing conditions of the tape. This method involves sensing both the displacement and the area of an indent, which can then be used, in association with the load delivered, to quantify mechanical attributes of a material. Specifically, in this study, experimental hardness and elastic modulus values for each indent in the REBCO layer were obtained and aggregated. The preliminary data indicates that the samples can be differentiated by both the hardness and modulus values. The REBCO layer is quite rough, which leads to a lot of variability in the data. Further investigation is being carried out via another method called modulus mapping. This method involves tapping the nanoindenter tip across a region of a sample, providing a map of the surface topology and the mechanical properties. From these maps, further indents can be made in flat, uniform areas to gather more specific data. With a sense of how the processing conditions impact the mechanical properties, it may allow nanoindentation to be used as an in-line quality control tool during the thin-film tape manufacturing process.
FACULTY ADVISOR: Dr. Matthew Jewell

48 Quantitative Nanoscale Measurements of DNA: Changing the Face of Forensic Investigations?

AUTHORS: Michael Schneider
SCHOOL: UW-Platteville

ABSTRACT: First Contact™ is an adhesive polymer developed by Photonic Cleaning Technologies LLC to clean the surfaces of astronomical instruments and other sensitive equipment. Through a grant from NASA, First Contact™ is being tested to determine whether it can remove particles at a scale smaller than dust, such as DNA or microbes. To measure the amount of DNA removed from surfaces, a quantitative Polymerase Chain Reaction (qPCR) assay has been developed. This method differs from end point PCR by measuring the actual amount of DNA in a sample using fluorescent tags. This method has shown that First Contact™ has promising possibilities of removing most or all of the measurable DNA present on multiple surfaces. The sensitivity of the assay suggests First Contact™ may be a valuable tool to collect DNA from crime scenes in order to collect forensic evidence. This research aims to measure precisely how much DNA can be recovered and amplified from a variety of surfaces relevant to space travel as well as crime scene investigation.
FACULTY ADVISOR: Dr. Mark Levenstein

49 Effects of pH on the Biological Synthesis of Gold Nanoparticles

AUTHORS: Andrea Hunger
SCHOOL: UW-Eau Claire

ABSTRACT: Methanobactin (mb) is a small peptide produced by some species of bacteria that live exclusively on methane as their source of carbon and energy. There are two main types of methanobactin that have been isolated and characterized by other research groups: SB2 and OB3b, each isolated from different methanotrophic bacteria. Our study used only OB3b-mb. This peptide is capable of reducing copper (II) found outside the cell to copper (I). The copper (I) is then transported inside the cell by methanobactin where it is available for enzymes, including those that oxidize methane to methanol. Methanobactin has also been shown experimentally to reduce several other metal ions, including gold. Specifically, methanobactin reduces Au (III) to Au0 (atomic gold), in the presence of acid. The atomic gold atoms then naturally aggregate to form nanoparticles which can be characterized using transmission electron microscopy and UV-visible spectroscopy. Additionally, we have found that we can create a basic solution that is shelf stable for up to seven months. This solution contains Au (III), methanobactin and a strong base, and almost no atomic gold is generated. Then, once sufficient acid is added to lower the pH below 5.5, gold nanoparticles begin to form at a similar rate no matter how long the reaction was dormant, up to 7 months. It was also determined that acidifying the reaction to pH 2 results in the formation of gold platelets, while acidification to pH 5.5 produces more isolated nanoparticles. No reaction was found to occur above pH 5.5. The focuses of this study were to determine the effect of pH on the rate of the reaction between methanobactin and Au (III), as well as the effect of pH on shape and size distribution of particles, and to generate clues as to the mechanism by which this reaction occurs. This work has implications for treating Wilson's disease in humans (caused by the accumulation of excess copper) and illuminates novel biochemical oxidation-reduction reactions that likely have analogs in other organisms and for other metals.

FACULTY ADVISOR: Dr. Marcus McEllistrem

50 Investigation of Lanthanides as Catalysts in Oxygen Reduction Reactions and in CO2 Reduction Using Cyclic Voltammetry

AUTHORS: Katrina Idarraga
SCHOOL: UW-Eau Claire

ABSTRACT: Electrochemistry can be used to analyze different aspects of redox reactions involving lanthanides compounds which can inform us on their ability to be effective catalysts. Lanthanides are found in nuclear waste, and they take a relatively short time to decay to nonradioactive species. Using lanthanides as catalysts in reduction reactions can be a way to repurpose nuclear waste and is a more affordable way to create energy. Although there are some uses for specific lanthanides found in nuclear waste, current separation methods of different lanthanides are expensive and difficult. Therefore a nonselective use, such as catalyzing reactions, is important to be investigated and developed as it would allow for the lanthanides in nuclear waste to become a source of clean energy. Cyclic voltammetry will be used to analyze the reaction mechanisms, kinetics, and application as catalysts of lanthanide compounds. These elements will be examined in bench top electrochemical cells using a three electrode system where the working electrode is a platinum electrode modified with a nafion film. The voltammograms produced by the potentiostat will be used to study the movement of electrons and advance understanding of the properties of lanthanide compounds. This investigation of lanthanide compounds will aid in developing effective lanthanide based catalysts for oxygen reduction reactions and CO2 reduction.

FACULTY ADVISOR: Dr. Krysti Knoche Gupta

ABSTRACTS (51-56)

51 Protecting the Planets from Microbial Contamination

AUTHORS: Kaitlyn Timmins
SCHOOL: UW-Platteville

ABSTRACT: NASA has sent six rovers to Mars, four successfully, and has proposed a future mission to return samples of Martian rocks, soils, and atmosphere to Earth. NASA's Office of Planetary Protection is tasked to consider the implications of alien microbial life on other planets. Bacteria can survive in the vacuum of space, making it crucial to limit the introduction of alien species into Earth's biosphere. First Contact™ polymer is designed to atomically clean optical surfaces through adhesion. It has been used to fully remove particulate from telescope lenses, LIGO's interferometer, and even the Hope Diamond. Here, we demonstrate that First Contact™ can remove Bacillus atrophaeus spores from glass, aluminum, titanium, and stainless steel, validating its role as an important tool to protect the planet from alien colonization.

FACULTY ADVISOR: Dr. Mark Levenstein

52 Assessing Window Strike Susceptibility to Reduce Avian Mortality

AUTHORS: Bayli Vacho
SCHOOL: UW-Eau Claire

ABSTRACT: According to The American Bird Conservancy, collisions with glass kill more than a billion birds in North America every year, making it the largest avian threat other than house cats. Migrant species are believed to be particularly vulnerable to window strikes, especially those in their first year. Therefore, we hypothesized that migrant birds collide with windows on the UW-Eau Claire lower campus with a greater frequency than non-migratory species. Additionally, we hypothesized that the cardinal direction of windows (e.g. North-facing) would influence window strikes of migratory birds but not for non-migratory taxa. Daily observations of struck, dead birds on a fixed route of UWEC lower campus was conducted in the mornings during fall and spring migratory seasons (Sep. 9-Oct. 12, 2018 & May 1-16, 2019). Birds found were identified to species and collision data (e.g. location, window direction) were collected for analyses. Eighty-three percent of struck birds recorded were migratory species, supporting our first hypothesis. West-facing windows had the fewest strikes, while birds collided with south-facing windows the most, supporting our second hypothesis. Two buildings in particular, which have many large windows, were struck the most. In addition, the hall with the highest number of bird strikes is the most recently constructed building on lower campus, which was constructed under the current esthetic trend of including large windows. As new buildings are proposed and built, considerations and measures—like proximity to the river, size and direction of windows, and decals or nets on collision hotspots—should be taken to reduce the number of bird collisions on campus, especially for migratory species.

FACULTY ADVISOR: Dr. Robert C. Jadin

53 Microbial Reduction and Isolation with First Contact™ Adhesive Polymer from Several Surfaces Imaged with Scanning Electron Microscopy

AUTHORS: Benjamin Zellmer, Michael J Schneider, Kaitlyn L. Timmins, Dr. Lee A Farina, Dr. James P. Hamilton, Dr. Mark E. Levenstein
SCHOOL: UW-Platteville

ABSTRACT: Spacecraft traveling to and from Earth carry microbes able to survive the journey that can threaten native and foreign biomes. The ability to sterilize space-bound materials is a guiding principle of NASA's Office of Planetary Protection. First Contact™ polymer safely cleans via adhesion and can remove microbes before flight or collect them upon return. We have examined the abilities of First Contact™ to remove and isolate Bacillus atrophaeus spores from space-relevant surfaces. Scanning Electron Microscopy (SEM) provides visual confirmation of the removal of microbes on several surfaces

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including titanium, aluminum, and silicon. First Contact™'s adhesion properties are robust and demonstrate its dual functionality to remove microbes and recover them for further analysis.
FACULTY ADVISOR: Dr. Mark Levenstein

54 Discovery of Emmacin-Related Antibacterial Compounds

AUTHORS: Jonathan Farren
SCHOOL: UW-River Falls

ABSTRACT: In past decades, bacteria have proven their ability to develop resistance toward all approved antibiotics. Infectious disease currently counts as the second leading cause of death worldwide, which demonstrates a constant need for novel antibiotics. However, industrial effort and success toward antibiotic discovery has declined throughout the last few decades. While most antibiotic classes contain many approved members that all work through the same mechanism of action, Trimethoprim (TMP) is the only FDA-approved Dihydrofolate Reductase (DHFR) inhibitor. One particularly virulent bacterial strain is Methicillin-Resistant Staphylococcus aureus (MRSA), which is often resistant to TMP. Emmacin, a molecule that has been proven to inhibit DHFR, is a promising antibiotic lead that shows no resistance to MRSA. We are exploring this molecular scaffold as an antibiotic agent by synthesizing Emmacin derivatives.
FACULTY ADVISOR: Dr. Matthew O'Reilly

55 Applying Predictive Models to Course Curriculums for Early Struggling Students

AUTHORS: Nathanael Braukhoff, Austin Fitzgerald, Evan Majerus, Zhiwei Yang
SCHOOL: UW-Platteville

ABSTRACT: The purpose of this research is to provide data and tools necessary for students and faculty advisors to predict and prevent academic struggle. The dataset we used consists of historical grade data mined from UW-Platteville graduates and withdrawals between the years 2013 and 2018. Our research questions are the following: 1) What is the likelihood for each grade per course that students have taken, 2) How well can we predict a student's next term GPA using their previous term GPA, 3) Given varying amounts of prior course performance data, what is the probability that a student will graduate, 4) What is the percentage of students who have struggled while attending UW-Platteville, 5) What are the correlations between grades of all course combinations, 6) Given student performance data on prerequisite courses how accurate and how far into the future can we predict post-requisite course performance. We have found that 76% of students in both the Computer Science and Software Engineering programs have struggled at some point during their time at the University of Wisconsin - Platteville. We compared the performance of multiple predictive models. We used Zero-R as our baseline model and compared that to regression models and Gradient Boosted Trees. We found that Gradient Boosted Trees and the regression models outperformed the Zero-R model, but performed comparatively to each other. We observed the strength of monotonic relationships between grades in courses of different departments; computer science and math courses show high correlations as expected. We are currently implementing our predictive models into an application for faculty advisors to use.
FACULTY ADVISORS: Dr. Douglas Selent, Dr. Seth Adjei

56 Fluid Flow Modeling of Non-Prismatic Micro and Nanopores

AUTHORS: Nathaniel Michek
SCHOOL: UW-Platteville

ABSTRACT: Traditional filtration setups with the use of prismatic pores to separate particles and macromolecules on the micro and nano scale take significant filtration time due to pore geometry. The

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creation of non-prismatic nanopores on silicon nanomembranes have potential to lower resistance while allowing for customization of shape based pore selectivity. These qualities can contribute to increased accuracy with decreased filtration time, both important factors in detection of bacteria and viruses. The modeling of filtration flow rates for non-prismatic and prismatic pore geometries were modeled using computational fluid dynamics with STAR CCM+ and analytical models such as the Hagen-Poiseuille model. Comparisons between the numerical and analytical methods were performed over a range of pore sizes and shapes. This presentation focuses on the setups of multiple numerical and analytical models of micro and nanopores.
FACULTY ADVISOR: Dr. Gokul Gopalakrishnan

57 A Comparison of Modeling Methods for Silicon Nanomembrane Pressure Sensors

AUTHORS: Jonas Wagner
SCHOOL: UW-Platteville
ABSTRACT: A thin silicon membrane forms the fundamental sensing element of many Micro Electromechanical Systems (MEMS) devices. These MEMS sensors are used in applications such as touch screens, microphones, navigation systems, bioMEMS devices, and pressure measurement devices. The performance of these devices is highly dependent on the deformation and strain caused by external stimuli. Due to the high aspect ratio geometry and anisotropic physical properties of single crystal silicon membranes that make up the latest generation of these sensors, it is difficult to accurately predict their response to stimuli using analytical methods. The alternative is to use sophisticated computational methods such as Finite Element Analysis (FEA). We use the ANSYS Workbench FEA platform to investigate the deformations of different types of crystalline silicon membranes to characterize the sensitivity of such membranes to pressure stimuli. This analysis improves our understanding of how these membranes respond to external stimuli and enables improvements in the design of the next generation MEMS sensors. We will discuss the methods used to compute these results and compare the FEA results with experimental measurements and analytical calculations.
FACULTY ADVISOR: Dr. Gokul Gopalakrishnan

58 Image Analysis to Determine Fiber Orientation in Anisotropic Composite Materials

AUTHORS: Steve Ball
SCHOOL: UW-Platteville
ABSTRACT: Several properties of microfiber and nanotube based materials, such as mechanical strength, thermal conductivity and electrical resistance, can be engineered by varying the extent to which the fibers and tubes are aligned with a desired direction. This process requires the ability to quantify the angle at which the fibers are oriented as well as how the fiber orientations are distributed. In this presentation, I describe the process and tools developed for this quantification, which relies primarily on a 2D-fast Fourier transform of images generated by scanning electron and atomic force microscopes. I will compare two methods that I have developed: a manual process that uses different software for image analysis and postprocessing, and a second method that combines these into a single Python program. Results of the image analysis on a set of test images as well as real samples will be presented.
FACULTY ADVISORS: Dr. Gokul Gopalakrishnan, Dr. Harold T. Evensen

59 Development of Wastewater-Based Growth Media for Inexpensive Commercial Cultivation of Fast-Growing Microalgae

AUTHORS: Colin Long
SCHOOL: UW Oshkosh

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ABSTRACT: Cyanobacteria (blue-green microalgae) efficiently use solar energy to convert carbon dioxide (CO2) into carbon polymers including high-value bioproducts. Our group has introduced optimized, chemically synthesized genes into Synechococcus sp. PCC 7002 as well as sp. UTEX 2973 cyanobacteria to produce isoprene and other terpenes via the methylerythritol phosphate (MEP) pathway. Isoprene is the building block for thousands of terpene products such as pharmaceuticals, synthetic rubber and high-density biofuels. UTEX 2973 has a maximal growth rate (~2 hour doubling time) about twice that of PCC 7002, which translates to ~8 times the biomass, or bioproduct, production in a 12 hour period. Wastewater treatment plants are capable of providing high nutrient content wastewaters for formulation of inexpensive algal growth media. Sampling and mixing of wastewaters from various stages of the treatment process allows for creation of affordable growth media that need only minor nutrient additions to achieve robust algal growth. Such wastewater media, coupled with nearby industrial, CO2 flue gas emissions sets the stage for viable, algal CO2 capture, wastewater remediation, and bioproduction. Toward that goal we have analyzed waters from the Waupaca WI Wastewater Treatment Plant (WWTP) and are working with the WWTP and Waupaca Iron Foundry to test algal growth on their waste streams. Preliminary data show growth of both Synechococcus PCC 7002 and UTEX 2973 cyanobacteria on initial formulations of wastewater media. Data on algal growth rates and yields, and nutrient analyses will be presented.
FACULTY ADVISOR: Dr. Toivo Kallas

60 Nanoscale Vacuum-channel Field Emission Transistor

AUTHORS: Kayla Golden, Charles Nelson, Grant Brewer
SCHOOL: UW-Platteville
ABSTRACT: Before solid state electronics took off in the 1960s, vacuum tubes were the dominant component in electronics. Though the applications of modern transistors now dominate those of vacuum tubes, there are a few advantages to vacuum tubes that derive from their electrons traveling between the anode and cathode through a vacuum rather than a material: fast switching speeds, extreme operating temperatures, and radiation hardness. We are pursuing the use of aligned carbon nanotube (CNT) films to fabricate a modern-day version of the vacuum tube transistor: the nanoscale vacuum-channel field emission transistor (VFET). This presentation will discuss our use of thin films of purified semiconducting CNTs with electron beam lithography and other methods for fabrication, and the progress we've made thus far – including improvements to our design and fabrication process that successfully produced functioning CNT transistors. In addition, we will present the means by which we will distinguish between conduction, field emission, and leakage currents. Future work will study the performance of the etched nanoscale vacuum channel, and improvements from use of aligned CNT films and conducting CNTs.
FACULTY ADVISOR: Dr. Harold Evensen

61 Markerless Inactivation of Cyanophycin Synthesis in Synechococcus sp. PCC 7002 Cyanobacteria for Enhanced Isoprene Production

AUTHORS: Brandon Thomas, Matthew Nelson, Dr. Toivo Kallas
SCHOOL: UW Oshkosh
ABSTRACT: Growing concerns about climate change and the inevitable exhaustion of the earth's fossil fuel reserves have prompted much interest in carbon-neutral, sustainable fuel sources. Because of their photoautotrophic lifestyle and ease of genetic modifications, cyanobacteria such as Synechocystis and Synechococcus hold great promise as bioproduction platforms. Isoprene (C5H8), a feedstock chemical for terpenes, including rubber and some fuels, can be produced in cyanobacteria by the addition of an isoprene synthase (ispS) gene to the methylerythritol 4 phosphate (MEP) pathway. One strategy to increase isoprene production is to increase carbon flow into the MEP pathway by inactivating
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competing carbon pathways. The goal of this project was to inactivate the Synechococcus sp. PCC 7002 cyanophycin synthesis pathway. Cyanophycin synthase, encoded by the cphA gene, catalyzes the polymerization of aspartic acid and arginine to make cyanophycin, which functions as a storage molecule for carbon and nitrogen. To inactivate the cphA gene, polymerase chain reaction and Gibson Assembly were used to construct a plasmid containing a negative selection cassette (an antibiotic resistance marker and an inducible killing gene) flanked by cphA upstream and downstream regions to facilitate replacement of the native cphA gene by homologous recombination. Transformants that contain the ΔcphA construct will be transformed with a ΔcphA construct lacking the cassette. Then, induction of the killing gene will be used to select for removal of the cassette, resulting in a markerless genetic modification (leaving behind no antibiotic-resistance gene). A "CRISPR" strategy is being pursued in parallel for efficient and unlimited markerless genetic modifications.
FACULTY ADVISOR: Dr. Toivo Kallas

62 On Creating a Nanometer Scale Vacuum Channel for CNT Transistors

AUTHORS: Connor Trocke
SCHOOL: UW-Platteville
ABSTRACT: The goal of this research proposal, was to create a vacuum channel through a carbon nanotube mesh. The width of this channel is to be about 50 nanometers so as to be small enough for a current to pass across. Current methods have included adding polymer on top of the mesh, creating the channel in the polymer, and irradiating the exposed nanotubes to break them down. This new method is a mixture of Electron Beam Lithography and standard CNT spin depositing, in which PMMA is spun onto the surface, and then exposed using the Electron Scanning Microscope (E-Beam Lithography) leaving a ridge of PMMA 50 nanometers wide, on top of which CNTS are spun. The ridge undergoes the standard liftoff process ideally lifting off the CNTS with it, leaving a 50 nm channel through the sample. A second layer of lithography is done so as to form gold terminals that are sputtered on either side of the ridge, forming the vacuum field effect transistors.
FACULTY ADVISOR: Dr. Harold Evensen

63 Shape Based Manipulation and Separation of Micro and Nanoscale Objects

AUTHORS: Angelica Drees, Jonas Wagner, Ben Thronson (UW-Eau Claire), Nathan Shannon, David Rohr, Brandon Wisinski, Adam Heuermann, Dr. Gokul Gopalakrishnan
SCHOOL: UW-Platteville
ABSTRACT: While the separation of microscopic objects by size has been studied for decades, the more difficult problem of separating similarly sized objects with different shapes has gained interest over the last several years. Shape selective techniques are particularly important in the manipulation and detection of high-aspect ratio particles, from nanowires and nanotubes, to microbes such as E. Coli. We describe how such objects can be separated and spatially manipulated using nanopatterned sieves fabricated from single crystal silicon nanomembranes. We describe techniques developed for the creation of complex pores shapes, which must overcome challenges arising from the crystal structure of silicon. We also discuss the geometric constraints and limitations of this process and thereby evaluate the phase space of particle geometries that can be addressed by this technique.
FACULTY ADVISOR: Dr. Gokul Gopalakrishnan

ABSTRACTS (1-4)

1 The Slik App

AUTHORS: Justin Prochaska (UW-Platteville/Slik Technologies, Inc.), Kyle Heywood, Quinn Jaworski, Jayden Prochaska, Steve Woerpel (Slik Technologies, Inc.)
SCHOOL: UW-Platteville
ABSTRACT: The Slik App, developed by Slik Technologies Inc., will introduce app-managed oil changes that can be performed almost anywhere the customer is parked. We're calling it the "uber of oil changes" for your vehicle. We aim to offer the most convenient solution to routine maintenance by using sophisticated software, so that customers need not make extra time in their busy day. Other than solve problems of convenience, we aim to tackle problems in the auto-maintenance industry as a whole by providing much needed updates to the way we schedule maintenance, buy parts, delivery infrastructure, roadside services, and much more. Oil changes will be the first service we focus on, but Slik Technologies Inc. will grow to cover almost every aspect of the automotive industry so that we can offer convenience, standardization, transparency, understandability, and accessibility; entirely changing the way we handle our vehicles.
FACULTY ADVISOR: Dr. Leslie Hollingsworth

2 PIVOTAL

AUTHORS: Carol Brehmer, Ebanie Schmidt
SCHOOL: UW-Green Bay
ABSTRACT: We designed a belt that is hypoallergenic, easy-to-use, and comfortable. It is adjustable on both sides and uses a magnetic buckle. Our main audience consists of outdoor hobbyists and enthusiasts along with blue collar workers. We are competing against the entire belt industry, but our main competitors are Arcade belts, Nike, Adidas, and other athletic companies. Ultimately, we would like to have our belt available to all ages and market sectors.
FACULTY ADVISOR: Ryan Kauth

3 Cooler Can

AUTHORS: Brandon Behringer
SCHOOL: UW-Parkside
ABSTRACT: The Cooler Can is a thermoelectric device that eliminates the need for ice in coolers. It can quickly chill 2 cans in 30 minutes at the prototype stage. It cools twice as a traditional minifridge and can achieve freezing temperatures. Currently, there is no other Peltier driven device on the market that is a mini freezer. This device can turn most coolers into mini freezers. Simply plug it in, hang on the lip of the cooler, insert cans, and close the lid.
FACULTY ADVISOR: Dr. William Parker

4 Source Code Vulnerability Detection

AUTHORS: Matthew Block
SCHOOL: UW-Stout
ABSTRACT: A cloud-based software tool to detect and report security and source code vulnerabilities within large scale systems written in C/C++ will be presented. The tool can efficiently detect the use of vulnerable functions within minimal false positive rates by distinguishing between unsafe functions being used with safety checks. The tool also detects security vulnerabilities relevant to source code parallelizability such as race conditions. The study is conducted on multiple large-scale systems comprising millions of lines of code. The results and reports are compared to results gained from prior studies done on the same systems. The results from the tool will be presented alongside a live demonstration on a small open-source system. This a joint project between students and faculty of UW-Stout and UW-Parkside. The finished tool

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will be available to the public through a web portal. Our source code vulnerability detection tool is currently under development. We are working to include the detection of many more source code vulnerabilities. The tool will eventually be shared with the research community within our state and worldwide. Results will be leveraged to support those who educate in the fields of software engineering and computer science to better prepare their students to implement a coding practice that is secure and robust.
FACULTY ADVISOR: Dr. Saleh Alnaeli

5

Skillzboard

AUTHORS: Seneida Biendarra, Brian Tuttle
SCHOOL: UW-Platteville

ABSTRACT: A niche lifestyle for a small group of practitioners until recently, rock climbing is now emerging as a mainstream recreational activity, thanks in part to the growth of indoor climbing gyms and the appearance of permanent fixed hardware at outdoor crags. This growth, currently at about 10% a year, is expected to continue to increase. There are several indicators of this mainstreaming of the sport: 2018 saw two climbing films hit theaters worldwide, one of them winning the Academy Award for Best Documentary, and in 2020 climbing will be premiered as an Olympic sport. This growth is rapidly creating a large number of climbers who learn to climb at an indoor gym and often lack the necessary skills to safely transition to the outdoors, resulting in recognition within the industry that “gym-to-crag” education will be critical to the sustainable growth of the sport in the coming years. The Skillzboard is a portable educational tool for rock climbers, climbing instructors and other professionals working at elevated settings (fire fighters, search and rescue personnel, lighting installation and maintenance staff, and arborists). The board simulates real-life climbing (ascending and descending) and tethering systems through a modular design that can be used to instruct or practice these skills in a safe environment. The board can be quickly set up in different orientations and in nearly any indoor or outdoor location, due to its versatile mounting mechanisms.
FACULTY ADVISOR: Dr. Gokul Gopalakrishnan