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Research Internships in Science and Engineering

Research Interns in Science and Engineering (RISE)
Summer 2003 - Student Projects

Student Major/School	Mentor	Faculty Sponsor	Department	Student Project
Andrea Burbank Physics Stanford	Jennifer Ross	Deborah Kuchnir Fygensen	Physics	Diffusion in microtubules
Juan Chavez Mechanical Engineering UC Irvine	Garrett Cole	Noel MacDonald	Materials and Mechanical Engineering	Micro-mechanical voltage controlled tunable filters formed in GAAS
Paul-Henri Coulard Materials Engineering UCSB	Frederic Diana	Pierre Petroff	Materials	Large-area nano-patterned templates fabrication and transfer using nano-imprint lithography
Eric Fraser Physics & Economics Pomona College	Edward Letts	Shuji Nakamura	Materials	Characterization of Nitride-based crystal for optical devices
Ryan Haggerty Chemical Engineering UCSB	Eric Toberer	Ram Seshadri	Materials	The effect of nonstoichiometry on the crystal structure of $La_{0.5}Sr_{0.5}CoO_{3-x}$
Micah Hall Electrical Engineering University of Memphis	Camelia Owens	Francis Doyle	Chemical Engineering	Run-to-run control of blood glucose cancentrations for Type 1 diabetic patients
Kevin Herlihy Chemistry and Environmental Studies UCSB	Vojislav Srdanov	----	Chemistry and Biochemsitry	Organic light emitting diode (OLED) synthesis

Jonathan Hollander Materials and Engineering University of Illinois at Urbana Champaign	Benjamin Haskell	Shuji Nakamura Jim Speck	Materials	Growth of (1100) m-plane Gallium Nitride on Aluminum Oxide via hydride vapor-phase epitaxy
Amardeep Kaur Chemical Engineering UCSB	Christian Steinbeck	Bradley Chmelka	Chemical Engineering	Investigating a new chromonic liquid crystal
James Lau Materials Science Cal Poly, San Luis Obispo	Mark Elsesser	David Pine	Chemical Engineering and Materials	Small clusters of encapsulated polymer microspheres
Chris Lightcap	Kimball Hall	Eric Matthys	Mechanical and Enivronmental Engineering	Drag reduction of turbulent flows by microalgae
Blythe Miron Chemical Engineering UCSB	Dimitris Stroumpoulis	Matt Tirrell	Chemical Engineering	Grid patterns and vesicle fusion of amphiphilic bilayers
Brietta Oakley Materials Science and Engineering University of Kentucky	Dmitri Klenov	Susanne Stemmer	Materials	Ultraviolet ozone oxidation of ultrathin titania dielectric films
Miyoko Ohashi Chemical Engineering UCSB	Ryan Hayward	Bradley Chmelka	Chemical Engineering	Nanostructural control of surfactant-silica thin films
Ryan Palmer Physics and Mathematics California Lutheran University	Howard Rathburn	Frank Zok	Materials	Optimization of sandwich panels for blast mitigation
Sheena Ramdeen Biology and Chemistry Brandeis University	Jason Sagert	Herbert Waite	Molecular, Cellular and Developmental Biology	The effects of oxidative stress on the mechanical PROPERTIES OF MUSSEL BYSSAL THREAD
John Ring Mechanical Engineering Dartmouth College	Ira Leifer	----	Chemical Engineering	Oil slick fate and transport modelling
Lynsey Turgeon	Norma	Jacob	Chemical	Optical and mechanical

Chemical Engineering UCSB	Alcantar	Isaelachvili	Engineering	properties of CDSE
John Welsh Chemical Engineering Dartmouth College	Michael Suchchikh	Eric McFarland	Chemical Engineering	An atomic hydrogen source for use in an ultrahigh vacuum
Arthur Wojcicki Chemical Engineering University of South Carolina	Pankaj Karande	Samir Mitragotri	Chemical Engineering	Binary formulations in the enhancement of transdermal drug delivery

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Andrea's Project Page - RISE summer 2003

Intern: Andrea Burbank, Stanford University
Mentor: Jennifer Ross
Faculty Supervisor: Deborah Kuchnir Fygensen
Department: Physics

DIFFUSION IN MICROTUBULES

Microtubules are integral components of the cytoskeleton and form much of the cell's framework. Hollow tubes of tubulin, they exist in the cytoplasm of eukaryotic cells, providing them with structure and strength. With a diameter of about 25 nanometers, microtubules are large enough to facilitate transport of small molecules that diffuse in their interiors. Determining the mechanism for and rate of this diffusion can have implications for drug delivery as well as providing greater insight into the cell interior; the anti-cancer drug taxol, for example, has been shown to diffuse in the microtubule interior, binding reversibly to the dimers along its sides. Using fluorescently marked compounds and a technique known as Fluorescence Recovery After Photobleaching (FRAP), our work has focused on investigating diffusion inside microtubules for molecules with various molecular weights in an array of different circumstances. The relative rates of diffusion of molecules in free solution and in loosely and tightly packed microtubule bundles can provide insight into their modes of diffusion, whether in the microtubule interior, in the interstices between bundled microtubules, or in free solution between bundles. Analyzing these regions for diffusion will further understanding of mobility within the cell and inform future efforts for drug delivery.

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Juan's Project Page - RISE summer 2003

Intern: Juan Chavez, UC Irvine
Mentor: Garrett Cole
Faculty Supervisor: Noel MacDonald
Department: Materials and Mechanical Engineering

MICRO-MECHANICAL VOLTAGE CONTROLLED TUNABLE FILTERS FORMED IN GAAS

Tunable optical filters are vital components for various applications, such as optical sensing and dense wavelength division multiplexed optical networks. GaAs MOEMS are desired because of their enhanced electrical properties, wide tuning range, robust design, and high yield. The device structure consists of a fixed GaAs/Al0.98Ga0.02As distributed Bragg Reflector (DBR) stack and a suspended GaAs/Al0.98Ga0.02As DBR stack that are separated by an air gap. This single Fabry-Perot cavity has its entering wavelength changed as the suspended DBR actuates with an applied voltage. More efficient tuning is reached with an increasing number of DBR layers within each stack. Careful characterization must be practiced to define an accurate relationship between the voltage applied and the displacement of the actuating DBR stack. Numerous computer models are required to troubleshoot possible modal problems, buckling, and ohmic conductivity.

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Paul-Henri's Project Page - RISE summer 2003

Intern: Paul-Henri Coulard, UCSB
Mentor: Frederic Diana
Faculty Supervisor: Pierre Petroff
Department: Materials

LARGE-AREA NANO-PATTERNED TEMPLATES FABRICATION AND TRANSFER USING NANO-IMPRINT LITHOGRAPHY

The main objective of this project is the processing of “nano-patterned” substrates, via a modern and developing technology: Nano-Imprint Lithography (NIL). In NIL, a thin layer of a thermoplastic polymer (on top of a Si or GaAs substrate) is imprinted by a master stamp to give a negative surface topography. This process can be repeated several times to give a very large patterned surface area. By using chemical etching or Reactive Ion Etching, the pattern is transferred into the underlying Si or GaAs substrate. Finally, the remaining polymer is removed. But before using NIL, master templates or master stamps have to be realized. To do so, a new technique was developed in collaboration between Prof. P. Petroff group at UCSB and Prof. J. Heath group at UCLA. In this technique, superlattices of GaAs and AlGaAs are grown by Molecular Beam Epitaxy before being cleaved and selectively etched. It allows the fabrication of arrays of nanolines (nanolines typically 1 cm in length and 10 – 50 nm in width).

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Eric's Project Page - RISE summer 2003

Intern: Eric Fraser, Pomona College
Mentor: Ed Letts
Faculty Supervisor: Shuji Nakamura
Department: Materials

CHARACTERIZATION OF NITRIDE-BASED CRYSTALS FOR OPTICAL DEVICES

Various nitride-based compounds have been grown on sapphire substrates to be used in solid-state lighting devices. Two of the most popular techniques for growing the nitrides are Metalorganic Chemical Vapor Deposition (MOCVD) and Hydride Vapor Phase Epitaxy (HVPE). MOCVD is used in this lab primarily to grow thin films of varying compositions; HVPE is used primarily to grow bulk GaN. The resulting samples can be processed to construct lighting devices that yield significant energy savings, lower heat output, and longer lifetimes compared to current lighting methods (incandescent, fluorescent, halogen, etc.). These devices require high-quality crystals. Therefore, the compounds — specifically GaN, InGaN, and AlN — must be characterized to determine crystal quality and the growth conditions must be optimized to improve quality. Atomic Force Microscopy (AFM) and X-Ray Diffraction (XRD) techniques were used to characterize the samples. Data on crystal quality, crystal orientation, dislocations, impurities, and composition was gathered using these techniques. The examined crystals varied widely in quality. Growth conditions, including growth temperature, pressure, and relative composition of elements, are thus optimized based on characterization data from previous growths.

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Ryan's Project Page - RISE summer 2003

Intern: Ryan Haggerty, UCSB
Mentor: Eric Toberer
Faculty Supervisor: Ram Seshadri
Department: Materials Research Laboratory

THE EFFECT OF NONSTOICHIOMETRY ON THE CRYSTAL STRUCTURE OF La0.5Sr0.5CoO3-x

The ceramic La0.5Sr0.5CoO3-x has the ability to form with varying amounts of oxygen while retaining its perovskite structure. As the temperature is raised, the diffusion of atoms in the crystal lattice becomes more favorable. Oxygen vacancies move through the lattice of La0.5Sr0.5CoO3-x to form an equilibrium with the oxygen partial pressure at each interface. This is known as oxygen ion conduction. The combination of oxygen ion and electrical conductivity makes La0.5Sr0.5CoO3-x an ideal cathode material in solid oxide fuel cells. Bulk samples of La0.5Sr0.5CoO3-x with varying x have been prepared by solid state synthesis. The concentration of oxygen vacancies has been determined through oxidation reduction titrations. The structure of the samples was then characterized using powder X-ray diffraction in order to find a relation between the structural properties and the amount of oxygen vacancies in the material. These studies complement existing work on magnetron-sputtered thin film samples of the same material.

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Micah's Project Page - RISE summer 2003

Intern: Micah Hall, The University Of Memphis
Mentor: Camelia Owens
Faculty Supervisor: Francis Doyle
Department: Chemical Engineering

RUN-TO-RUN CONTROL OF BLOOD GLUCOSE CONCENTRATIONS FOR TYPE 1 DIABETIC PATIENTS

Type 1 diabetes mellitus is a disease that is characterized by insufficient insulin production in the body. If not treated properly, the diabetic patient can experience complications due to either hyperglycemia or hypoglycemia. Hyperglycemia is a state of elevated concentrations of glucose in the blood system, which over a period of time, puts the diabetic at risk of developing neuropathy, retinopathy, and other peripheral vascular diseases. Hypoglycemia occurs when blood glucose concentrations are too low. If not treated, the diabetic can lose consciousness or even die. In our study we will be applying a run-to-run algorithm in controlling blood glucose levels on a day-to-day basis. Run-to-run control exploits the repetitive nature of a meal cycles. Small perturbations in the patients' insulin amounts and timing will be administered to develop a model that reflects a patient's sensitivity to these adjustments. Insulin injections and blood glucose concentration measurements will be performed around the diabetic patients' meal times (breakfast, lunch, and dinner). In collaboration with Sansum Medical Research Institute and Roche Diagnostics, Inc., a clinical trial is underway to asses the feasibility of the run-to-run algorithm in improving insulin therapy for 15 diabetic patients.

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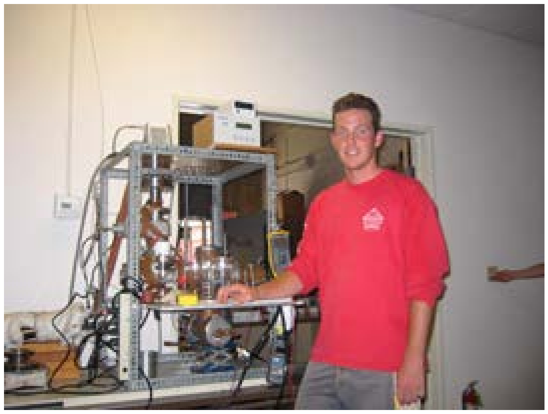
Kevin's Project Page - RISE summer 2003



Intern: Kevin Herlihy, UCSB
Mentor: Vojislav Sradnov
Faculty Supervisor:
Department: Chemistry and Biochemistry

ORGANIC LIGHT EMITTING DIODE (OLED) SYNTHESIS

The main goal this summer was to create a working OLED. To do this, vacuum chambers were utilized to deposit the organic molecules Alq3 and TPD as well as aluminum onto a glass slide covered with ITO. Later versions of the device will include a layer of red light emitting organometallic molecule containing europium. The vacuum chambers, reaching 10^-7 mBar, were first utilized to calibrate the deposition of each material. Once this was done, the proper rate of deposition could be used to deposit the correct amount of each molecule over the surface of the device. In addition, masks were created using solid aluminum plates to generate a defined layout for each deposition. These masks prevented any electrical shorts that might have been created by contact between the two electrodes ITO and aluminum. Once the simple OLED is successfully created, more complicated versions of the same device are planned. Future devices will harbor varying levels of each organic molecule which will be created by close-range deposition. Multiple aluminum cathodes on the same device will allow us to determine the optimal combination of organic molecule thicknesses.

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Jonathan's Project Page - RISE summer 2003

Intern: Jonathan Hollander, University of Illinois at Urbana-Champaign
Mentor: Ben Haskell
Faculty Supervisor: Shuji Nakamura/Jim Speck
Department: Materials

GROWTH OF (11¯00) m-PLANE GALLIUM NITRIDE ON ALUMINUM OXIDE VIA HYDRIDE VAPOR-PHASE EPITAXY

Studies of non-polar GaN planes have shown an increase in device performance though suffering from relatively challenging or costly fabrication. New theories pronounce (11¯00) GaN as having potential to be the most stable non-polar growth plane, however many available substrates have too large lattice mismatch. In attempt to find a suitable sapphire orientation, we are led to believe that an 8.668 degree miscut from the (112¯3) plane toward the [0001] direction may yield a proper growing surface. Several cutting and polishing techniques must be employed in order to sufficiently improve the surface quality to meet proper growing conditions at this inclination. Once a substrate is fabricated, films may be grown by way of HVPE. System parameters are carefully selected and tested to minimize threading dislocation density, which may be on the order of 1010 cm-2 for a device-quality film. Characterization of films after growth including optical microscopy, scanning electron microscopy, atomic force microscopy, and x-ray diffraction, are important to assess the crystalline quality and homogeneity across the substrate.

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MATERIALS RESEARCH LABORATORY at UCSB: an NSF MRSEC
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Amardeep's Project Page - RISE summer 2003

Intern: Amardeep Kaur, UCSB
Mentor: Christian Steinbeck
Faculty Supervisor: Brad Chmelka
Department: Chemical Engineering

INVESTIGATING A NEW CHROMONIC LIQUID CRYSTAL

Chromonic liquid crystals are newly discovered family of liquid crystals. They typically consist of planar aromatic molecules. Because many dyes and drugs contain extended ƒà systems, they may form chromonic liquid crystals. The study of chromonic liquid crystals is therefore an important field of research, as it will help in the better understanding of the behavior of many dyes and drugs. In a Chromonic liquid crystal, molecules self-assemble into highly ordered board like structures that can form different liquid crystal phases. The first step in the characterization of liquid crystals is the determination of the temperature and concentration phase diagram. In our research, we use optical microscopy and deuterium nuclear magnetic resonance (NMR) to investigate the phase behavior of tetra(4-sulfonatophenyl)porphyrin (TPPS4) as a functions of concentration, temperature and pH. In acidic solutions (pH < 2), TPPS4 was found to form extended J-aggregates and liquid crystalline phases at concentrations as low as 10mM.

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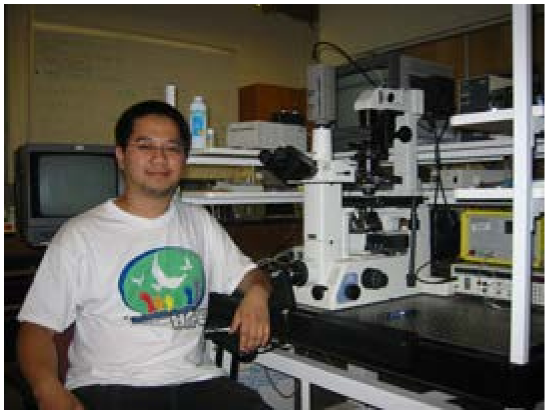
James' Project Page - RISE summer 2003



Intern: Kwok On (James) Lau, California Polytechnic State University, San Luis Obispo
Mentor: Mark Elsesser
Faculty Supervisor: David J. Pine
Department: Chemical Engineering and Materials

SMALL CLUSTERS OF ENCAPSULATED POLYMER MICROSPHERES

It is possible to synthesize and separate bulk quantities of colloidal clusters composed of polymer microspheres. Clusters containing two to fifteen particles are isolated using density gradient centrifugation. The clusters can then be encapsulated in oil droplets and the droplet size is controllable. We are currently investigating methods to increase the yield and purity of clusters containing two to four particles. We are also studying the effectiveness of various solvents for encapsulating the clusters and assembling the encapsulated clusters into monolayers.

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Chris's Project Page - RISE summer 2003

Intern: Chris Lightcap, Lehigh University
Mentor: Kimball Hall
Faculty Supervisor: Eric Matthys
Department: Mechanical and Environmental Engineering

DRAG REDUCTION OF TURBULENT FLOWS BY MICROALGAE

The goal of this project is to determine the drag reducing potential of a polysaccharide produced by the red algae porphyridium. We are testing to find if they can be applied to the surface of a ship to increase its velocity and reduce cavitation, the process creating noise. Microalgae are found naturally in the ocean, however, for this experiment they are grown in a bioreactor, or specialized aquarium. The solution of polysaccharide and algae are subject to a measured pressure drop along a pipe. This information, along with the volumetric flowrate, will reveal the percent difference in skin friction coefficient, also known as the drag reduction. The results have been outstanding, nearly 60% drag reduction relative to water; the solution has reached its greatest potential according to Virk's maximum drag reduction asymptote. The polymer remains exceptionally drag reducing despite successive dilutions with water, having 15-20% drag reduction after diluted more than 95%. The solution will become highly diluted onboard the vessel making this information paramount.

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Blythe's Project Page - RISE summer 2003

Intern: Blythe Miron, UCSB
Mentor: Dimitis Stroumpoulis
Faculty Supervisor: Matt Tirrell
Department: Chemical Engineering

GRID PATTERNS AND VESCILE FUSION OF AMPHIPHILIC BILAYERS

My project involves patterning of ligands to cell adhesion in a concentration varying way. Using microcontact printing, I am able to transfer a polymerized bilayer grid pattern on a silicon dioxide surface from an inkpad containing a bilayer formed on mica by vesicle fusion. Subsequently two differently labeled vesicle solutions can be flown in parallel such that a concentration gradient of vesicles is built. Fusion of the vesicles in between the solid bilayer barriers (square corrals) will form a concentration gradient of fluid bilayer patches displaying different colors. This method of surface patterning can be used to analyze the affinity that different combinations of amphiphilic molecules have on specific cells, by observing how well cells can spread on the different corrals. Ultimately, this project could benefit the study of how a variety of human tissues could be grown on biocompatible surfaces and used in tissue therapy or biocompatible materials used for implantation.

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Bri's Project Page - RISE summer 2003

Intern: Brietta Oakley, University of Kentucky
Mentor: Dimitry Klenov
Faculty Supervisor: Susanne Stemmer
Department: Materials

ULTRAVIOLET OZONE OXIDATION OF ULTRATHIN TITANIA DIELECTRIC FILMS

As transistor devices are required to be smaller and smaller, a material with a higher dielectric constant than SiO_2 is needed to act as a gate dielectric in order to maintain/improve performance. In this project, ultraviolet ozone oxidation is being explored as a possible method to produce different metal oxide thin films for this application. An emphasis has been placed on thin titanium films because of oxidation ease as well as the high dielectric constant of TiO_2. The UV ozone oxidation method has the advantage of being a low temperature process when compared to other common methods of thin film oxidation, such as O_2 annealing and direct deposition from a Ti oxide target. Samples are oxidized in O_2 in the presence of ultraviolet light of a specified wavelength (185 nm). The UV light encourages the presence of O_3, which will rapidly oxidize the thin titanium film with little to no substrate damage. By altering the parameters of time, temperature, and oxygen pressure, optimal conditions are determined for this process. Samples are then analyzed with transmission electron microscopy and X-ray photoelectron spectroscopy to determine the phases of oxide present, level of oxidation, and presence of semiconductor substrate damage.

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Miyoko's Project Page - RISE summer 2003

Intern: Miyoko Ohashi,
Mentor: Ryan Hayward
Faculty Supervisor: Brad Chmelka
Department: Chemical Engineering

NANOSTRUCTURAL CONTROL OF SURFACTANT-SILICA THIN FILMS

Nanotechnology is an important field of study in recent years. One aspect involves mesoporous materials, which contain pores in the 2-5 nm range. Surfactants, molecules that possess two opposite polarity or charge, can form complex structures at the nanometer scale level, including hexagonal, cubic and lamellar liquid crystal phases. Liquid crystals formed by nonionic surfactants can be fixed by allowing silica to solidify in the hydrophilic part of the structure. Silica shaped around a liquid crystal can then be obtained by burning out the organic component. The self-assembled structures can serve as barriers, low dielectric or insulation materials, catalysts, and selective membranes for separation processes. This research explores the production of bicontinuous cubic silica nanostructures with Brij-56, a nonionic surfactant. The large surface area and accessibility of pores makes the bicontinuous cubic structure a promising candidate for catalysis. Also, the continuous network of nanoporous structure may function as a selective membrane. This research explores the phase structure diagram of the Brij-56/silicon dioxide system, in comparison to the known phase diagram of the Brij-56/water system. The cubic phase occupies a very small region of the surfactant/water phase diagram; yet for applications in nanotechnology it is important that the desired structure can be reliably produced. Thus, it is important to understand the control of nanostructure by relevant parameters in order to optimize synthetic conditions. Our results show that cubic structure forms around the same region of composition and temperature in both systems. Further study is to be conducted for deeper understanding of the behavior.

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Ryan's Project Page - RISE summer 2003

Intern: Ryan Palmer, California Lutheran University
Mentor: Howard Rathburn
Faculty Supervisor: Frank Zok
Department: Materials

OPTIMIZATION OF SANDWICH PANELS FOR BLAST MITIGATION

Navy ship hulls have undergone a tremendous diet over the past 50 years, for example WWII vintage battleship hulls were generally six to eight inches of solid steel. Due to technological advancements in our defense systems, these Navy ships have been able to decrease hull thickness to roughly half an inch of solid steel. Recent events such as the terrorist attack on the U.S.S. Cole (DDG 67) show the importance of naval structures to survive blast events. The U.S. Navy's Office of Naval Research has funded the study of cellular core sandwich panels to improve blast mitigation capability of naval structures. The excellent crushing and stretching behaviors of sandwich panels make them a highly attractive alternative to the widely used solid steel structures. Many different topologies are been studied, including truss assembly, wire mesh and honeycomb. Abaqus CAE is used to predict the performance of these structures and will help in optimizing the performance of the sandwich panels for use in naval structures that may come in contact with a blast.

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Sheena's Project Page - RISE summer 2003

Intern: Sheena Ramdeen, Brandeis Univsrsity
Mentor: Jason Sagert
Faculty Supervisor: Herbert Waite
Department: Molecular, Cellular, and Developmental Biology

THE EFFECTS OF OXIDATIVE STRESS ON THE MECHANICAL PROPERTIES OF MUSSEL BYSSAL THREAD

In order to survive in the intertidal zones, marine mussels produce byssal threads that keep them secured to rocky substrata and protect against the waves' incessant pounding. Mussel byssus possesses mechanical properties, most importantly shock absorbency and self-healing, that could potentially be used in a variety of industrial and medical applications. Past research has indicated a significant difference between the self-healing ability of wild threads and that of cultured threads. As such, the goal of this project was to determine if said differences are due to oxidative aging. Cultured threads were treated for 24h in filtered seawater solutions of sodium periodate, tyrosinase, and hydrogen peroxide, as well as subjected to agitation at 200rpm in filtered seawater for 48h. Following each treatment, the threads were pulled to 35% strain using the MTS Bionix 200 to determine how the mechanical properties had changed. Subsequently, treated threads underwent amino acid analysis to ascertain how oxidation affected their biochemistry. Only the periodate treatment produced any apparent effect, decreasing both the threads' initial modulus and hysteresis, as well as eliminating the otherwise well defined yield point. However, further biochemical testing is necessary to determine why only periodate had a significant effect on the threads.

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John's Project Page - RISE summer 2003

Intern: John Ring, Dartmouth College
Mentor: Ira Leifer
Faculty Supervisor: ----
Department: Chemical Engineering

OIL SLICK FATE AND TRANSPORT MODELLING

Oil and methane seeps off the coast of Santa Barbara provide an exceptional opportunity to study the movements of oil on the water surface. The natural seeps bring a continuous flux of new oil to the ocean surface, which mimics an oil spill and allows researchers to study the oil slick in a natural marine environment. Innovative methods of tracking oil slicks and collecting oil samples were used during field expeditions to gather data on how wind and currents affect slick transport by advection. Calibration experiments were performed with the oil slick sampler (CATDRUMS) to compare field collection data with lab analyses. Gas chromatography was used to determine how evaporation and weathering change the oil in the first few hours after the oil rises to the surface. Data sets from field expeditions were analyzed and compared with existing oil spill scenario computer models, in the hopes of developing a new model, which better predicts the oil slick’s movements and weathering.

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Lynsey's Project Page - RISE summer 2003

Intern: Lynsey Turgeon,
Mentor: Norma Alcantar
Faculty Supervisor: Jacob Israelachvili
Department: Chemical Engineering

OPTICAL AND MECHANICAL PROPERTIES OF CDSE

There is much interest in the optical and mechanical properties of nanoparticles since they often have properties much different than bulk materials. There is a special interest in the properties of CdSe nanoparticles due to their photoluminescence. CdSe nanoparticles have an excellent tunable band gap through the visible range, which can be utilized when creating quantum-dot lasers, single electron transistors, and optical probes. These nanoparticles can also be used as carriers for photocopying, ultrasound contrast agents, and as absorbents. To study the mechanical and optical properties of CdSe, a device called the Surface Forces Apparatus (SFA) is used. The SFA measures the friction force of two nanoparticle films laterally shearing with varying velocity and applied pressure. In another experiment, a spectrometer is used along with a camera to record the fringes seen as a result of diffraction. My job in the lab involves analyzing the data obtained through these experiments. I use various programs such as Excel, KaleidaGraph, Origin, and Winview as an aid. I make various measurements such as friction force and absorption and graph the results as functions of sliding velocity and wavelength. From my research we hope to better understand the properties of CdSe.

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John's Project Page - RISE summer 2003

Intern: John Welsh, Dartmouth College
Mentor: Michael Sushchikh
Faculty Supervisor: Eric McFarland
Department: Chemical Engineering

AN ATOMIC HYDROGEN SOURCE FOR USE IN AN ULTRAHIGH VACUUM

An atomic hydrogen source was constructed, tested, and characterized under ultrahigh vacuum (UHV) conditions and is available for use in the study of surface reactions. The atomic hydrogen radical is a key intermediate of many important industrial reactions and, therefore, an atomic hydrogen source aids in the study of these reaction mechanisms. Under normal atmospheric conditions, the atomic hydrogen radical is extremely reactive and difficult to study. Hence, the use of an atomic hydrogen source in characterizing reaction mechanisms requires UHV conditions. A vacuum chamber was assembled, and an ultimate vacuum pressure of 10-10 Torr was achieved. The hydrogen source functions by thermally cracking molecular hydrogen within the UHV chamber. The thermal cracking is achieved by electron beam heating on a tungsten surface. The design of custom control electronics was necessary in order to heat the tungsten appropriately.

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Arthur's Project Page - RISE summer 2003

Intern: Arthur Wojcicki, University of South Carolina
Mentor: Pankaj Karande
Faculty Supervisor: Samir Mitragotri
Department: Chemical Engineering

BINARY FORMULATIONS IN THE ENHANCEMENT OF TRANSDERMAL DRUG DELIVERY

The world of chemical enhancers in transdermal drug delivery contains hundreds of individual enhancers that allow up to a certain size molecule to penetrate the stratum corneum (top layer of skin) and pass into the patient's blood stream. Each single enhancer is given a value of enhancement and skin irritation. The theory involved leads the lab group to believe that a binary combination of these enhancers should result in an ideal formulation with very high enhancement and low skin irritation value. Many of the underlying molecular mechanisms of these chemicals remain a mystery, which hinders the progression of any rational design of such mixtures. However, through the development of a new high throughput screening tool, several binary formulas can be tested per day in order to analyze any patterns that may arise among the numerous different types of enhancers used. Such categories include fatty acids, fatty esters, fatty alcohols, ionic and nonionic surfacants, and terpenes that offer different intermolecular interactions affecting the enhancement of each unique combination. Enhancement is measured through conductivity since it shows a strong linear relationship with permeability. Several compositions already display positive synergistic transport enhancement, in addition to negative and neutral synergy that can also aid in the further understanding of these various enhancers.

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