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Information and Safety | Research | Facilities | Education | People | News & Events | Webmail

Education

Undergraduate Opportunities
K-12 Science Activities
For Teachers
Education Contacts
News

Research Internships in Science and Engineering

Research Interns in Science and Engineering (RISE)
Summer 2005 - Student Projects

Student Major/School	Mentor	Faculty Sponsor	Department	Student Project
Nancy Braschayko Biology Lake Superior State University	Jon Marhenke	Peter C. Ford	Chemistry Biochemistry	Photochemical Studies of Vaska's Compound: $Rh(CO)_2I_2$ and $Rh(C(O)CH_3)(CO)_2I_3$
Brett Brotherton Computer Engineering UC Riverside	Tim Sherwood	Tim Sherwood	Computer Science	A high throughput string matching architecture for intrusion detection and prevention
Magda Brzozowska Warsaw University	Jan Andrews	David Clarke	Materials	Magentic polymer nanocomposites: Synthesis and characterization
Lindsay Deneault Biomedical Engineering Virginia Commonwealth University	Wren Greene	Jacob Israelachvili	Materials	Mechanism and control of the adsorption of lipid bilayer vesicles to glass surfaces
Bryan Elder Chemical Engineering UCSB	Jerry Macala	Peter Ford, Galen Stucky	Chemistry	Activation of methane by bromination over metal-laoded zeolites
Sally M. Jensen Biomedical Engineering University of Rochester	Badriprasad Anantha-narayanan	Matthew Tirrell	Engineering	Inducing cell adhesion to RGD-functionalized bilayer membranes
Stephanie Kern Forensic Chemistry Lake Superior State University	Chosu Khin	Peter C. Ford	Chemistry Biochemistry	Study of the nitrosylation pathways of copper(II) cyclam derivatives
Sergey Lossev Creative Studies	Badriprasad Anantha-	Matthew	Engineering	Identifying signature movement patterns

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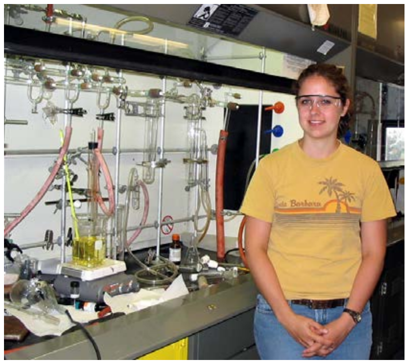
Pawel W. Majewski Warsaw University	Brian Naughton	David Clarke	Materials	Synthesis and characterization of nanosized ferrites coated with silica
Alex McCloskey Mechanical Engineering UCSB	Mike Pontin	Robert McMeeking	Materials	Loaded sandwich structures: Material testing and shear off study
Jonathan Nguyen Mechanical Engineering California State University, Sacramento	Noah Phillips	Tony Evans	Materials	Particle rearangement during braze infiltration
Rohan Patel Electrical Engineering UCSB	Georg Fantner	Paul Hansma	Physics	Nanoscale manipulation of biological materials
Jeremy Pett Physics UCSB	Kim Weirich	Deborah Fygenson	Physics	Binding strength of DAE tile sticky end
Richard Quinto Electrical Engineering California State University LA	Ricardo G. Sanfelice	Joao Hespanha	Electrial and Computer Enginering	Object avoidance for general navigation systems
Magdalene Reynolds Chemistry Mills College	Mustafa Akbulut	Jacob Israelachvili	Chemical Engineering	Preparation of surface force apparatus for coalescence
Omair Saadat Electrical Engineering Stanford University	David K. Wood	Andrew N. Cleland	Physics	Microfabrication of a cell-sorting device

Return to the RISE homepage

Nancy's Project Page - RISE summer 2005



Intern: Nancy Braschayko, Biology, Lake Superior State University
Mentor: Jon Marhenke
Faculty Supervisor: Peter C. Ford
Department: Department of Chemistry and Biochemistry

PHOTOCHEMICAL STUDIES OF VASKA'S COMPOUND, Rh(CO)2I2-, AND Rh(C(O)CH3)(CO)2I3-

Homogeneous catalysts are widely used in industry to make products efficiently and selectively. Since catalysts work by providing low-energy pathways for these chemical reactions, the structure and reactivity of intermediates along these pathways is of interest. Two types of laser flash photolysis—time resolved optical and time resolved infrared spectroscopy—are used to study the kinetics and mechanisms of catalysts by generating the reactive intermediates and studying them directly. The main goal of this photochemical investigation is to attain detailed information regarding the reactivity of three species produced by photolysis— Vaska's complex, IrCO(PPh3)2Cl; Rh(CO)2I2-; and Rh(C(O)CH3)(CO)2I3-. Previous work done with Vaska's complex shows conflicting views as to whether the photoproduct is an iridium dimer or three-coordinate CO-loss species. Similarly, species produced by photolysis of Rh(CO)2I2- are being explored, with particular interest in the mechanism of its reaction with CH3I. The reductive elimination of Rh(C(O)CH3)(CO)2I3- to yield Rh(CO)2I2- will also be investigated photochemically.

Return to the RISE 2005 project list

Brett's Project Page - RISE summer 2005

Intern: Brett Brotherton, Computer Engineering, University of California, Riverside
Mentor: Tim Sherwood
Faculty Supervisor: Tim Sherwood
Department: Department of Computer Science

A HIGH THROUGHPUT STRING MATCHING ARCHITECTURE FOR INTRUSION DETECTION AND PREVENTION

Computer networks have become and integral part of our economy and daily lives, and ensuring that they are safe from intrusion is a top priority. The backbone of most modern intrusion detection systems is usually a string-matching algorithm. In order to detect an attack, the information coming through the network is matched up against strings that represent characteristics of an attack. To keep up with increasing network speeds we need to be able to match thousands of strings at a rate of around 10 billion bits/second, which is why we have developed a new architecture to perform the high speed string matching. The design breaks up the strings into many small state machines, which search for a portion of the rule. Dividing the rules saves space, which means the hardware can run faster, and is small enough to fit on chip. This robust architecture has the capability of being updated while it is running, while most of the currently known methods do not. Also, it is 10 times more efficient than the currently best-known methods. We are using an FPGA to develop a fully functional prototype that we can drop into the network for testing.

Return to the RISE 2005 project list

Magda's Project Page - RISE summer 2005

Intern: Magda Brzozowska, Warsaw University
Mentor: Jan Andrews
Faculty Supervisor: David Clarke
Department: Materials

MAGNETIC -POLYMER NANOCOMPOSITES – SYNTHESIS AND CHARACTERIZATION

The studies on the polymer nanocomposites are the answer for the need of obtaining small electronic devices. The nanocomposites, which are the aim of this project, consist of $Ni_{0.5}Zn_{0.5}FeO_2$ magnetic particles suspended in polymer (PVDF – polivinylidene difluoride) matrix. Since ferrite particles have magnetic properties and polymer has a high dielectric constant they may be used as a capacitor and inductor in one. Synthesis of ferrite nanoparticles is performed by aqueous co-precipitation reaction between metal salts and sodium hydroxide. The main synthesis problem to overcome was the incompatibility of the polymer even with trace amounts of water while the ferrite nanoparticles were synthesized in water – based reaction. The use of surfactants allowed getting a combined solution of ferrite magnetic particles and polymer in dimethyl formamide (DMF). Nanocomposites were created by evaporating the solvent on the Petrie dish. The nanoparticles were characterized by X-ray powdered diffraction as well as conductivity measurements. The polymer's properties were determined by Fourier transform infrared spectroscopy and also X-ray diffraction. Finally the nanocomposites morphology and structure was specified by scanning and transmission electron microscopy together with SQUID and dielectric measurements.

Return to the RISE 2005 project list

Lindsay's Project Page - RISE summer 2005

Intern: Lindsay Deneault, Biomedical Engineering, Virginia Commonwealth University
Mentor: Wren Greene
Faculty Supervisor: Jacob Israelachvili
Department: Materials

MECHANISM AND CONTROL OF THE ADSORPTION OF LIPID BILAYER VESICLES TO GLASS SURFACES.

Supported bilayers are important in drug delivery systems and allow researches to study membrane components in a controlled environment. Vesicle fusion to a surface provides a simple and convenient way of preparing high quality supported bilayers. However, little is known about the physics and chemistry of bilayer formation from vesicles and interactions between bilayers and surfaces. Most believe that vesicles adsorb to the surface, fuse with other vesicles, rupture to form bilayer discs, then spread to form a continuous bilayer. Additional models stress bending rigidity and curvature, adhesion energy, and contact potential. Unresolved issues include the cause of vesicles rupture, timing of fusion, whether fusion causes rupture, and whether adsorption causes fusion. Here, we study each process of vesicle adsorption and bilayer formation independently using the Quartz Crystal Microbalance (QCM), Fluorescence Recovery After Photobleaching (FRAP), and UV/VIS to understand the various internal vesicle forces and interparticle forces that determine how vesicles spread as bilayers onto surfaces. These data will provide insight into how lipid type, initial vesicle size, physical and chemical nature of the surfaces, and the solution and osmotic conditions modify the interaction forces. We seek to create the optimum conditions to produce uniform and stable supported lipid bilayers.

Return to the RISE 2005 project list

Bryan's Project Page - RISE summer 2005

Intern: Bryan Elder, Chemical Engineering, University of California, Santa Barbara
Mentor: Jerry Macala
Faculty Supervisor: Peter Ford
Department: Department of Chemistry

ACTIVATION OF METHANE BY BROMINATION OVER METAL-LOADED ZEOLITES.

The high cost of transporting natural gas has resulted in the flaring of several trillion cubic feet per year. In order to transport the gas, it must be either compressed under extreme pressure to a liquid state, or converted to a liquid by chemical process. One such process allows the conversion of linear alkanes to linear alcohols. This technique occurs in two steps: bromination and metathesis. The bromination step is very important as it activates the alkane for the metathesis step. It has been found that a catalyst may enhance the conversion of methane at lower temperatures to methylbromide, the desired product. Zeolites may be useful catalysts for this reaction. Their cage-like structure is made up of AlO_4 and SiO_4 tetrahedra that produce an overall negative charge on the zeolite. To compensate for this charge, the zeolite can be easily loaded with metal cations that have been experimentally successful in other metal-oxide catalysts. This new technique may provide a cheaper and more effective method for the bromination of alkanes to alkylbromides.

Return to the RISE 2005 project list

Sally's Project Page - RISE summer 2005

Intern: Sally M. Jensen, Biomedical Engineering, University of Rochester
Mentor: Badriprasad Ananthanarayanan
Faculty Supervisor: Matthew Tirrell
Department: MRL

INDUCING CELL ADHESION TO RGD-FUNCTIONALIZED BILAYER MEMBRANES.

Surface properties of biomaterials are becoming increasingly important as application in biomedical devices and sensors grow. Current research involves functionalizing a bilayer membrane with the specific amino acid sequence, arginine- glycine- aspartic acid, RGD. This peptide, from the fibronectin protein in the extra-cellular matrix (ECM), is commonly used as a cell adhesion-promoting molecule. RGD can promote integrin-receptor mediated attachment of cells on various surfaces and can be used to modify bilayer membranes as well as other surfaces. Lipids with RGD head groups, spacers, and double, sixteen carbon tails form vesicles and can subsequently be made into lipid bilayers on a prepared surface after a fusion and rupture process. The concentration of RGD modified lipids is varied and the changes in adhesive qualities of the surface are measured. Altering the length of the spacer group between the peptide and the tails may also affect the adhesive qualities. This study attempts to provide a correlation between concentration and accessibility of RDG modified peptide amphiphiles and the number and morphology of cells adhered. This research encourages new possibilities for cell adhesion to biocompatible surfaces for uses in tissue engineering or implantations.

Return to the RISE 2005 project list

Stephanie's Project Page - RISE summer 2005

Intern: Stephanie Kern, Forensic Chemistry, Lake Superior State University
Mentor: Chosu Khin
Faculty Supervisor: Peter C. Ford
Department: Chemistry and Biochemistry Department

STUDY OF THE NITROSYLATION PATHWAYS OF COPPER(II) CYCLAM DERIVATIVES

Nitric Oxide (NO) interactions with metal-centered heme proteins play an important role in the bioregulation functions. In humans, NO is associated with vasodilation, neurotransmission, immune response and a number of diseases that have been associated with over and/or under production of NO. Reductive nitrosylation is one reaction pathway for NO interaction with metal centers. During reductive nitrosylation reaction, reduction of metal center by NO takes place and nitrosylated products result. In this research, Cu(II) cyclam derivatives with different molecular groups, such as chromophores, are used to study their interactions with NO in light for the development of fluorescence based NO sensor. Kinetic and mechanistic aspects of these Cu(II) cyclam complexes will be further explored.

Return to the RISE 2005 project list

Education

Undergraduate Opportunities
K-12 Science Activities
For Teachers
Education Contacts
News

Sergey's Project Page - RISE summer 2005

Intern: Creative Studies, University of California Santa Barbara
Mentor: Badriprasad Ananthanarayanan
Faculty Supervisor: Matthew Tirrell
Department: MRL

IDENTIFYING SIGNATURE MOVEMENT PATTERNS FOR CANCEROUS CELLS

In order to combat cancer effectively it is essential to detect the malignancy in a very early stage. It has been found that a correlation between cell motility and metastatic potential exists. Visual gradient systems have been shown to characterize metastatic potential based on in vitro single cell behavior with a75% accuracy. These previous studies point to a difference in cell motility; creating the goal of developing a computer assisted diagnosis system for cancer. By placing a single cell onto a cell bed of elastomeric microneedles, the isolated traction and adhesion forces of the cell's motility can be measured. Using this technique a new key parameter is determined via time-lapse video microscopy. Isolated mechanical force with a direction and a resolution in time may allow identification of signature patterns for cancerous cell movement. The automated diagnosis system would use a fine needle aspirate sample from a tissue region of interest that would be placed onto a cell bed and analyzed via an automated microscopy procedure equipped with neuronal net algorithms. Fine needle aspirations would allow for a test of metastatic potential of suspect tissues earlier then conventional imaging techniques.

Return to the RISE 2005 project list

Pawel's Project Page - RISE summer 2005

Intern: Pawel W. Majewski, Warsaw University
Mentor: Brian Naughton
Faculty Supervisor: David R. Clarke
Department: Materials

SYNTHESIS AND CHARACTERIZATION OF NANOSIZED FERRITES COATED WITH SILICA

Nanosized ferrites present unique magnetic properties that are not found in the bulk materials. They display no hysteresis effect and can operate as inductors at much higher frequencies than conventional elements. In this work we focus on preparation and characterization of nickel-zinc ferrites (5-20 nm in diameter) produced by the aqueous precipitation technique. Particles are coated with a silica layer to obtain the magnetic material with desired particle separation and low conductivity. Coating reaction is conducted in the basic ethanol based solution with a tetraethoxysilicate (TEOS) as silica-forming precursor. After the reaction, particles are pressed into pellets. The final product along with the samples from previous steps are characterized by the following techniques: SQUID measurements for DC magnetic properties characterization, high frequency magnetic susceptibility measurements, X-Ray Powder Diffractometry (XRD), and Small Angle X-Ray Scattering (SAXS) for particle-size determination. Additionally, Ion Coupled Plasma Atomic Emission Spectrometry (ICP-AES) is used for chemical composition determination. The information from these techniques helps draw a connection between synthesis procedure and final material properties. As a result this project will help to expand the knowledge and understanding of nano-scale material structure and properties.

Return to the RISE 2005 project list

Alex's Project Page - RISE summer 2005

Intern: Alex McCloskey, Mechanical Engineering, University of California, Santa Barbara
Mentor: Mike Pontin
Faculty Supervisor: Robert McMeeking
Department: Materials

DYNAMICALLY LOADED SANDWICH STRUCTURES: MATERIAL TESTING AND SHEAR OFF STUDY

Recent events such as the attack on the U.S.S. Cole (October 12, 2000) have prompted the United States defense department to search for new and improved ways to protect its active forces. As one response the US Office of Naval Research is funding UCSB's Materials department to investigate different blast-proof structures for battleship hull armor. The department has considered and is currently testing different cellular core sandwich panel designs to replace the half-inch solid steel hulls currently used by the Navy. Optimization of such structures is primarily done through finite element modeling. Such modeling requires values for the properties of the materials in question (Al6xn and 304 stainless steel) which must be determined through material testing. Further, confirmation of the validity of such models can be attained by performing a series of ballistics tests and comparing their results to those obtained by way of finite element modeling.

Return to the RISE 2005 project list

MATERIALS RESEARCH LABORATORY at UCSB: an NSF MRSEC
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Jonathan's Project Page - RISE summer 2005

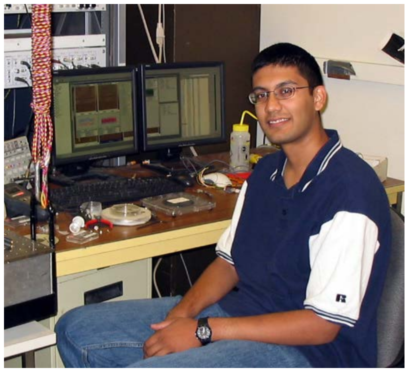
Intern: Jonathan Nguyen, Mechanical Engineering, California State University, Sacramento
Mentor: Noah Philips
Faculty Supervisor: Tony Evans
Department: Materials

PARTICLE REARRANGEMENT DURING BRAZE INFILTRATION

Material advancements over the past 60 years have allowed U.S. Naval ship hull designs to be thinned from six inches of solid steel to about half an inch. Events such as the terrorist attack on USS Cole led the Office of Naval Research to initiate a project that would investigate sandwich structures with greater resistance to dynamic shock waves. A sandwich structure is fabricated with a metal core joined to two outer metal panels with a nickel alloy braze, however the braze creates undesirable brittle phases in the joint. Effects of 303 Stainless Steel filler material on the fracture toughness of a brazed joint were investigated. Varying particle sizes along with powder packing strategies of the filler material in the joint was explored to improve packing density. The ductility of the filler material is expected to inhibit crack growth, thereby improving the overall integrity of the joint. Voids in the joint were evaluated in order to minimize poor joint characteristics. Joint fabrication techniques include pre-placed filler material with braze outside and sintered filler material with braze outside. It is anticipated that a binary particle distribution of the filler material will yield the most promising microstructure.

Return to the RISE 2005 project list

Rohan's Project Page - RISE summer 2005



Intern: Rohan Patel, Electrical Engineering, University of California, Santa Barbara
Mentor: Georg Fantner
Faculty Supervisor: Paul Hansma
Department: Physics

NANOSCALE MANIPULATION OF BIOLOGICAL MATERIALS

Atomic force microscopy (AFM) has the ability to take high resolution topographic images. Continued development in the field has led to a demand for an AFM system capable of both nanoscale surface modification as well as single molecule manipulation. On this scale, with the piezoelectric scanner alone, issues such as hysteresis arise giving us limited positional accuracy of the cantilever tip. The addition of a strain-gauge closed-loop controller minimizes the nonlinearity and hysteresis effects. This advancement allows for better positioning resulting in more accurate surface modifications and manipulations. Scan speeds of the AFM have also been improved with the use of much smaller cantilevers corresponding to a resonant frequency two orders of magnitude greater than larger cantilevers. To control this faster and more accurate system, we developed a new control environment capable of imaging at 50Hz line rate at an imaging resolution of 512 by 512 pixels. For manipulation applications, we control the z-movement of the cantilever tip with respect to the sample, allowing us to accurately indent and pull on the surface. We look forward to combining these new AFM techniques to create a new imaging and control system capable of greatly surpassing the abilities of current commercial products.

Return to the RISE 2005 project list

Jeremy's Project Page - RISE summer 2005

Intern: Jeremy Pett, Physics, University of California, Santa Barbara
Mentor: Kim Weirich
Faculty Supervisor: Deborah Fygenson
Department: Physics

BINDING STRENGTH OF DAE TILE STICKY ENDS

From previous experiments we know that 5 nucleotide DAE tile sticky ends, when part of a tile, melt around 40 degrees Celsius. This, however, is not the melting temperature of a 5 nucleotide long piece of double stranded DNA. Knowing the melting temperature of DAE tile sticky ends when separate from the tile itself is useful in determining the effect tile-tile interaction has on melting temperature. We designed a DNA hairpin that mimics the sticky ends of tiles and found the melting temperature of sticky ends by themselves. This technique allows us to isolate the effect on the binding temperature of the 5 base pair sticky ends and compare it to the binding temperature of the tile as a whole. From this we can determine where energy is stored in specific regions of the DNA tube.

Return to the RISE 2005 project list

Richard's Project Page - RISE summer 2005

Intern: Richard Quinto, Electrical Engineering, California State University, Los Angeles
Mentor: Ricardo G. Sanfelice
Faculty Supervisor: Joao Hespanha
Department: Electrical and Computer Engineering, UCSB

OBJECT AVOIDANCE FOR GENERAL NAVIGATION SYSTEMS

Scientists are developing new ideas to improve navigation systems. One possible answer is by intelligent design that provides a number of properties desired by the users. Safety is a primary concern in transportation, in addition to comfort and several standard norms of security. Object Avoidance for General Navigation Systems offers that comfort. In this paper we present an algorithm for a wheeled mobile robot of the unicycle type that approaches a desired target while avoiding obstacles. We program the robot in C++ along with the libraries of the ActivMedia Robotics Interface for Application (ARIA) software to accomplish the desired task. We tested our algorithms on a Pioneer 2 robot from ActivMedia Robotics and we present the obtained results.

Click **here** to see the web-site of my summer project

Return to the RISE 2005 project list

Magdalene's Project Page - RISE summer 2005

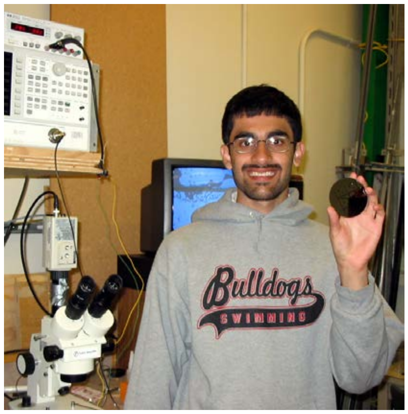
Intern: Magdalene Reynolds, Chemistry, Mills College
Mentor: Mustafa Akbulut
Faculty Supervisor: Jacob Israelachvili
Department: Chemical Engineering

PREPARATION OF SURFACE FORCE APPARATUS FOR COALESCENCE

Coalescence, the study of liquid-liquid interactions, is important for research in subjects like cloud formation and biological processes. While important, research dealing with the intermolecular forces within the interactions is very limited. The surface force apparatus, kin to the atomic force microscope, could offer valuable data and information about the forces. By bringing together its two curved plates coated in solution and withdrawing the plates, the SFA could measure the repulsion and attraction of the two plates and the respective liquids on the plates. Until now, the SFA was not designed for liquid-liquid study and could not control the liquids to properly study their behaviors. The project's intention is to prepare the plates of the SFA to handle and implement liquids consistently. Two processes, spin-coating and dipping, are used to apply solutions to silicon wafers, using the variables from the processes to control the measured product. Two polymers, polystyrene and polydimethylsiloxane, in different weight percents in toluene will be prepared and measured for thickness on the wafers, to be analyzed with ellipsometery.

Return to the RISE 2005 project list

Omair's Project Page - RISE summer 2005



Intern: Omair Saadat, Electrical Engineering Department, Stanford University
Mentor: David K. Wood
Faculty Supervisor: Andrew N. Cleland
Department: Physics

MICROFABRICATION OF A CELL-SORTING DEVICE

We fabricated a microfluidic device designed to sort cells based on the cell's impedance, which in turn depends on the amount of DNA present in the cell. This device was composed of an antenna and microfluidic channels made of poly-dimethyl-siloxane (PDMS). We fabricated a mold composed of a silicon substrate and a thick photo-resist, SU-8 and used it to cast the PDMS devices. A precise pressure pump was used to pump a silane solution with dissolved polystyrene beads through the device. We used the polystyrene beads to simulate actual cells. We used a high voltage switch to electro-osmotically switch the flow of the fluid from one channel to the other. We intend to use this feature to sort cells by direct the fluid to either one channel to another. We coupled this switch to an antenna that could detect cells flowing through the fluid by detecting impedance change caused by the cells.

Return to the RISE 2005 project list