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### Research Internships in Science and Engineering

Research Interns in Science and Engineering (RISE)  
 Summer 2006 - Student Projects

Student Major/School	Mentor	Faculty Sponsor	Department	Student Project
<a href="#"><u>Andrea Bayles</u></a> Biochemistry UC Santa Barbara	J. Benjamin Beck	Craig Hawker	Materials	Preparation of Polymeric Nanoparticles via Intramolecular Crosslinking: Chain Collapse
<a href="#"><u>Justin Butler</u></a> Biomedical Engineering UC Santa Barbara	Brian Vicente	Susannah Scott Ram Seshadri	Chem. Engineering Materials	Tungsten Carbide Catalysts for the Hydrogen Economy
<a href="#"><u>James Byrne</u></a> Chemical Engineering University of Texas, Austin	Guihui Wu	Joseph Zasadzinski	Chemical Engineering	Optimization Of The Biotinylation Of DPPC Vesicles For Active Targeting
<a href="#"><u>Terence Choy</u></a> Chemistry Columbia University	Karen Sohn	Ed Kramer	Materials	Spherical and Cylindrical Phase Transitions in Diblock and Triblock Copolymers
<a href="#"><u>Joshua Fields</u></a> Materials Science and Engineering Cornell University	Richard Chapleau	Martin Sagermann	Chemistry and Biochemistry	Engineering pH Controlled Allostery in Glutathione-S-Transferase
<a href="#"><u>Stephanie Gomez</u></a> Chemistry Mills College	Andrew Morrill	Martin Moskovits	Chemistry and Biochemistry	Growth And Functionalization Of Tin Oxide Nanowires For Sensing Applications
<a href="#"><u>Stephani Gulbrandsen</u></a> Materials Franklin W. Olin College of	Asanga Ranasinghe	Steven Buratto	Chemistry and Biochemistry	<i>In situ</i> deposition of Pt/Ru metal nanoclusters for use in direct methanol fuel cells

Engineering				
<b><u>Jennifer Kunkel</u></b> Chemical Engineering University of Massachusetts, Amherst	Luke Bawazer	Dan Morse	Molecular, Cellular, and Developmental Biology	The Directed Evolution of Biomining Proteins
<b><u>Geoffrey Leonard</u></b> Chemical Engineering University of Virginia	Ryan Snyder	Michael Doherty	Chemical Engineering	An Investigation Into The Solubility, Enthalpic, And Metastable Zone Width, Alternations For $\alpha,\beta$ -Alkanedicarboxylic Acids
<b><u>Matthew Menyo</u></b> Materials Science and Engineering Pennsylvania State University	Brandon Heiken	Dan Morse	Molecular, Cellular, and Developmental Biology	Low Temperature Synthesis of Titania Thin Films for Photovoltaic Cells
<b><u>Amy Nabel</u></b> Chemistry UC Santa Barbara	Jimmy O'Dea	Steven Buratto	Chemistry and Biochemistry	Recast Nafion-Silica Polymer Composites for Fuel Cell Application
<b><u>Rodolfo Neuber</u></b> Computer Engineering UC Santa Barbara	Tim Sherwood	Tim Sherwood	Computer Science	Building A Range Adaptive Profiling Processor
<b><u>Andrew Robertson</u></b> Chemistry Lake Superior State University	Jerry Macala	Peter Ford	Chemistry and Biochemistry	Homogenous Catalytic Conversion of Biomass into Hydrogen
<b><u>Adam Schaller</u></b> Materials Science and Engineering Michigan Technological University	Christy Poblenz	Jim Speck	Materials	Characterization of Bulk GaN and AlGaIn/GaN Heterostructures for High Electron Mobility Transistors
<b><u>Robert Stuart</u></b>				

Mechanical Engineering UC Santa Barbara	Kendra Grant	Carlos Levi	Materials	Calcium-Magnesium Alumino-Silicate Attack On Environmental Barrier Coatings
<a href="#"><u>Holly Szumila</u></a> Aerospace Engineering and Space Physics Embry-Riddle Aeronautical University	Jun Li	Ram Seshadri	Materials	Synthesis And Characterization Of Nanostructured Metal Carbide Catalysts For The Hydrogen Economy
<a href="#"><u>Sara Thoi</u></a> Chemistry UC San Diego	Brian Vicente	Susannah Scott	Chemistry and Biochemistry	Tandem Alkane Dehydrogenation-Olefin Metaheis Via The Use Of Iridium-Based Pincer Complex And Methyltrioxorhenium/ font >
<a href="#"><u>Joshua Walker</u></a> Chemistry Jackson State University	Wren Greene	Jacob Israelachvili	Chemical Engineering	The Dissolution Of Quartz By Muscovite Mica; The Phenomena Of Pressure Solution: SFA Technique
<a href="#"><u>Antonio Woods</u></a> Chemistry Jackson State University	Janice Hong	Gui Bazan	Chemistry and Biochemistry	Synthesis Of Conjugated Polymers For Applications In DNA Detection

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### Andrea's Project Page - RISE Summer 2006



Intern: Andrea R. Bayles, Biochemistry, UC Santa Barbara

Mentor: J. Benjamin Beck

Faculty Supervisor: Craig Hawker

Department: Materials

#### PREPARATION OF POLYMERIC NANOPARTICLES VIA INTRAMOLECULAR CROSSLINKING: CHAIN COLLAPSE

Polymeric nanoparticles, 5-20 nm in diameter, exhibit interesting properties that lend them to advances in many areas of technology. Synthesizing nanoparticles within a diameter range of 5-20 nm, however, is not trivial. Current methods such as dendrimerization and microemulsion techniques are thus far incapable of preparing nanoparticles in this desired size range.

I used intramolecular chain collapse to produce polymeric nanoparticles 5-20 nm diameter by crosslinking single polymer chains upon themselves. In this method, functional groups within linear polymer chains react under dilute conditions to create intramolecular cross-links, forming a collapsed polymer particle.

Linear copolymers of methyl methacrylate and isocyanatoethyl methacrylate were synthesized via RAFT-mediated free radical polymerization. Copolymer composition was confirmed by  $^1\text{H}$  NMR, and Gel Permeation Chromatography (GPC) provided the average molecular weight and polydispersity index of the polymer products.

The isocyanate groups located on the individual polymer chains were reacted with the difunctional 2,2'-(ethylenedioxy)bis-(ethylamine) species to make urea linkages. This reaction, achieved by the dropwise addition of polymer to diamine, collapses each chain into a nanoparticle. Infrared spectroscopy (IR) confirmed the presence of ureas and absence of isocyanates in the collapsed samples. GPC demonstrated relative decreases in hydrodynamic volume indicating a successful collapse reaction.

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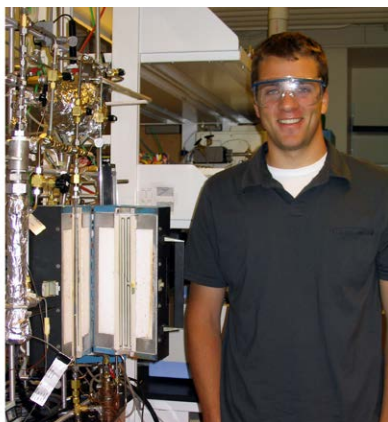
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### Justin's Project Page - RISE Summer 2006



Intern: Justin Butler, Chemical Engineering, UC Santa Barbara

Mentor: Brian Vicente

Faculty Supervisor: Susannah Scott and Ram Seshadri  
Department: Chemical Engineering and Materials

#### TUNGSTEN CARBIDE CATALYSTS FOR THE HYDROGEN ECONOMY

Fuel cells, such as the polymer electrolyte (PEM) fuel cell, are promising alternatives to combustive sources for energy production. These fuel cells, however, require high purity hydrogen to operate efficiently. An effective hydrogen purification method is the water gas shift (WGS) reaction. This reaction converts carbon monoxide and water into carbon dioxide and hydrogen. It is currently catalyzed by expensive, unstable materials. A plug flow reaction system has been designed to test the catalytic properties of alternative catalysts for the WGS reaction. This reaction system has been used to test the WGS activity of tungsten carbide, which is an inexpensive and stable catalyst. The activity of tungsten carbide was compared to that of a palladium catalyst supported on alumina to determine if it is a viable alternative catalyst.

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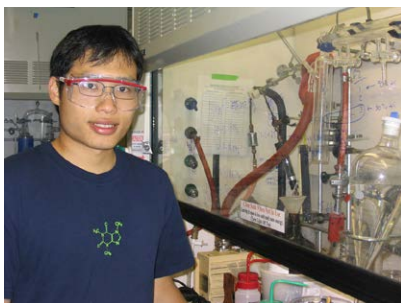
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### Terence's Project Page - RISE Summer 2006



Intern: Terence Choy, Chemistry, Columbia University

Mentor: Karen Sohn

Faculty Supervisor: Ed Kramer

Department: Materials

#### SPHERICAL AND CYLINDRICAL PHASE TRANSITIONS IN DIBLOCK AND TRIBLOCK COPOLYMERS

Block copolymers composed of immiscible monomer units are known to phase separate into chemically distinct domains on the order of 10 to 100 nm. This property has been the interest of much research in the past 35 years for applications in nanolithography and electronics manufacturing. Therefore, understanding the kinetics of pattern formation and producing ordered domains is highly desirable.

A commercial blend of poly(styrene-*b*-ethylene-*r*-butylene) (SEB) diblock and poly(styrene-*b*-ethylene-*r*-butylene-*b*-styrene) (SEBS) triblock exhibits an order-order transition (OOT) between hexagonally packed cylinders and body-centered cubic spheres at  $\sim 140^\circ\text{C}$  before crossing into the disordered phase at  $\sim 200^\circ\text{C}$ .

In thin films, however, the film thickness and annealing time also affect the expressed morphology. Curiously, the spherical morphology has been observed below the OOT at low film thicknesses and short annealing times in the blend.

The project aims to derive the kinetics that govern the morphologies of the block copolymers. To simplify the system, the two components of the blend were fractionally precipitated and purified. Films of SEB diblock and SEBS triblock were annealed under various conditions, and then characterized by surface force microscopy (SFM). This affords valuable knowledge for future projects seeking to obtain long range ordering on templated substrates.

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### Josh's Project Page - RISE Summer 2006



Intern: Joshua Fields, Materials Science and Engineering, Cornell University  
Mentor: Richard Chapleau  
Faculty Supervisor: Martin Sagermann  
Department: Chemistry and Biochemistry

#### ENGINEERING PH CONTROLLED ALLOSTERY IN GLUTATHIONE-S-TRANSFERASE

The goal of the presented research is to introduce responsive allosteric function into a protein to enable its remote control. We describe here two specific mutants of the enzyme GST (glutathione-S-transferase) that were engineered specifically to introduce allosteric response. We control the allostery via the introduction of specific pH-sensitive residues. The charges of the mutated residues (aspartate and histidine) can be reversibly toggled on & off selectively by varying the proton concentration of the surrounding medium. In the off state the mutant residue is neutral and has no effect on the protein's binding site. In the on state, however, the mutated residue becomes charged and induces conformational changes that interfere with the binding activity. We hypothesize that a structural change is transmitted through the body of the protein molecule thus altering its binding site. Consequently, the function of the newly created mutant proteins can be remotely controlled via external pH adjustments.

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**Stephanie's Project Page - RISE Summer 2006**

Intern: Stephanie Gomez, Chemistry, Mills College

Mentor: Andrew Morrill

Faculty Supervisor: Martin Moskovits

Department: Chemistry and Biochemistry

**GROWTH AND FUNCTIONALIZATION OF TIN OXIDE NANOWIRES FOR SENSING APPLICATIONS**

Tin oxide nanowires grown by way of the vapor-liquid-solid (VLS) method are a proven gas sensing element. Tin oxide nanowire devices were constructed by laying down VLS grown tin oxide nanowires on silica wafers and then evaporating titanium and gold through a copper grid contact mask. The devices were then assembled into a usable circuit that would allow for current to be recorded. With a constant voltage, pressure, volume and temperature, the current is dependent entirely on the absence or existence of gas in the system. Results show that the presence of oxygen gas greatly lowers the current of the circuit while the presence of carbon monoxide raises the current. Surface defects in the tin oxide nanowire are what allow conductance through the circuit. Oxygen attaches to these receptor sites, lowering the current. Carbon monoxide reopens these receptor sites, raising the current. The samples were then modified with an aminopropyl trimethoxy silane monolayer which reduces the number of available defects thus causing a less intense decrease in current with the addition of oxygen. The ability to change the sensitivity and selectivity makes these nanowire devices useful in a variety of applications and since they use conductometric based sensing they are easy to integrate into modern silicon based technology.

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### Stephani's Project Page - RISE Summer 2006



Intern: Stephani Gulbrandsen, Materials, Franklin W. Olin College of Engineering  
Mentor: Ansanga Ransighe  
Faculty Supervisor: Steven Buratto  
Department: Chemistry and Biochemistry

#### *IN SITU* DEPOSITION OF PT/RU METAL NANOCLUSTERS FOR USE IN DIRECT METHANOL FUEL CELLS

Tin oxide nanowires grown by way of the vapor-liquid-solid (VLS) method are a proven gas sensing element. Tin oxide nanowire devices were constructed by laying down VLS grown tin oxide nanowires on silica wafers and then evaporating titanium and gold through a copper grid contact mask. The devices were then assembled into a usable circuit that would allow for current to be recorded. With a constant voltage, pressure, volume and temperature, the current is dependent entirely on the absence or existence of gas in the system. Results show that the presence of oxygen gas greatly lowers the current of the circuit while the presence of carbon monoxide raises the current. Surface defects in the tin oxide nanowire are what allow conductance through the circuit. Oxygen attaches to these receptor sites, lowering the current. Carbon monoxide reopens these receptor sites, raising the current. The samples were then modified with an aminopropyl trimethoxy silane monolayer which reduces the number of available defects thus causing a less intense decrease in current with the addition of oxygen. The ability to change the sensitivity and selectivity makes these nanowire devices useful in a variety of applications and since they use conductometric based sensing they are easy to integrate into modern silicon based technology.

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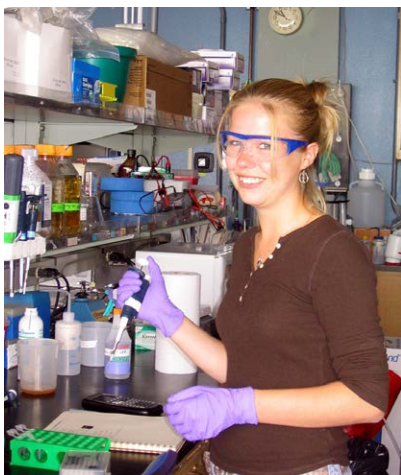
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### Jennifer's Project Page - RISE Summer 2006



Intern: Jennifer Kunkel, Chemical Engineering,  
University of Massachusetts, Amherst

Mentor: Luke Bawazer

Faculty Supervisor: Dan Morse

Department: Molecular, Cellular, and Developmental  
Biology

#### THE DIRECTED EVOLUTION OF BIOMINERALIZING PROTEINS

In nature, many organisms possess the ability to form minerals using only biological processes, in contrast to the high temperatures and pressures currently needed in industry. Understanding how these systems work could potentially provide bio-inspired and biomimetic routes for synthesizing technologically important inorganic materials at low temperatures. The sponge species *Tethya aurantia* has proven to be a useful biomineralizing model because it is able to form silica spicules which account for seventy percent of its dry weight. Silica-forming proteins, called silicateins, have been identified in the form of axial filaments in the spicules. By taking the genes of these silicateins, mutant libraries have been created. The overall project goal is to evolve silicateins in order to isolate functional, mutant biomineralizing enzymes with novel properties using recombinant biotechnology strategies. Before this goal can be met, gene templates for *in vitro* protein expression must be created using standard molecular biology approaches. Through the use of PCR-based methods, restriction digestion, and ligation reactions, this goal can be accomplished.

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### Geoffrey's Project Page - RISE Summer 2006



Intern: Geoffrey Leonard, Chemical Engineering,  
 University of Virginia  
 Mentor: Ryan Snyder  
 Faculty Supervisor: Michael Doherty  
 Department: Chemical Engineering

#### AN INVESTIGATION INTO THE SOLUBILITY, ENTHALPIC, AND METASTABLE ZONE WIDTH, ALTERNATIONS FOR $\omega$ -ALKANEDICARBOXYLIC ACIDS

In many molecular systems with carbon chains, physical properties alternate, namely the melting point, density, solubility, and enthalpies of solution, based upon whether the molecule has an even or odd number of carbon atoms. For the  $\omega$ -Alkanedicarboxylic acid series, the even numbered species have characteristically greater melting points and densities; this alternation results from a consonance between torsional straining and non-ideal packing effects when the odd numbered species crystallise. The objective of this study was to investigate whether alternation developed in the phase transition properties of solubilities (in water and in amphiphilic solvents), enthalpies of solution, and meta-stable zone widths. The solvophobic effects of water produced the lowest solubilities, and the solvent molecules capable of multi-faceted H-bonding yielded the greatest solubilities. In all solvents the solubilities displayed two dominant trends: the odd acids solvated more readily and both the even and odd acids' solubilities monotonically decreased as the chain length increased. Enthalpies of solutions were determined from the solubility data, and this property too displayed an alternative trend that reconciled with known enthalpies of fusion. Metastable zone width measurements (using the polythermal method) characterised the thermodynamic driving force for nucleation, the  $\omega$ -factor, and across the series, the  $\omega$ -values increased and displayed an alternation – odd species had systematically lower values.

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### Matthew's Project Page - RISE Summer 2006



Intern: Matthew Menyo, Materials Science and Engineering, Pennsylvania State University  
Mentor: Brandon Heiken  
Faculty Supervisor: Dan Morse  
Department: Molecular, Cellular, and Developmental Biology

#### LOW TEMPERATURE SYNTHESIS OF TITANIA THIN FILMS FOR PHOTOVOLTAIC CELLS

Anatase titania thin films with thickness of 1-3 microns and large areas ( $\sim 2 \text{ cm}^2$ ) were synthesized at low temperature through a kinetically controlled vapor-diffusion method. The diffusion of ammonia as a base catalyst into a 50 millimolar precursor solution yielded free standing titania films. The films were rinsed and filtered, then characterized using X-ray powder diffraction, X-ray photoelectron spectroscopy, IR and RAMAN spectroscopy, and scanning electron microscopy. Anatase nanocrystals were found in films grown at temperatures as low as  $50^\circ\text{C}$  and after reaction times as short as 20 hours. This temperature is much lower than many other techniques currently used for the production of anatase titania films. Film growth has also been recorded on substrates (glass cover slides and ITO) suspended by tape on the surface of the precursor/air interface. These films exhibit greater crystallinity than freestanding films grown under identical conditions, perhaps because the substrate provides a surface for nucleation to take place. Uses in polymer photovoltaics, dye-sensitized solar cells (DSSCs), photocatalysis, and hydrogen sensing are being explored as commercial applications for this low temperature route to crystalline titania.

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**Amy's Project Page - RISE Summer 2006**

Intern: Amy Nabel, Chemistry, UC Santa Barbara

Mentor: Jimmy O'Dea

Faculty Supervisor: Steven Buratto

Department: Chemistry and Biochemistry

**RECAST NAFION-SILICA POLYMER COMPOSITES FOR FUEL CELL APPLICATION**

Fuel cells are an attractive alternative to the combustion of fossil fuels for energy production. Most current proton exchange membrane (PEM) fuel cells use the polymer Nafion as the fuel cell electrolyte. While Nafion has the advantages of being a strong proton conductor and having good mechanical stability, it depends strongly on the presence of water to conduct protons, limiting the humidity and temperature at which the fuel cell can be run. Current research is being done to recast Nafion and inorganic-Nafion composite membranes from solution in order to increase proton conductivity and allow the membrane to be used at lower humidities and higher temperatures.

A variety of Nafion and composite Nafion-silica polymer membranes were prepared by recasting from solution. Properties of the membranes were characterized with the use of thermogravimetric analysis and a PEM fuel cell. Using these methods, water content and potential voltages were found for certain recast membranes. Water content increased with the addition of silica to the recast membrane. There were no significant changes in water content between commercially available Nafion membranes and the non-composite recast membranes. Nafion membranes recast from water-based solution had higher potential voltages than commercially available Nafion of comparable thickness.

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### Rodolfo's Project Page - RISE Summer 2006

Intern: Rodolfo Neuber, Computer Engineering, UC  
Santa Barbara

Mentor: Tim Sherwood

Faculty Supervisor: Tim Sherwood

Department: Computer Science

#### BUILDING A RANGE ADAPTIVE PROFILING PROCESSOR

Current methods of programming analysis are limited to value-prediction, code optimization, and behavioral analysis, among other things; however, very little analysis focuses on identifying performance bottlenecks. Earlier this year, a new method of programming analysis was created to indicate where a program text can be modified to directly increase its performance and possibly remove bottlenecks. This new method of analysis profiles entire sections of the program text's assembly code by keeping track of how many times an instruction within those sections has been executed. The profiling works by grouping less frequently executed instructions into larger sections, and by separating more frequently executed instructions into smaller sections. Currently this analysis is implemented in software and is limited to analyzing files after a program has been executed. This paper details how this new method of programming analysis can be implemented as a processor using a Field Programmable Gate Array (FPGA). To ensure that the processor design is accurate, a comparison of its ability to profile will be made against its software counterpart. Results of the profiling will also show that the processor can handle the profiling in real time without using resources on the machine. Nafion membranes recast from water-based solution had higher potential voltages than commercially available Nafion of comparable thickness.

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### Andrew's Project Page - RISE Summer 2006



Intern: Andrew Robertson, Chemistry Lake Superior  
State University  
Mentor: Jerry Macala  
Faculty Supervisor: Peter Ford  
Department: Chemistry and Biochemistry

#### HOMOGENOUS CATALYTIC CONVERSION OF BIOMASS INTO HYDROGEN

Currently, hydrogen gas is predominantly created from the break down of fossil fuels and other long chain hydrocarbons. The availability of fossil fuels is diminishing thus a new technique for production of  $H_2$  is needed. One such technique is the water gas shift reaction. By combining  $H_2O$  and  $CO$ , under the correct conditions,  $H_2$  and  $CO_2$  gases can be produced. When reacted in the presence of a catalyst, the activation energy is lowered pushing the reaction towards the products. Bio-molecules such as glucose can be effectively broken down into  $CO$  in the presence of base. This  $CO$  is then utilized in the Water Gas Shift Reaction in the presence of water and a catalytic species thus producing  $H_2$ . The research mainly investigates the efficiency of several Ruthenium and Rhodium carbonyls and chlorides as the catalytic species. The main purpose of this investigation is to determine varying conditions in which a high production yield of  $H_2$  is achieved. As well, research into determining an accurate catalytic mechanism is being conducted.

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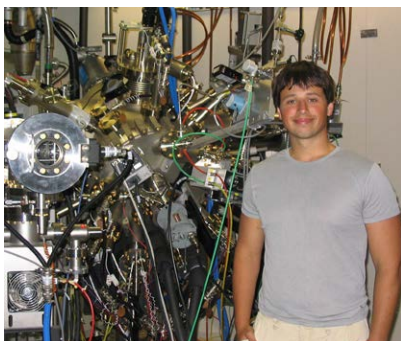
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### Adam's Project Page - RISE Summer 2006



Intern: Adam Schaller, Materials Science and  
Engineering, Michigan Technological University  
Mentor: Christy Poblenz  
Faculty Supervisor: James Speck  
Department: Materials

#### CHARACTERIZATION OF BULK GaN AND AlGaN/GaN HETEROSTRUCTURES GROWN BY MOLECULAR BEAM EPITAXY

Peerless long-range communication via cell phone or other device requires a high frequency signal. To achieve these frequencies transistors must be manufactured to operate under high power, high temperature conditions. The demand for high performance transistors requires increasingly specialized materials. GaN and its alloys with AlN provide a large band-gap material for such applications. Typical band-gap values for semiconductors range from 0.360eV to 2.170eV whereas GaN has a band-gap of 3.4eV. To grow a GaN/AlGaN heterostructure with favorable electrical characteristics a developed understanding of how physical properties affect electrical properties is necessary. Dislocation density, surface morphology, growth conditions, and impurities play an important role in the device quality. To observe these qualities, in-situ and post growth characterization was employed. During growth, reflective high energy electron diffraction was used to qualitatively determine the thickness of the Ga and AlGa on the surface of the substrate. Post growth atomic force microscopy (AFM) revealed varying surface morphologies as the III/V ratio changed during growth. The hall test was utilized to compare the charge density and electron mobility of the heterostructures to their surface morphologies. A relationship between electrical properties and growth conditions was established with the combined hall and AFM data.

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### Robert's Project Page - RISE Summer 2006



Intern: Robert Stuart, Mechanical Engineering, UC Santa Barbara  
 Mentor: Kendra Grant  
 Faculty Supervisor: Carlos Levi  
 Department: Materials

#### CALCIUM-MAGNESIUM ALUMINO-SILICATE ATTACK ON ENVIRONMENTAL BARRIER COATINGS

Environmental barrier coatings (EBCs) have the intended use of protecting ceramic matrix composites (CMCs) in use in jet turbines from atmospheric water vapor. CMCs are advantageous for use in jet turbines because of their light weight and high operating temperatures. But without an EBC, CMCs interact with water vapor at high temperatures and pressures, causing sublimation. There is cause for concern that silicate particulate matter in the environment (CMAS) will melt onto the EBCs and cause delamination, compromising coating integrity. Initial results from experiments involving CMAS melts on two prospective EBCs (barium-strontium alumino-silicate, BSAS, and yttria silicate,  $Y_2SiO_5$ ) have shown there has been significant chemical attack of CMAS on the EBC. These results have been found by use of scanning electron microscope (SEM) analysis as well as energy dispersive X-ray (EDX) analysis. A consistent composition of the particulate matter testing substance, CMAS, was investigated. The application of CMAS onto EBC samples has been revised from its original tape form into pellet form. Difficulties of sample EBC production were overcome by changing to alternate production methods. The initial results are expected to be fully verified in the near future but early analysis suggests that the results have been replicated.

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### Holly's Project Page - RISE Summer 2006



Intern: Holly Szumila, Aerospace Engineering and Space Physics, Embry-Riddle Aeronautical University  
 Mentor: Jun Li  
 Faculty Supervisor: Ram Seshadri  
 Department: Materials

#### SYNTHESIS AND CHARACTERIZATION OF NANOSTRUCTURED METAL CARBIDE CATALYSTS FOR THE HYDROGEN ECONOMY

To seek better fuel sources that are renewable and environmentally friendly is a growing concern and has led to a focus on the hydrogen economy. To use hydrogen, the water-gas shift and fuel reforming processes are considered. Current catalysts used are based on the platinum group metals (PGMs). Better catalysts must be found. Non-PGM transition metal carbides for catalysis are found to have similar reactivity as the PGMs. The transition metal carbides are inexpensive, have greater resistance to coking and poisoning, and possess greater thermal stability than the PGMs. Previous research reports on the high activity of  $\text{Mo}_2\text{C}$  and WC from steam reforming of methane as potential catalysts. The transition metal carbides possess great catalytic properties but poor surface area and catalytic deactivation by conversion to oxides. Our research objective is to synthesize nanostructured metal carbides with the desired phase, surface composition, and surface area. We are successful in synthesizing nanostructured, porous  $\text{Mo}_2\text{C}$  and WC. Characterization of the material using X-ray diffraction, scanning electron microscopy, X-ray photoelectron spectroscopy, and BET surface area analysis is performed in laboratory investigations. The surface morphologies are promising for catalysis, and we now examine whether the morphologies are retained after subjection subject to catalytic conditions.

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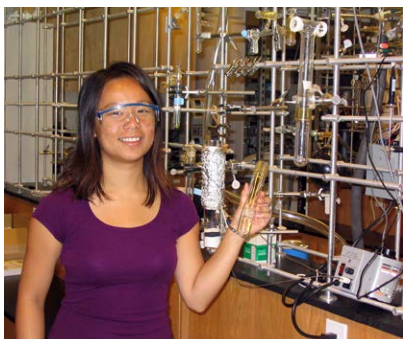
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### Sara's Project Page - RISE Summer 2006



Intern: Sara Thoi, Chemistry, UC San Diego

Mentor: Brian Vicente

Faculty Supervisor: Susannah Scott

Department: Chemical Engineering

#### TANDEM ALKANE DEHYDROGENATION-OLEFIN METATHESIS VIA THE USE OF IRIDIUM-BASED Pincer COMPLEX AND METHYLTRIOXORHENIUM

The combination of an iridium-based pincer complex (IrPOCOP, a selective alkane dehydrogenation catalyst) and methyltrioxorhenium (MTO) grafted onto alumina or silica-alumina (an olefin-metathesis catalyst) has been shown to perform alkane metathesis. We studied the roles of both catalyst components in an effort to improve the productivity and selectivity of the alkane metathesis reaction. The interaction of the iridium complex with alumina was studied by  $^{31}\text{P}$  solid-state NMR. Hexamethyldisilazane (HMDS) treatment of silica-alumina was performed at  $250^\circ\text{C}$  in order to remove all accessible hydroxyl groups, as confirmed by IR spectroscopy. Methyltrioxorhenium grafted onto a heterogeneous alkane dehydrogenation catalyst,  $\text{Pt}/\text{Al}_2\text{O}_3$ , was also shown to perform olefin, and possible alkane, metathesis.

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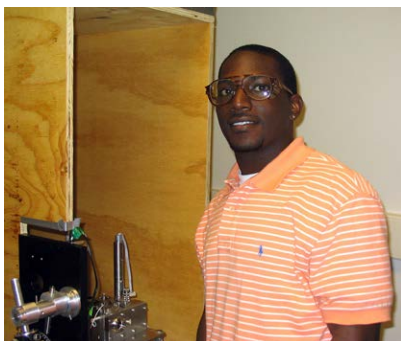
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### Joshua's Project Page - RISE Summer 2006



Intern: Joshua Walker, Chemistry, Jackson State University

Mentor: Wren Greene

Faculty Supervisor: Jacon Israelachvili

Department: Chemical Engineering

THE DISSOLUTION OF QUARTZ BY MUSCOVITE MICA THE PHENOMENA OF PRESSURE SOLUTION: SFA TECHNIQUE

Pressure solution encompasses such phenomena as pitting and indentation at grain contacts, stylolite formation, overgrowths, dissolution seams, cleavages, and deformation of metamorphic rocks. Laboratory and Geological field studies find that the presence of clays, particularly muscovite mica, enhances quartz dissolution when in contact. The mystery at hand is how mica a soft rock, dissolves quartz, which is a hard rock. In the research presented here, we directly investigate the dissolution of quartz in contact with mica. In calcium chloride dissolution is observed even at relatively low pressures while in the absence of solution, no dissolution is observed. Using the surface forces apparatus, we are able to directly observe dissolution several nanometers of quartz over timescales of minutes to hours, allowing us to follow the changing rate of dissolution with time. We will attempt to apply electric fields to the surfaces to see the effect on the dissolution of quartz. We will also attempt to measure the electric field when mica and quartz comes together.

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**Antonio's Project Page - RISE Summer 2006**Intern: Antonio Woods, Chemistry, Jackson State  
University

Mentor: Janice Hong

Faculty Supervisor: Guillermo Bazan

Department: Chemistry and Biochemistry

**SYNTHESIS OF CONJUGATED POLYMERS FOR APPLICATIONS IN DNA DETECTION**

The detection of small quantities of biological targets has always imposed limitations on research and diagnostics. Currently, tests for the presence of DNA require that the DNA be amplified or grown in order to identify a specific target. In poorer countries, it is the cost of diagnosis and the time required to diagnose, not the therapeutic drugs, which often prevents treatment. Accuracy, selectivity, and repeatability have hindered the majority of current biosensors that have been proposed to resolve this diagnostic problem. In the research presented here, the Bazan lab has proposed a biosensor so sensitive and repeatable that the costly DNA amplification can be reduced and perhaps eliminated. The sequence-specific biosensor presented uses technology based on fluorescence resonance energy transfer (FRET) between cationic conjugated polymers (CCPs) and fluorescent dye-labeled peptide nucleic acid (PNA) probes, which are synthetic analogues of DNA with a charge-neutral and peptide backbone. The CCPs binds to the DNA then it uses its light harvesting properties to transfer energy to amplify the signal of the dye when close enough, the PNA probes selectively identify DNA when complementary, and the fluorescent dye is an indicator which informs if the PNA is complementary or non-complementary.

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