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Research Internships in Science and Engineering

Research Interns in Science and Engineering (RISE)
Summer 2004 - Student Projects

Student Major/School	Mentor	Faculty Sponsor	Department	Student Project
Ashwini Ashokkumar Chemical Engineering UCSB	Sumit Paliwal	Samir Mitragotri	Chemical Engineering	Ultrasound assisted chemotherapy
Ryan Birringer Materials Science University of Wisconsin Madison	Andrei Kolmakov	Martin Moskovits	Chemistry	Reactor cell for in situ spectroscopy of metal oxide FET configured nanostructures
Lia Bregante Mechanical Engineering UCSB	Sean Keane	Susanne Stemmer	Materials	The effect of microstructure on electrical properties of Strontium Titanate thin films
Ariel Brumbaugh Biochemistry University of Washington	Jason Sagert	Herbert Waite	Molecular Cell Developmental Biology	Secondary structure analysis of a prominent protein in mussel byssal threads
Nicholas Burgan-Illig Computer Systems Engineering UMass-Amherst	Ramesh Rajaduray	Daniel Blumenthal	Electrical and Computer Engineering	Opticalburst switching networks with forward resource reservation
Solome Girma Mechanical Engineering SUNY at Stony Brook	Tobias Schaedler	Carlos Levi	Materials	Metastable phase evolution in $YO_{1.5}$-TIO_2-ZRO_2
Micah Hall Electrical Engineering University of Tennessee Knoxville	K. Ramesha	Ram Seshadri	Materials	Computational investigation into determining the electronic structure characteristics of the Perovskite material $RMNO_3$ (R=La AND Y)
Gretchen Keller Chemistry UCSB	Janice Hong	Guillermo Bazan	Chemistry	Multicolor biosensors based on conjugated

				copolymers
Jacob Koskimaki Biomedical Engineering Economics University of Utah	Emin Oroudjev	Helen Hansma	Physics	Comparative force spectroscopy of gluten: How nonpolar amino acid side chains contribute to the protein's visoelastic nature
Courtney Krause Chemistry University of Washington	Dwight Seferos	Guillermo Bazan	Chemistry	Self-Assembling monolayers featuring quantum dots
Grace Lee Electrical Engineering UCSB	Hisashi Masui	Steven DenBaars	Materials ECE	Package Techniques on ultraviolet light emitting diodes
Zhi Liang Electrical Engineering UCSC	M. Sushchikh	E. McFarland	Chemical Engineering	Infrared spectroscopy setup for studying heterogeneous catalytic reaction under controlled temperature and pressure
Scott Montgomery Biochemistry UCSB	Martin Sagermann	Martin Sagermann	Chemistry and Biochemistry	Purification of a truncated H-subunit of VMA13P, a V-type atpase
Rose Nguyen Chemical Engineering UCSB	Alex Chu-Kung	Matthew Tirrell	Chemical Engineering	Effects of self-assembly on peptide antimacrobial activity
Matthew Pearlson Chemical Engineering UMass-Amherst	Thomas Jaramillo	Eric McFarland	Chemical Engineering	Cu_2O-ZnO thin-film heterojunction for photoelectrochemical water splitting
Christopher Picardo Computer Engineering University of Notre Dame	Ryan Kastner, Tim Sherwood	Ryan Kastner, Tim Sherwood	Electrical and Computer Engineering Computer Science	Quantifying reconfigurable computing systems
Lauren Snedeker Materials Science and Engineering Michigan Technological University	Aditi Risbud	Ram Seshadri	Materials	Synthesis of CoZnO as a potential transparent dilute magnetic semiconductor material

Matthew Stabile Electrical Engineering UCSB	Benjamin Haskell	Shuji Nakamura	Materials	Growth of low-defect density nonpolar Gallium Nitride by hydride vipor phase epitaxy
Xuan-An Troung Biochemical and Molecular Biology Contra Costa College	Tuan Dinh	Samir Mitragotri	Chemical Engineering	Intercellular transport processes
Siyan Zhang Chemical Engineering UCSB	Ju Chou	Rric McFarland	Chemical Engineering	Coupling reaction of propylene catalyzed by pure Pd nanoclusters

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Ashwini's Project Page - RISE summer 2004

Intern: Ashwini Ashokkumar, UCSB
Mentor: Sumit Paliwal
Faculty Supervisor: Samir Mitragotri
Department: Chemical Engineering

ULTRASOUND ASSISTED CHEMOTHERAPY

Brain cancer is a difficult type of cancer to treat, with very few alternatives available for treatment. Our current research shows that a short application of low-frequency ultrasound selectively sensitizes prostate and skin cancer cells against a bioflavonoid, quercetin. Moreover, ultrasound has been shown to enhance transport of several drugs across biological membranes including skin and cell membranes. Therefore ultrasound can be used an attractive non-invasive localized treatment technique for brain cancer assisted by chemotherapy. Our current work focuses on studying permeability enhancement of brain tissue using ultrasound. Pig brain is used as the brain tissue model. A custom made franz diffusion cell with ultrasound transducer fitted on the donor side is used for studying transport of radio-labeled drug mannitol. Both high frequency (1 MHz) and low-frequency (79 kHz) transducers are used in the study. Initial experiments with high frequency ultrasound demonstrate that ultrasound enhances the permeability of mannitol up to 1.5-12 times over a period of 3-6 hours. Our experiments show that these enhancements are independent of ultrasonic thermal effects. Since low frequency ultrasound primarily works through mechanical effects, we expect even higher enhancements.

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Ryan's Project Page - RISE summer 2004

Intern: Ryan Birringer,
University of Wisconsin - Madison
Mentor: Andrei Kolmakov
Faculty Supervisor: Martin Moskovits
Department: Chemistry

REACTOR CELL FOR IN SITU SPECTROSCOPY OF METAL OXIDE FET CONFIGURED NANOSTRUCTURES

Metal oxide nanowires configured as field effect transistors can be used as gas sensors to detect changes in the surrounding environment. These transistors can also be used to catalyze certain gas phase reactions. FET nanostructures are good candidates for gas sensors because their high surface area to volume ratio means that the bulk electrical properties are very dependent on reactions occurring at the surface. For instance, oxygen atoms attach to the surface of the nanowire when it is contained in an oxidizing environment. This binding of oxygen atoms to the surface creates a depleted zone. This depleted zone is on the same order of magnitude as the size of the wire itself, resulting in a large increase in wire's electrical resistance. The goal of this project is to create a small reaction cell that will allow for in situ conductance and spectroscopic measurements of these metal oxide FET nanostructures in variable gaseous environments. Through in situ conductance and Raman Spectroscopy measurements, the author hopes to formulate a better understanding of how different surface reactions affect the electrical properties of these FET nanostructures.

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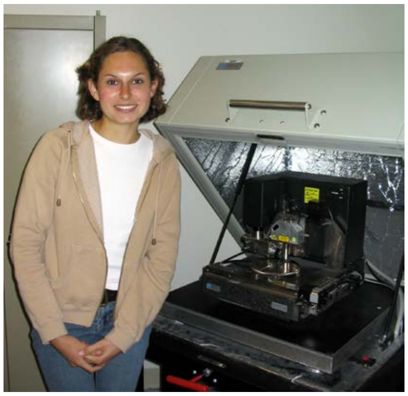
Lia's Project Page - RISE summer 2004



Intern: Lia Bregante, UCSB
Mentor: Sean Keane
Faculty Supervisor: Susanne Stemmer
Department: Materials

THE EFFECT OF MICROSTRUCTURE ON THE ELECTRICAL PROPERTIES OF STRONTIUM TITANATE THIN FILMS

As a prototype, incipient ferroelectric material having a perovskite structure and exhibiting a nonlinear, electric field tunable dielectric constant at very low temperatures, SrTiO3 has potential applications in tunable microwave devices that must operate at such temperatures. When thin films of SrTiO3 are deposited by rf sputtering on epitaxial Pt, their microstructure is seen to vary with the growth temperature and length of annealing time of the Pt. A second sputtered film itself, the Pt is grown on a sapphire (Al2O3) substrate and is used in this case as a bottom electrode, as is commonly done in ferroelectric devices and integrated capacitors because of its known chemical stability and high conductivity. Atomic force microscopy (AFM) allowed for the examination of the microstructures of both the Pt and SrTiO3 thin films. More specifically, analysis of RMS surface roughness, average grain size, and grain orientation yielded data that provided insight into the relationship between the microstructures of the two materials, and the effect of microstructure on the dielectric properties of the SrTiO3 thin films.

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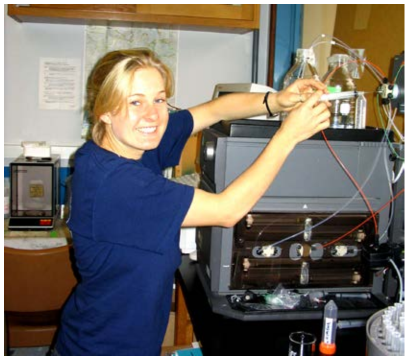
Ariel's Project Page - RISE summer 2004



Intern: Ariel Brumbaugh, University of Washington
Mentor: Jason Sagert
Faculty Supervisor: Herbert Waite
Department: Molecular Cellular and Developmental Biology

SECONDARY STRUCTURE ANALYSIS OF A PROMINENT PROTEIN IN MUSSEL BYSSAL THREADS

As Marine mussels thrive attached to substrates along rocky intertidal seashores where water velocities can reach as high as ten meters per second. A key adaptation in the mussels' survival in this high-energy environment is their proteinacous holdfast known as the byssus. The byssus is a collection of protein-rich threads which are excreted by the mussel and have a unique combination of mechanical properties which have yet to be replicated in any man-made material. Some of those properties include: a high toughness, a large stiffness gradient (ranging from rubber at one end of the fiber to nylon at the other) and the ability to 'self-heal' after deformation. Through understanding the proteins that function in the byssus, synthetic materials could be designed to mimic the desired mechanical properties and therefore impact such ranging fields from dentistry to cross-ocean shipping. A novel 56 kDa protein has been purified and partially characterized and a portion of this protein has been recombinantly expressed for analysis of secondary structure using circular dichroism and light scattering techniques.

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Nick's Project Page - RISE summer 2004

Intern: Nicholas Burgan-Illig, UMass-Amherst
Mentor: Ramesh Rajaduray
Faculty Supervisor: Daniel Blumenthal
Department: ECE

OPTICAL BURST SWITCHING NETWORKS WITH FORWARD RESOURCE RESERVATION

Optical Burst Switching (OBS) has been proposed as a technique to enable all-optical networks of the future. Data packets are assembled into bursts and then disassembled after being switched through the optical network. Traditional optical networks utilize Optical-Electric-Optical (OEO) translation at each switch. With OBS, packets are kept entirely in the optical domain. This greatly reduces latency and increases the speed of the network. Forward Resource Reservation (FRR) has been proposed as a technique to help reduce latency even further. Resources are reserved in advance to avoid contention with other bursts, thereby reducing the probability of burst loss. To reserve resources, prediction of the burst size and delay is necessary. One prediction technique is to measure burst size and delays under different input traffic conditions. Once the conditions are known, it is possible to retrieve data for these conditions and make predictions for resource reservation. Data from simulations of varying input traffic conditions have been analyzed to create this summary data. It is also necessary to create a dedicated FRR signaling system for network implementation. Programs in C++ have been created to enable such a system, involving two interlinking queues communicating over a channel to request and process resource requests.

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Solome's Project Page - RISE summer 2004

Intern: Solome Girma, SUNY at Stony Brook
Mentor: Tobias Schaedler
Faculty Supervisor: Carlos Levi
Department: Materials

METASTABLE PHASE EVOLUTION IN YO 1.5 - TIO2 - ZRO2

Sandwiched between the anode and the cathode, solid oxide fuel cells (SOFC) rely upon a thin layer of an oxygen ion conducting electrolyte, conventionally Yittria stabilized Zirconia (YSZ). This translates into the ability to convert energy at high temperatures (800°C -1,000°C) in a very efficient and environmentally friendly way. In order to improve SOFC, new electrolyte materials have to be developed that exhibit higher ionic conductivity at lower temperatures. This research focuses on the evolution of metastable phases over a wide range of compositions centered about the pyrochlore phase in the TiO2 – YO3/2 – ZrO2 phase diagram. In addition, the effects of different phases and compositions on the ionic conductivity are studied. Precursor methods have been used to make powders of selected compositions, which are then pyrolysed and progressively heat-treated at higher temperatures until equilibrium at 1300°C is reached. The phases present and their microstructure are studied by X-ray diffraction and transition electron microscopy.

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Micah's Project Page - RISE summer 2004

Intern: Micah Hall, University Tennessee-Knoxville
Mentor: K. Ramesha
Faculty Supervisor: Ram Seshadri
Department: MRL

COMPUTATIONAL INVESTIGATION INTO DETERMINING THE ELECTRONIC STRUCTURE CHARACTERISTICS OF THE PEROVSKITE MATERIAL RMNO3

Curiosity in the properties of the giant magnetoresistant (GMR) perovskite material RMnO3 (R = La or Y) basically arisen from the fact that in these particular structures, there is a type of structural distortion and asymmetry with the bond lengths and angles within the MnO6 octahedra. Preliminary observations of this phenomenon have shown that this anomaly is due to a Jahn-Teller (J-T) distortion of the orbital arrangement within MnO6. To further explore this phenomenon, a series of computational calculation were performed. These calculations can accurately generate diagrams called the density of states diagram and electronic band diagrams. After obtaining a representation of the up and down spin orientations of the electrons for the materials LaMnO3 and YMnO3 with the density of states diagram, it clearly demonstrates that these materials have magnetic properties and similar structural characteristics. For the electronic band diagrams, emphasis was centered on the orbital region dz2 because of the distortion of the orbitals in the z-direction. After evaluating these diagrams, both of the materials reflected having properties of a semiconductor and it can be seen that the width of the bands in YMnO3 is slightly less than for LaMnO3 resulting in the larger J-T distortion.

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Gretchen's Project Page - RISE summer 2004

Intern: Gretchen Keller, UCSB
Mentor: Janice Hong
Faculty Supervisor: Guillermo Bazan
Department: Chemistry

MULTICOLOR BIOSENSORS BASED ON CONJUGATED COPOLYMERS

The Bazan group has developed a multicolor biosensor for the detection of sequence-specific oligomeric DNA. The polymer polyfluorene phenylene cobenzothiadiazole (PFPB) is primarily blue-emitting, but contains a lower energy green-emitting site. Energy transfer to the green occurs only with complexation to another polyelectrolyte and can thus be used to detect the presence of DNA. If DNA labeled with a red-emitting dye is introduced and is complimentary to the unlabeled strand then further energy transfer occurs and red emission is observed. The following research was conducted in an effort to evaluate the utility of this type of sensor. Primary interest lies in the dependence of energy transfer efficiency on factors including DNA length, pH of solution, and the presence or absence of non-specific electrolytes and polyelectrolytes.

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Jacob's Project Page - RISE summer 2004

Intern: Jacob Koskimaki, University of Utah
Mentor: Emin Oroudjev
Faculty Supervisor: Helen Hansma
Department: Physics

COMPARATIVE FORCE SPECTROSCOPY OF GLUTEN: HOW NONPOLAR AMINO ACID SIDE CHAINS CONTRIBUTE TO THE PROTEIN'S VISCOELASTIC NATURE

Gluten, a wheat storage protein fraction, is composed of subfractions including glutenins and gliadins. These proteins contain significant amounts of nonpolar amino acids, and are not readily dissolved in water due to their hydrophobic nature. It has been found that a number of of these subproteins are organized into a cross-linked network through the interaction of disulfide bonds. Yet despite significant research efforts, the structural organization of individual proteins and the corresponding network they form is still largely unknown. Atomic force spectroscopy has proven to be one of the best methods of choice for studying the physical and mechanical properties of single molecules, and their organization in corresponding mesostructures. This technique can help deduce how the largely nonpolar amino acid side chains of gluten contribute to its viscoelastic nature. Understanding the protein's viscoelasticity is important for the utilization of wheat gluten in the food industry and some technical applications.

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Courtney's Project Page - RISE summer 2004

Intern: Courtney Krause, University of Washington
Mentor: Dwight Seferos
Faculty Supervisor: Guillermo Bazan
Department: Chemistry

SELF-ASSEMBLING MONOLAYERS FEATURING QUANTUM DOTS

As electronics have grown smaller, it has become increasingly important to discover new technologies, which will shrink components, lower power requirements and reduce heat production. Currently data is stored in electrons, however, in the future data may be stored in electron spin. It has been shown that Cadmium-Selenide (CdSe) quantum dots connected by conjugated organic molecules are able to transfer spin from one dot to another. This system is created using self-assembling monolayers. Glass slides are functionalized with either an amine or thiol group; the functional groups then bind to quantum dots, creating a monolayer. After the initial layer is in place, organic molecules are introduced to the surface followed by an additional layer of quantum dots – this process can be repeated to add more layers. UV/Vis and atomic force microscopy are used to characterize the thickness and uniformity of each layer's surface. Characterization of the layers will allow for improved design and streamlined production for future researchers.

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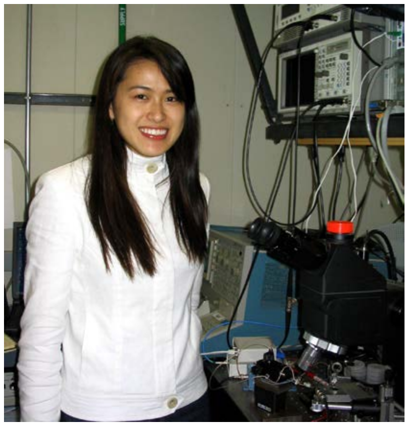

Intern: Grace Lee, UCSB
Mentor: Hisashi Masui
Faculty Supervisor: Steven DenBaars
Department: Materials ans ECE

PACKAGE TECHNIQUES ON ULTRAVIOLET LIGHT EMITTING DIODES

Emerging developments of GaN-based light emitting diode (LED) have attracted considerable attention for practical application of solid-state lighting. Materials and techniques utilized in packaging optical devices play an important role in determining their performance. Currently, there is little understanding of packaging methods employed in technologically relevant LEDs will influence efficiency. In particular, ultraviolet (UV) LEDs on silicon carbide substrate fabricated with metal organic chemical vapor deposition (MOCVD) are investigated. The intent of this study is to ensure the consistency of UV LED performance by optimization of packaging techniques. Measurements of electrical and optical characteristics will be evaluated on unpackaged and packaged devices. Packaging procedure is accomplished through device die separation, sub-mount die attachment, contact wire bonding, and encapsulation methods. Surface characterization techniques, such as Atomic Force Microcopy (AFM) and Nomarski Microscope, will be employed to determine the adhesion in resulting wire-bonding contacts. Trends in performance associated with various packaging techniques will be reported.

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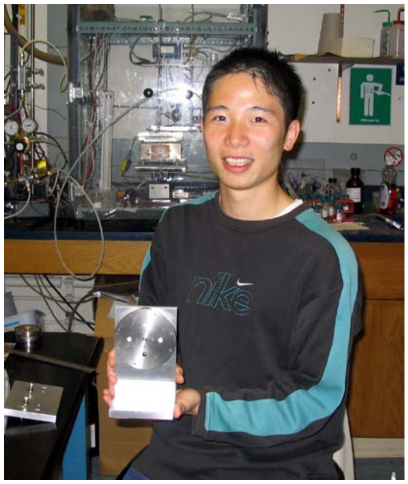

Intern: Zhi Liang, UCSC
Mentor: M. Sushchikh
Faculty Supervisor: E. Mcfarland
Department: Chemical Engineering

INFRARED SPECTROSCOPY SETUP FOR STUDYING HETEROGENEOUS CATALYTIC REACTION UNDER CONTROLLED TEMPERATURE AND PRESSURE

Fourier Transform Infrared (FTIR) spectroscopy is a well-recognized tool for investigating material structure as well as catalytic reactivity. As FTIR spectrometers are generally not configured to study thin films, a multi-sample accessory for the analysis of thin films has been designed, built and tested. Films of C-60 derivatives synthesized by electrochemical deposition were characterized by FTIR using the multi-sample accessory. Despite decades of research, many questions persist regarding the mechanism of low-temperature carbon monoxide oxidation. For the study of powder catalysts, a reaction chamber has been designed and built into the sample compartment of the FTIR spectrometer. The chamber can be operated at low-pressures, a wide range of temperatures, and features a gas flow design that emulates a packed bed reactor.

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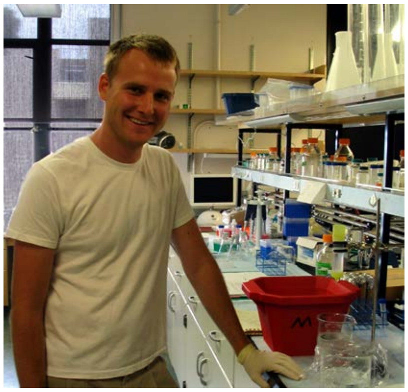
Scott's Project Page - RISE summer 2004



Intern: Scott Montgomery, University of Washington
Mentor: Martin Sagermann
Faculty Supervisor: Martin Sagermann
Department: Chemistry and Biochemistry

PURIFICATION OF A TRUNCATED H-SUBUNIT OF VMA13P, A V-TYPE ATPASE

The V-type ATPases use ATP to actively transport protons into organelles and extracellular compartments. The H-subunit, or Vma13p, is a 478 amino acid protein that plays an essential regulatory role in V-type ATPase activity. Previous crystallization studies of the Saccharomyces cerevisiae H-subunit have revealed potential binding regions for the ATPase and other macromolecules. In this study, a truncated version of the H-subunit, lacking the C-terminal domain, has been recombinantly overexpressed in Escherichia coli and purified. The subunit is currently undergoing crystallization trials using the hanging-drop vapor-diffusion method. Additionally, preliminary yeast pull down experiments using both the wild type and truncated subunits suggest a number of potential proteins that may interact with the H-subunit, including other V-type ATPase proteins.

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Rose's Project Page - RISE summer 2004

Intern: Rose Nguyen, UCSB
Mentor: Alex Chu-Kung
Faculty Supervisor: Matthew Tirrell
Department: Chemical Engineering

EFFECTS OF SELF-ASSEMBLY ON PEPTIDE ANTIMICROBIAL ACTIVITY

It has been found that some naturally occurring peptides are bactericidal towards a broad spectrum of bacteria, including many drug resistant strains. These antimicrobial peptides operate by a novel mechanism, the permeabilization of bacterial cell membranes. As a result, it is difficult for bacteria to develop resistance towards these peptides since resistance would require restructuring its cell wall. To do this the cell must evolve drastically, which is highly unlikely. One strategy used to affect peptide properties is conjugation of the peptide to saturated hydrocarbon chains. Doing this changes various properties of the peptide including hydrophobicity and creates an amphiphilic peptide conjugate, called a peptide amphiphile. Peptide amphiphiles with lipid-like tails have been shown to form vesicles. Peptide functionalized vesicles allow us to study the effect of peptide orientation and assembly on antimicrobial activity. By modifying various factors, such as size, shape, and composition, a relationship between the effects of solution self-assembly of peptides and their relationship to antimicrobial activity can be achieved. Antimicrobial peptides are being considered as a drug candidate for the future. This can open new doors on how drugs are made, and possibly create a new form of drug delivery.

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Matt's Project Page - RISE summer 2004

Intern: Matthew Pearlson, UMass-Amherst
Mentor: Thomas Jaramillo
Faculty Supervisor: Eric McFarland
Department: Chemical Engineering

Cu2O-ZnO THIN-FILM HETEROJUNCTION FOR PHOTOELECTROCHEMICAL WATER SPLITTING

Hydrogen energy can be produced cleanly and renewably by solar photoelectrochemical water-splitting. This is accomplished with semiconducting materials that were first investigated for this application in the early 1970's. Regrettably, decades of research in this field has not developed a material that can produce hydrogen cost-effectively. Efficient materials are expensive but often unstable. Robust materials are typically inexpensive, but demonstrate low efficiency. Nevertheless, recent works in heterojunction systems, devices that consist of two or more semiconductors, have shown promising results for improved photocatalytic activity and stability. This is the first report of a heterojunction comprised of Cu2O and ZnO investigated for this application. The heterojunction consists of Cu2O with a thin ZnO overlayer. Cu2O is an excellent absorber of solar radiation but a material which photocorrodes in solution. ZnO is transparent to visible light and is photo-cathodically stable – two factors which motivate its use as a protective layer to inhibit the corrosion of Cu2O. Synthesis of this photoelectrochemical system, as well as characterization using electrochemical methods along with standard microscopic and spectroscopic techniques, is discussed. Also to be presented are transition-metal nanoparticulate catalysts synthesized on the electrode surface in an effort to enhance surface electrocatalytic activity.

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Chris's Project Page - RISE summer 2004

Intern: Christopher Picardo, University Notre Dame
Mentors: Ryan Castner and Tim Sherwood
Faculty Supervisors: Ryan Kastner and Tim Sherwood
Department: ECE and Computer Science

QUANTIFYING RECONFIGURABLE COMPUTING SYSTEMS

In this paper we first provide a detailed description of common constraints present on modern FPGAs (i.e. memory size and distribution, chip architecture, bus width, broken components, etc.) Secondly, we show how to overcome these problems by means of trade-offs, which can help maintain or improve performance that allows the realization of robust computing systems. To achieve this goal we design a video game system on a NIOS II development board from Altera Corporation. Because the NIOS II board has at least one programmable microprocessor, a master clock, programmable memory, a JTAG programmer, I/O pins, standard expansion slots, and debugging tools like push buttons, switches and LED displays, our system architecture (i.e. video game system architecture) uses these FPGA components to design a RISC microprocessor, a data-path and controller, data memory, address memory, video memory, and input and output that connects to a VGA port and a game-pad controller. The goal is to make these components achieve system level integration. Furthermore, since the majority of image processing applications run faster on FPGAs than on general-purpose processors, it is our intention to use the development of this video game system as a learning tool where we can identify constraints, quantify resources and find solutions to problems that appear during design and implementation. The end result is a robust computing system.

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Lauren's Project Page - RISE summer 2004

Intern: Lauren Snedeker, Michigan Technology University
Mentor: Aditi Risbud
Faculty Supervisor: Ram Seshadri
Department: MRL

SYNTHESIS OF CoZnO AS A POTENTIAL TRANSPARENT DILUTE MAGNETIC SEMICONDUCTOR MATERIAL

Wide bandgap semiconductor materials like zinc oxide are useful for electronic devices and computer applications. These materials are transparent due to their wide bandgap (For ZnO, Eg= 3.3 eV). The wurtzite crystal structure plays an important role for a potential use as a dilute magnetic semiconductor. In the case of ZnO, the Zn^{2+} ions are substituted with Co^{2+} ions in order to create a potential dilute magnetic semiconductor. The synthesis of ZnO nanoparticles via thermal decomposition of zinc acetylacetonate, $[Zn(acac)_2]$ in benzyl ether solvent at 300°C forms ZnO nanoparticles 9 nm in diameter. Maintaining the wurtzite structure, nanoscale $Co_xZn_{1-x}O$ with x= 0.05, 0.01, and 0.15 are also examined using $Co(acac)_2$ and $Zn(acac)_2$ in the respective ratios. Bulk CoZnO materials in these ratios were investigated by Risbud, et. al, 2003. In addition, the synthesis of nano ZnO and CoZnO is studied from a bulk precursor of ZnO and CoZnO. Characterization of these materials is performed via X-ray diffraction, Transmission electron microscopy, and DC magnetization measurements /SQUID.

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Matthew's Project Page - RISE summer 2004

Intern: Matthew Stabile, UCSB
Mentor: Benjamin Haskell
Faculty Supervisor: Shuji Nakamura
Department: Materials

GROWTH OF LOW-DEFECT DENSITY NONPOLAR GALLIUM NITRIDE BY HYDRIDE VAPOR PHASE EPITAXY

Nonpolar (1100) m-plane gallium nitride has been found to grow heteroepitaxially on (100) γ-LiAlO2 by several groups. When grown by hydride vapor phase epitaxy (HVPE), previous attempts yielded gallium nitride films that were unsuitable for device regrowth due to unreasonably high defect densities on the surfaces. Our growth of nonpolar gallium nitride films on (100) γ-LiAlO2 by HVPE has eliminated these bulk and surface defects and produced a smooth enough surface morphology to allow for the fabrication of m-plane gallium nitride templates and free-standing substrates for subsequent nonpolar device regrowth. With the production of useful gallium nitride wafers now feasible, a more efficient HVPE crystal growth system must be implemented to allow an increase in wafer production. The new HVPE system will be computer-controlled by a monitoring and data acquisition program written on National Instruments¡¦ Labview 7.0. The program that I am designing will allow manual operation of the system, but most importantly will include automatic control scripts that will monitor the system state by continuously checking the status of various valves, pressure sensors, and thermocouples. The system will be kept stable through specified alarm and interlock conditions and will include an interpreter program for logging and analyzing growth data.

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Xuan An's Project Page - RISE summer 2004

Intern: Xuan An Truong, Contra Costa College
Mentor: Tuan Dinh
Faculty Supervisor: Samir Mitragotri
Department: Chemical Engineering

INTRACELLULAR TRANSPORT PROCESSES

Viruses have been used as gene delivery vehicles in a number of gene therapy applications. To successfully deliver DNA into the nucleus, virus must facilitate cell-specific binding, internalization by endocytosis, escape from endocytic vesicles into the cytosol, cytoplasmic transport, translocation across the nuclear envelop, release/dissociation of gene in a form suitable for transcription, and finally expression of the delivered gene. A quantitative understanding of these physical processes, especially in an integrated mode, is still lacking. In the present study, we develop an integrative computational framework to describe physical processes involved in viral gene delivery. The framework relates biological functions of endocytic vesicles and molecular-level binding and trafficking events on microtubules to whole-cell distribution of viruses. We employ the model to study how motor-assisted transport influences accumulation of adenoviruses in the nuclear region and expression of viral genome. We also investigate the effects of nocodazole, a microtubule-depolymerizing drug on the overall transport efficiency. Model predictions are compared to experimental data available in literature.

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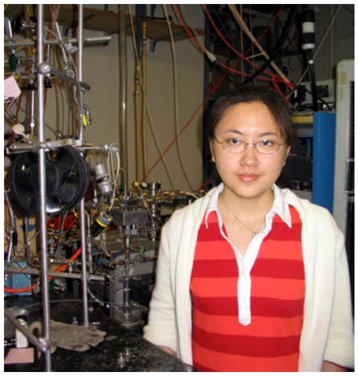

Intern: Siyan Zhang, UCSB
Mentor: Ju Chou
Faculty Supervisor: Eric McFarland
Department: Chemical Engineering

COUPLING REACTION OF PROPYLENE CATALYZED BY PURE Pd NANOCLUSTERS

It has been found that palladium (Pd) can catalyze the cyclization of acetylene on Pd/MgO thin film and bimetallic Pd/W surface. The cyclization of three acetylene molecules leads to the formation of benzene. The objective of this project was to use micelle encapsulation to synthesize pure Pd nanoclusters and to investigate the effects of various temperature and isotopes on the catalytic activities of Pd supported on TiO2. The catalytic activities were studied through a propylene reaction in the presence of both oxygen and hydrogen. The products included acetone, propane, carbon dioxide, and benzene. The experiment primarily focused on the discovery that a carbon-carbon single bond, which has a bond-energy of 348 kJ/mole, could be broken at an apparently low temperature of 70ºC. The main focus of this research was on the coupling reaction of propylene which forms benzene. Certain tools and techniques were utilized in order to obtain accurate data including a mass spectrometer, gas flow controller, gas residual analyzer (RGA), and nuclear magnetic resonance NMR). Finally, the Pd catalyst was characterized by a transmission electron microscope (TEM) to measure the morphology and size of the nanoclusters.

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