Research Internships in Science and Engineering

Research Interns in Science and Engineering (RISE)
Summer 2008 - Student Projects

Student Major / School	Mentor	Faculty Sponsor	Department	Student Project
Katelyn Cahill-Thompson Biomedical Engineering University of California, Davis	Joanna Deek	Cyrus Safinya	Materials	CHARACTERIZING THE Ph AND SALT DEPENDANCE OF NEUROFILAMENT GRAFTING DENSITIES
Christine Carpenter Materials Engineering California Polytechnic State University, San Luis Obispo	S. Scott Wasko	Herbert Waite	Molecular,Cellular, & Develomental Biology	MODELING THE PHASE TRANSITION THERMODYNAMICS OF WHELK EGG CAPSULE BIOPOLYMER
Ryan Chan Materials Chemistry Brown University	Nick Strandwitz	Galen Stucky	Materials	NOBLE METAL CATALYSIS IN NANOPARTICLE YOLK-METAL OXIDE SHELL ARCHITECTURE
Shelley Esakoff Biochemistry University of California, Santa Barbara	Jen Getz	Patrick Daugherty	Chemical Engineering	ENGINEERING HIGH STABILITY AND HIGH AFFINITY THROMBIN-INHIBITING PEPTIDES
Ameera Haamid Chemistry Jackson State University	Rachel Marullo and Amanda Trent	Matthew Tirrell	Chemical Engineering	EXAMINING THE FORMATION OF PEPTIDE AMPHIPHILE MICELLES
James Helton Chemical Engineering Arizona State University of Beirut	Andrew Pascall	Todd Squires	Chemical Engineering	INDUCED CHARGE ELECTRO-OSMOSIS OVER DIELECTRIC THIN FILMS

Rebecca Jenkins Physics California State University, San Bernardino	Min-Ying Tsai	Jim Speck	Materials	β-Ga2O3 BY PLASMA ASSISTED MOLECULAR BEAM EPITAXY
Paul Kierstead Chemistry University of California, Santa Barbara	Kim van Berkel	Craig Hawker	Materials	SYNTHESIS AND CORE VARIATION OF COMPOSITE POLYMER-METAL NANOPARTICLES
Ursula Koniges Chemical Engineering & Biochemistry University of Washington	Hongbo Zeng	Jacob Israelachvili	Chemical Engineering	HYDROPHILIC AND HYDROPHOBIC MATERIAL SURFACE MODIFICATIONS
Vikram Karandikar Biomedical Engineering Northwestern University	Ian Shieh	Joseph Zasadzinski	Chemical Engineering	VISUALIZING ALBUMIN INHIBITION IN LUNG SURFACTANT USING CONFOCAL MICROSCOPY
Clint Perlaki Bioengineering Oregan State University	Omar Saleh	Omar Saleh	Materials	ELECTROSTATIC PARING BETWEEN HOMOLOGOUS dsDNA STRANDS
Fadl Saadi Chemical Engineering Stanford University	Peng Zhang	Eric McFarland	Chemical Engineering	INVESTIGATING SUITABLE OXIDES FOR PHOCATALYTIC HYDROGEN PRODUCTION
Jaime Torres Chemistry California State University, Los Angeles	Luis Campos	Craig Hawker	Materials	HIGHLY VERSATILE AND ROBUST MATERIALS FOR APPLICATIONS IN MICROFLUIDICS
Birsen Varisli Chemistry Jackson State University	Anzarul Khan	Craig Hawker	Materials	SYNTHESIS OF NOVEL DENDRIMER FOR DRUG DELIVERY
Jake Vestal Chemical Engineering North Carolina State	Siggie Steltenkamp	Joseph Zasadzinski	Chemical Engineering	THE ROLE OF CHOLESTEROL IN LUNG SURFACTANT

Willie Wesley Chemistry Jackson State University	Brent Melot	Ram Seshadri	Materials	SYNTHESIS OF METAL OXIDE SPINELS USING HYDROTHERMAL TECHNIQUES

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Katelyn's Project Page - RISE Summer 2008

Intern: Katelyn Cahill-Thompson, Biomedical Engineering, University of California, Davis
Mentor: Joanna Deek
Faculty Supervisor: Cyrus Safinya
Department: Materials

CHARACTERIZING THE Ph AND SALT DEPENDANCE OF NEUROFILAMENT GRAFTING DENSITIES

Conditions leading to the accumulation of neurofilament networks are implicated in such neurodegenerative diseases as Lou Gehrig's disease, Parkinson's and Alzheimer's. This study characterizes the pH and salt dependence of NFnetwork grafting densities. Neurofilaments (NF), structural proteins within the intermediate filament family, are present predominately in neuronal cell axons and are composed of three subunits: high, medium and low (NF-H, NF-M and NF-L). Once assembled into filaments, the C-terminus tails of these subunits radiate outward, interacting with the sidearms of adjacent filaments to form extensive NF networks within the cell. The grafting density is the percentage of a particular subunit incorporated in a neurofilament, which we compare to the percentage initially present during assembly under various conditions. We have succeeded in isolating and indentifying the three subunits through anion exchange chromatography, gel electrophoresis and Bradford assays. The tails of NF-M and NF-H contain regions of dense phosphorylation; by altering the pH of the networks' assembly conditions, the charges of the tails will be altered. To similar affect, varying the pH changes the side-group charges of present amino acids. By altering charge, changes in pH may affect the subunit interactions and thus grafting densities. Salt concentration may shield the subunit tail from its own repulsive charges, allowing it to fold in onto itself rather than radiate outward, thus blocking the filament from further extension and altering grafting density. This study tests eleven subunit ratios at pH's of 6.0 and 6.8 with salt concentrations of 40mM, 90mM, 150mM, 240mM and 500mM. The grafting densities are monitored using stained polyacrylamide gel analysis and quantified stain intensity.

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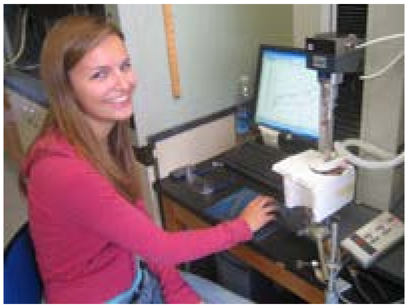
Christine's Project Page - RISE Summer 2008



Intern: Christine Carpenter, Materials Engineering, California Polytechnic State University, San Luis Obispo
Mentor: S. Scott Wasko
Faculty Supervisor: Herbert Waite
Department: Molecular,Cellular, & Develomental Biology

CHARACTERIZING THE Ph AND SALT DEPENDANCE OF NEUROFILAMENT GRAFTING DENSITIES

MODELING THE PHASE TRANSITION THERMODYNAMICS OF WHELK EGG CAPSULE BIOPOLYMER
Whelk egg capsules from Busycon canaliculatum were analyzed with tensile testing to understand the relationship between temperature and mechanical properties of the biomaterial. Under tensile loading, the proteins in the whelk egg capsule biopolymer (WECB) transition from ordered a-helices into random coils and ß-sheets. Previous studies indicated relationships between the stiffness of the material and temperature but with large variation in the data. The goal of this research is to make statistically significant conclusions and mathematically model the relationships between temperature and mechanical properties of WECB. Several samples were tensile tested over temperatures ranging from -4°C to 90°C to show the behavioral trends of transition stress, elastic modulus, and transformation strain. While previous studies suggested that the material may be elastomeric, test results show behavior contrary to entropic elasticity. The elastic modulus was found to instead have an inverse relationship to temperature. The results of this study show that WECB exhibits phase transition behavior more similar to the diffusion-free thermoelastic martensitic transformations in shape memory alloys (SMA). The transition stress has a linear relationship with temperature that matched Clausius-Clapeyron models of thermoelastic martensitic transformations.The transformation strain is not influenced by temperature, however, so the SMA model does not apply to all properties of WECB.

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Ryan's Project Page - RISE Summer 2008

Intern: Ryan Chan, Materials Chemistry, Brown University
Mentor: Nick Strandwitz
Faculty Supervisor: Galen Stucky
Department: Materials

NOBLE METAL CATALYSIS IN NANOPARTICLE YOLK-METAL OXIDE SHELL ARCHITECTURE

Gold nanoparticles have shown promising properties for use in fuel cell, automotive, and industrial catalysis, exhibiting catalytic activity similar to platinum at nearly half the cost. The nanoparticles' size and high surface-areato- volume ratio cause them to exhibit catalytic properties not seen in the bulk phase. However, performance and durability are highly dependent upon the support utilized as well as the nanoparticle size. Huang and Schüth have developed a novel support architecture consisting of a nanoparticle core enclosed in a porous metal oxide shell, synthesized through a three step process: hydrophilic gold nanoparticles are encased in silica through a Stöber method synthesis, covered in metal oxides using a solution phase reaction, and finally immersed in basic solution to remove the silica spacing layer (Fig. 1). The porous shell provides superior separation of the nanoparticles while simultaneously preventing sintering; the nanoreactors retain nearly 100% catalytic ability even after calcinations at 1073K. The charge and chemical functionality of the gold nanoparticle surface are presumably important parameters for subsequent coatings in metal oxides. Herein we focus on controlling the synthesis of the silica shell, exploring the effects of cationic, anionic, and neutral ligands as well as varying the Stöber reaction conditions. We report successful synthesis of monodisperse, 75-200nm Au@SiO2 spheres with 5-8nm Au nanoparticle cores. This architecture is easily replicable for many types of ligand-stabilized, hydrophilic nanoparticles, overcoming a significant hurdle in the application of nanoparticle catalysis.

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Shelley's Project Page - RISE Summer 2008

Intern: Shelley Esakoff, Biochemistry, University of California, Santa Barbara
Mentor: Jen Getz
Faculty Supervisor: Patrick Daugherty
Department: Chemical Engineering

ENGINEERING HIGH STABILITY AND HIGH AFFINITY THROMBIN-INHIBITING PEPTIDES

We are designing innovative high stability protein therapeutics to bind thrombin with high specificity and affinity with the potential application of treating cardiovascular disease. Cardiovascular disease is the number one cause of death in America with over 80 million fatalities a year. Many cardiovascular treatments target thrombin, a serine protease that catalyzes the conversion of fibrinogen to fibrin, which is needed to form a stable blood clot. Current treatments for cardiovascular disease, such as heparin, suffer from major adverse effects including excessive bleeding and immunogenicity. Proteins are potentially effective pharmaceuticals due to their ability to achieve high stability and high affinity. Craik et al. showed that the kalata B1 (KB1) scaffold found in the plant species Oldenlandia affinis is robust in the presence of 8 M urea, temperatures up to 100°C and incubation with intestinal proteases. Previously, peptides within the KB1 scaffold were isolated that bind thrombin using bacterial surface display. A fluorescence resonance energy transfer (FRET) assay was then designed to determine the inhibitory effect of the peptides on thrombin's proteolytic activity. First the substrate's affinity for thrombin needed to be determined in order to characterize thrombin inhibition. Preliminary results have shown that the substrate's affinity for thrombin is approximately 50 μM.

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Ameera's Project Page - RISE Summer 2008

Intern: Ameera Haamid, Chemistry, Jackson State University
Mentor: Rachel Marullo and Amanda Trent
Faculty Supervisor: Matthew Tirrell
Department: Chemical Engineering

EXAMINING THE FORMATION OF PEPTIDE AMPHIPHILE MICELLES

Amphiphilic molecules form micelles when introduced into an aqueous environment. A micelle structure consists of hydrophobic tails at the core of the structure with hydrophilic peptide groups as the shell. Pharmaceuticals and biologics can be protected from absorption within the core of the micelle and the peptide itself can be used as a therapeutic making these peptide amphiphilic micelles ideal objects for drug delivery. When micelles are created they form either spherical or cylindrical shapes. The micelle shape is critical in drug delivery because smaller spherical micelles may pass through membranes, whereas larger cylindrical micelles may be ideal for tissue binding. This project aims to find the cause of the formation of micelle spheres versus micelle cylinders. This is done by using various sequences of peptide chains and hydrophobic tails to determine if either groups persuade the micelle to form a certain shape. The peptides are characterized using reverse phase high performance liquid chromatography (HPLC), mass spectrometry, and dynamic light scattering (DLS). Currently, data shows that C10(GSS)4 and C16P4(GSS)4 forms a cylindrical micelle. Future work consists of characterizing and comparing more micelles and then introducing these structures into a physiological setting. Measuring the stability of these different micelles is a critical factor in drug delivery.

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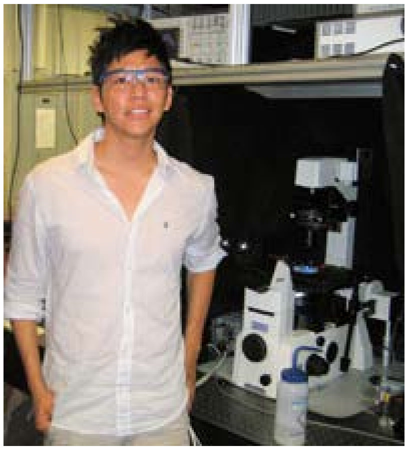
Jame's Project Page - RISE Summer 2008



Intern: James Helton, Chemical Engineering, Arizona State University
Mentor: Andrew Pascall
Faculty Supervisor: Todd Squires
Department: Chemical Engineering

INDUCED CHARGE ELECTRO-OSMOSIS OVER DIELECTRIC THIN FILMS

Advances in technology are making compact microfluidic devices possible for biological and chemical applications. Microfluidic devices allow one to integrate several different functions on to a single chip, for example, capillary electrophoresis, isoelectric focusing and microfluidic pumps. One way of manipulating fluids in these devices is to use electric fields. Induced Charge Electro-osmosis (ICEO) occurs when an AC electric field is applied across the channel which results in the formation of a polarized electric double layer at the surface of the metal. The fluid will move toward the electrode in both directions creating two recalculating patterns. The electrode was fabricated on a quartz substrate using basic photolithography techniques. The polydimethylsiloxane (PDMS) channels are patterned using soft lithography on an etched Si wafer. The channel used in this experiment is one side quartz and three sides PDMS both of which do not affect the electric field. The fluid is a solution of KCl and 500nm fluorescent polystyrene beads. The beads are added to the electrolyte, which will trace the planar velocity of liquid at surface of the electrode. Particle image velocimetry (PIV) was used to determine flow velocity. Velocities in a 60 µm/second range were measured. A nonconducting dielectric layer placed over the conductor is used to test how it will affect the fluid, which theory predicts will decrease the velocity. The result showed that a dielectric thickness of 100µm reduced the velocity by 15µm/s and correlated with the theoretical calculations.

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Rebecca's Project Page - RISE Summer 2008

Intern: Rebecca Jenkins, Physics, California State University, San Bernardino
Mentor: Min-Ying Tsai
Faculty Supervisor: Jim Speck
Department: Materials

ß-Ga2O3 BY PLASMA ASSISTED MOLECULAR BEAM EPITAXY

Metal oxides have been widely researched for their semiconductor properties, most commonly with band gaps in the visible spectrum. Gallium oxide, ß-Ga2O3, has been reported having a band gap in the UV range, approximately 260 nm. This would allow for ß-Ga2O3s to replace large DUV gas lasers and lamps currently used. The ß-Ga2O3 is grown in a layer-by-layer manner using molecular beam epitaxy, MBE. Knowing the growth conditions for varying substrates is critical in obtaining a high quality ß-Ga2O3 film. ß-Ga2O3 has a monoclinic lattice which makes it difficult to grow due to lattice mismatch with the substrates. It is expected that this mismatch can be reduced with the proper growth conditions. The resultant film is analyzed using an atomic force microscope (AFM), a scanning electron microscopy (SEM), and x-ray diffraction (XRD). The film is first analyzed in the AFM, characterizing the surface. A smooth surface (RMS roughness of 0 to 3 nm) is optimal. The film is then placed in the SEM to determine the thickness with respect to different growth periods. The film is finally placed in the XRD to confirm the lattice orientation of the ß-Ga2O3. This analysis is carried out as each of the growth variables is systematically changed. This process will allow for the determination of the most efficient method for the growth of high quality ß- Ga2O3 films.

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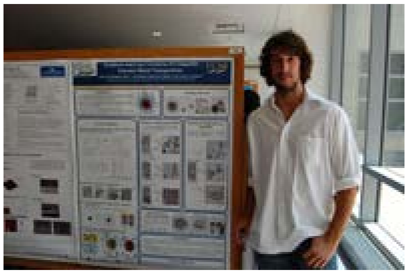
Paul's Project Page - RISE Summer 2008



Intern: Paul Kierstead, Chemistry, University of California, Santa Barbara
Mentor: Kim van Berkel
Faculty Supervisor: Craig Hawker
Department: Materials

SYNTHESIS AND CORE VARIATION OF COMPOSITE POLYMER-METAL NANOPARTICLES

Inorganic nanoparticles have been shown to exhibit many appealing characteristics including catalytic, electronic, and optical properties. These particles have potential applications in sensor technology, biomedicine, and microscopic imaging. Significant advantages in these applications can be achieved by encapsulating the inorganic nanostructures in organic materials. A simple and scalable method has recently been developed to synthesize hybrid polymer-metal nanoparticles [1]. This method, based on miniemulsion polymerization, allows for the encapsulation of varying shapes, sizes, and types of inorganic nanostructures into composite nanoparticles. In this work, techniques have been developed to co-encapsulate two or more different inorganic materials within a single composite structure, yielding particles that display a combination of the desirable nanoparticle properties. [1] van Berkel, K.Y.; Hawker, C.J. Manuscript in Preparation

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Ursula's Project Page - RISE Summer 2008

Intern: Ursula Koniges, Chemical Engineering & Biochemistry, University of Washington
Mentor: Hongbo Zeng
Faculty Supervisor: Jacob Israelachvili
Department: Chemical Engineering

HYDROPHILIC AND HYDROPHOBIC MATERIAL SURFACE MODIFICATIONS

Many commonly used polymers, such as polystyrene (PS) and polydimethylsiloxane (PDMS), are hydrophobic and thus not ideal for applications which benefit from hydrophilic material surface properties (such as biomaterials or micro fluidic devices). Conversely, mica is hydrophilic and not ideal for applications which benefit from hydrophobic surface properties. Means of altering the surface hydrophobicity of materials while maintaining bulk properties exist. This investigation concerns the surface modification of PS, PDMS, and mica via introduction of hydrophilic or hydrophobic functional groups to material surfaces. PS and PDMS are modified to increase surface hydrophilicity. Mica is modified to increase surface hydrophobicity. Introduction of hydrophilic functional groups is accomplished via UV-ozone treatment. Introduction of hydrophobic functional groups is accomplished via [3-Aminopropyl]triethoxysilane (APTES) solution immersion. The resulting surface energy effects are examined using sessile drop contact angle analysis. Surface forces apparatus (SFA) is used to measure deposited APTES monolayer thickness. Results indicate successful achievement of desired surface modifications.

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Vikram's Project Page - RISE Summer 2008

Intern: Vikram Karandikar, Biomedical Engineering, Northwestern University
Mentor: Ian Shieh
Faculty Supervisor: Joseph Zasadzinski
Department: Chemical Engineering

VISUALIZING ALBUMIN INHIBITION IN LUNG SURFACTANT USING CONFOCAL MICROSCOPY

Lung surfactant (LS) consists of proteins and lipids that occupy the air-water interface of the alveoli. By adsorbing to the interface, LS drastically reduces surface tension in the alveoli, allows effortless breathing, and prevents alveolar collapse. Dysfunction and inhibition of LS is one of the symptoms of acute respiratory distress syndrome (ARDS), a condition with a 50% mortality rate suffered by nearly 150,000 people annually. LS inhibition results from many different factors, with lung trauma being one. Trauma can allow plasma to enter the alveoli, which leads to albumin—a protein abundant in blood—adsorbing to the air-water interface in place of LS. Albumin inhibits LS function and can cause ARDS by occupying the interface. However, the reversal of albumin inhibition has been previously shown to occur in vitro with the administration of certain concentrations of polymers such as polyethylene glycol (PEG) or chitosan. Through the use of confocal microscopy, this project seeks to directly visualize the inhibition reversal mechanisms of PEG and chitosan when each is individually introduced with LS. By appropriately tagging LS, albumin, and the polymer of interest, confocal imaging allows us to track the behavior of the different components and obtain a clear view of the processes at hand.

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Clint's Project Page - RISE Summer 2008

Intern: Clint Perlaki, Bioengineering, Oregan State University
Mentor: Omar Saleh
Faculty Supervisor: Omar Saleh
Department: Materials

ELECTROSTATIC PARING BETWEEN HOMOLOGOUS dsDNA STRANDS

DNA recombination, a vital function for all living organisms, highly depends on recognition between two identical strands of double stranded DNA (dsDNA). A recent theory posits recognition is due to dipole attractions between basepairs; these attractions are only significant for identical sequences because of correlated deformations between the helices. If this theory is correct, we expect to observe characteristic changes in the elasticity of single dsDNA dimers upon self-binding. We measured the elasticity of experimental and control strands of dsDNA using magnetic tweezers and using solutions where the electrostatic repulsion between strands is minimized (i.e. in condensing conditions). Experimental strands consisted of two identical sequences connected together, while control strands had a random sequence. We were unable to find conditions where the experimental strand exhibited self-binding (i.e. condensation) and the control strand did not, so we instead studied the kinetics of self-binding. We measured both the time to condensation, and the time to decondensation, and found that while both strands condensed at the same rate, the experimental strand decondensed much more slowly than the control strand. These results are consistent with the following picture: the time to condensation depends on the first non-specific binding event between segments, and thus does not vary between the strands. However, once condensed, the strands are free to rearrange, allowing identical segments to bind; this strong binding leads to slow decondensation for only the experimental strand. These results support the hypothesis; however, we will continue testing this hypothesis by varying the time allowed for strand rearrangement.

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Fadl's Project Page - RISE Summer 2008

Intern: Fadl Saadi, Chemical Engineering, Stanford University
Mentor: Peng Zhang
Faculty Supervisor: Eric McFarland
Department: Chemical Engineering

INVESTIGATING SUITABLE OXIDES FOR PHOCATALYTIC HYDROGEN PRODUCTION

The splitting of water into H2 and O2 by photoelectrolysis using solar energy and suitable catalysts has attracted a lot of interest over the past few decades. For an oxide to be a viable catalyst for this reaction it must have a suitable bandgap, high quantum efficiency and must be relatively cheap to produce. This project aimed to find suitable nanostructures of oxides which would be able to yield higher efficiencies by decreasing the transportation distance of the electron and by increasing surface area of the catalyst. In this project we looked into hematite, copper (I) oxide and silver oxide nanostructures which may be suitable as cathode materials due to their short band gaps and relatively low costs. Several different structures of hematite were produced, including nanorods, quasicubic and mesoporous structures. To further increase efficiency, platinum was deposited on the hematite nanostructures. Also Pt@TiO2@Fe2O3 nanorods were synthesized as well as nanorods of both copper (I) oxide and silver oxide. These structures were studied using TEM and X-Ray diffraction and their internal quantum efficiencies (IQE) were measured using a 1kW lamp. The nanorods and mesoporous hematite structures produced were shown to have high IQE and appear to be very promising and encourage furthering research in the area.

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Jaime's Project Page - RISE Summer 2008

Intern: Jaime Torres, Chemistry, California State University, Los Angeles
Mentor: Luis Campos
Faculty Supervisor: Craig Hawker
Department: Materials

HIGHLY VERSATILE AND ROBUST MATERIALS FOR APPLICATIONS IN MICROFLUIDICS

Microfluidics describes a broad range of technologies that manipulate nanoliter and microliter volumes via micrometer sized channels within fabricated devices. The ability to miniaturize fluid handling has several advantages, including low sample volumes, fast response times, and portable on-site detection. However despite the advantages of microfluidic devices for lab-on-a chip applications, the use of poly(dimethyl siloxane) (PDMS) as the polymer of choice for the fabrication of such devices severely limits their ability to perform robust analysis. PDMS is incompatible with several organic based solvents and is notoriously gas permeable, which induces intense swelling that leads to device failure. Thus, we are currently developing new alternative systems based on poly([3- mercaptopropyl]methyl siloxane) (PMMS) to yield highly cross-linked matrices via thiol-ene click chemistry using a wide variety of multifunctional alkene compounds. Advantages of these systems include fast fabrication times and the ability to withstand organic solvents with minimal swelling. Uptake studies reveal that PMMS based materials swell less than PDMS in non-polar solvents by a factor of 5 by weight. Moreover, PMMS performs extremely well in organic solvents, such as ethyl acetate, which swells the PMMS materials ca. 20 times less than PDMS.

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Birsen's Project Page - RISE Summer 2008

Intern: Birsen Varisli, Chemistry, Jackson State University
Mentor: Anzarul Khan
Faculty Supervisor: Craig Hawker
Department: Materials

SYNTHESIS OF NOVEL DENDRIMER FOR DRUG DELIVERY

A supramolecular dendrimer-peptide conjugate is being designed for the targeted delivery of therapeutic agents. The designed non-polar alkyl branches are at the periphery of the dendrimer. This will act as a nanotemplate for the organization of peptide amphiphiles. This self-organization will lead to the formation of spherical assemblies in which the peptide will contain the recognition elements as well as drug molecules. Meanwhile, the dendrimer will act as a scaffold as well as a delivery vehicle. The synthesis of the dendrimer involves multiple efficient thiolene photoreactions under environmentally friendly conditions. Sequently, anhydride coupling reactions are performed to functionalize the dendrimer. The thiolene reactions are demonstrated to be very efficient (quantitative yields) and robust. The product purification requires only precipitation in a non-solvent that leads to isolation of products with high purity. The anhydride coupling reactions are also efficient and high yielding reaction. A generation 3 based dendrimer containing thiododecyl chains at the periphery will be synthesized and the self-assembly behavior of the supramolecular conjugate will be investigated in detail.

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Jakes's Project Page - RISE Summer 2008

Intern: Jake Vestal, Chemical Engineering, South Carolina State University
Mentor: Siggie Steltenkamp
Faculty Supervisor: Joseph Zasadzinski
Department: Chemical Engineering

THE ROLE OF CHOLESTEROL IN LUNG SURFACTANT

Lung surfactant (LS) is a complex collection of proteins and lipids found at the interface between air and the pulmonary fluid that lines the inside surfaces of the alveoli in mammalian lungs. The vital functions of lung surfactant are disrupted by Acute Respiratory Syndrome (ARDS), a condition in which serum proteins replace LS molecules on the interface following acute trauma to the abdomen. No effective treatment for ARDS exists and the crucial need for a synthetic LS-like preparation, able to restore function to serum-disabled LS, is of paramount importance to the effort to lower the 30% mortality rate of this fatal condition. An important question in the design of an ARDS treatment is weather cholesterol should be included. Although known to be present in mammalian lungs, the role that cholesterol plays in functional LS is almost totally unknown. In this study, the effect of cholesterol on bovine-derived LS was investigated with fluorescence microscopy, atomic force microscopy, Wilhelmy-plate surface force measurements, and surface viscometry. The effect of cholesterol on the phase behavior of LS during the breathing cycle is discussed, as well as the interactions between cholesterol and the surfactant proteins crucial to normal LS function.

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Willie's Project Page - RISE Summer 2008

Intern: Willie Wesley, Chemistry, Jackson State University
Mentor: Brent Melot
Faculty Supervisor: Ram Seshadri
Department: Materials

SYNTHESIS OF METAL OXIDE SPINELS USING HYDROTHERMAL TECHNIQUES

Little is known about the fundamental science behind magnetic interactions in crystallogrpahically-disordered materials. In order to further understand these interactions, we performed various methods of synthesis in an attempt to control the crystallographic ordering of oxides. The traditional route for preparing transition metal oxides requires the use of high temperature reactions. These high temperatures are detrimental to the synthesis of transition metal oxide spinels because the atoms in the crystal have a tendency to randomly distribute to the wrong crystallographic sites, resulting in a disordered structure with properties that are hard to control. In an attempt to control this atomic ordering, we have prepared nanocrystals of $CoGa_2O_4$ using a hydrothermal method. Hydrothermal techniques are conducted at milder conditions, therefore it is expected that the prepared nanocrystals will order appropriately. We will present structural and magnetic data demonstrating the difference between our nanocrystals prepared with hydrothermal techniques and samples prepared at high temperatures.

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