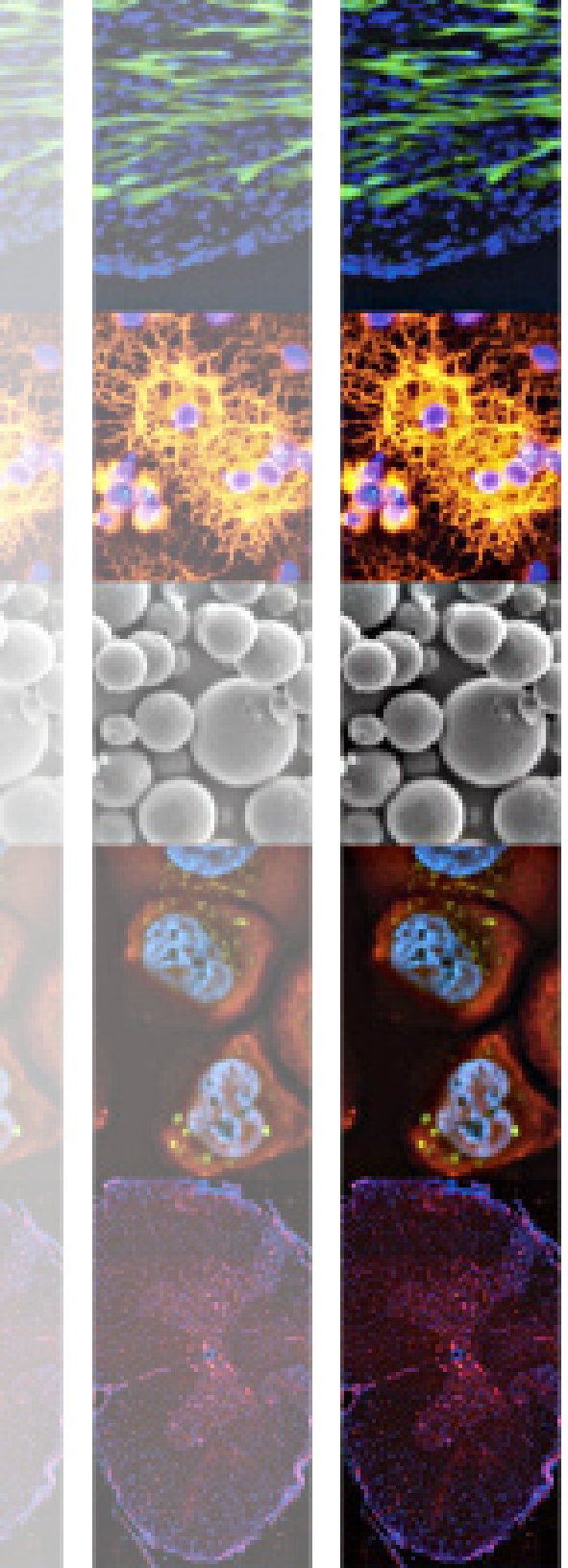

Stevenson Biomaterials Lecture Series

Research Poster Session
October 17, 2014

Syracuse Biomaterials Institute

Stevenson Biomaterials Lecture Series
Research Poster Session
October 17, 2014

Research Posters

POSTER INDEX

P10: The DNA Mediated Assembly and Ultracentrifugation Based Purification of Multi-color Qdot Clusters
Kaitlin Coopersmith, Mathew M. Maye

P11: Cell Viability Studies of Modified and Standard Poly-Vinyl Alcohol Hydrogels
Robin Danielle Ramos and Michelle Blum

P12: Novel Crosslinked Hyaluronic Acid Networks Designed For Axonal Stretch Growth
Pushkar S. Varde and Julie Hasenwinkel

P13: Shape Memory Actuated Polyelectrolyte Multi-layer Wrinkles
Ariel Ash-Shakoor, James H. Henderson and Patrick T. Mather

P14: Investigating Telodendrimer Based Cancer Drug Delivery Micelles
Wenjuan Jiang, Juntao Luo and Shikha Nangia

P15: Synthesis and Characterization of Arylcalciumphospho nates for Bone Therapeutic Applications
Valerie Lopez, Matthew Lijewski, and Karin Ruhlandt

P16: Effects of 3D Modeling Parameters on Dimensional Accuracy of 3D-Printed Anatomical Structures Derived from CT Data
Can Aslan, Nathaniel Ordway, Gwen Tillapaugh-Fay, Dalanda Diallo, Kent M. Ogden, and Pranav Soman

P17: Mechanics of the Organ of Asymmetry in the Zebrafish Embryo
Craig Fox, M. Lisa Manning and Jeffrey Amack

P18: Surface Stiffness Affects Bacterial Adhesion and Antibiotic Susceptibility of Attached Cells
Fangchao Song and Dacheng Ren

P19: Self-Reinforced Composites for Prevention of Fretting Corrosion of Biomedical Alloys: Electrochemistry and Surface Characterization
Eric S. Ouellette and Jeremy L. Gilbert

P20: Exploring a Single Engineered Protein Nanopore with an Enzymatic Domain
Avinash Thakur and Liviu Movileanu

P21: Defect Proliferation in Active Nematic Suspension
Prashant Mishra, Mark J. Bowick, Luca Giomi, Rastko Sknepnek and M. Cristina Marchetti

P22: Modulation of Phosphoinositide Monolayer Compressibilities by Physiological Levels of CA
Adolphe Kazadi Badiambile and Martin B. Forstner

P23: Complex Patterns Formed by Liquid Crystals in Circular and Annular Geometries
Kyle Lawlor, Oksana Manyuhina, Mark Bowick and Cristina Marchetti

P24: Propagating Stress Waves During Epithelial Expansion
Kazage J. C. Utuje, Shiladitya Banerjee and M. Cristina Marchetti

P25: Design of a CNC Tribological Bioreactor
Gabriel Smolnycki, Michelle M. Blum and Ryan Olson

P26: Self-Reinforcement of Poly(lactic acid) Fibers
Julia Tumbic, Patrick T. Mather

P27: Tracking Golgi on 2-D Substrates
Giuseppe Passucci, Megan E. Brasch, Nicholas O. Deakin, Christopher E. Turner, James H. Henderson, and M. Lisa Manning

P28: Design and Characterization of a Tribologically Enhanced Hydrogel Construct for Articular Cartilage Repair
Allen Osaheni, Michelle M. Blum, Rebecca A. Bader, Patrick T. Mather

P29: Poly(ε-caprolactone) Shape Memory Polymer for Filling Critical-sized defects
Richard M. Baker, James H. Henderson, Patrick T. Mather

P30: Tracking and Aalyzing Cells Over Long Timescales in Complex in vitro Biomaterial Environments
Megan E. Brasch, Richard M. Baker, M. Lisa Manning, and James H. Henderson

P31: Establishing a Co-culture between Pseudomonas Aeruginosa and IB3-1 Epithelial Cells for Evaluation of New Treatment Strategies
Elizabeth Luke, Patricia R. Wardwell, Ben Lundgren, Christopher T. Nomura, Rebecca A. Bader

Poster Abstracts

P01:

Understanding the Role that Quantum Rod Morphology and Microstructure has on Bioluminescence Resonance Energy Transfer with Firefly Luciferase

Lili Karam, Kaitlin Coopersmith, Mathew M. Maye
Department of Chemistry, Syracuse University

Semiconductor quantum dots (QDs) are ideal for energy transfer applications due to their easily manipulated optical properties, broad absorption profiles, and high photostability. By tailoring morphology and aspect ratio of the QDs through altering synthetic parameters, we have been able to design optimal energy acceptors for bioluminescence resonance energy transfer (BRET). To create the bionanoconjugates, the QDs were functionalized with histidine and incubated with PPyGRTS firefly luciferase possessing a 6xHis tag. Red QDs with a rod-in-rod microstructure were found to exhibit the highest BRET ratios. We observed that the QD emission wavelength is red-shifted at lower loading ratio during BRET, indicating binding of the protein to lower energy defect sites on the QDs. Protein binding on the QDs surface was also investigated utilizing thermal gravimetric analysis, Fourier transform infrared spectroscopy, and agarose gel electrophoresis.

P02:

Creation of a Monomeric Proteinaceous Scaffold for the Potential use as a Controllable Nanovalve

Aaron J Wolfe, Jack Gugel , Josh Mills and Liviu Movileanu
Structural Biology, Biochemistry and Biophysics Program, Syracuse University, 111 College Place, Syracuse. Department of Physics, Syracuse University, 201 Physics Building, Syracuse

The controlled release of compounds is of broad interest. The separation of compounds until a specific time has far-reaching potential; from making batteries for nanobiotechnological applications, to targeted drug delivery. To this end we propose the creation of a nanovalve. A nanovalve is as a protein which can be triggered to change its confirmation allowing the release of a compound from one area to another. The creation of a controllable nanovalve system will incorporate a fusion protein utilizing the assets of two highly specialized proteins into one monomeric protein polymer. Here I will show the design and functional testing of these fusion proteins

P03:

Triple Shape Memory Composite Foams

Hossein Birjandi Nejad , Richard M. Baker and Patrick T. Mather
Syracuse Biomaterials Institute and Biomedical and Chemical Engineering Department, Syracuse University, Syracuse, NY 13244

Abstract: Shape memory foams have been reported in the past though they have been limited to dual SMPs. Meanwhile, advances by SMP researchers have led to several approaches toward triple shape polymers that feature more than one switching phase and thus a multitude of temporary shapes allowing for a complex sequence of shape deployments. Here, we report the design and characterization of a triple shape memory polymeric foam that is open cell in nature. We envision mass production of the foams for applications spanning healthcare, aerospace, and packaging industries where geometrically complex actuation may be required.

P04:

Dual-Spun Shape Memory Elastomeric Composites

Jaimee M. Robertson and Patrick T. Mather
Syracuse Biomaterials Institute, Syracuse University

Shape memory elastomeric composites (SMECs) are unique in that they are both soft and rubbery, and yet, they are able to fix a temporary shape. Previous SMEC fabrication methods involved infiltration of electrospun fibers with a crosslinkable elastomer. The current work offers an alternative fabrication process, termed dual electrospinning, in which a shape memory polymer (SMP) and a thermoplastic elastomer are electrospun simultaneously. Hot compaction of the resulting fiber mat gives a SMEC film. Advantages of this approach over the previous infiltration method include better control over the relative composition and the added potential for redefinition of the permanent shape. In this report, the effects of composition on thermomechanical and shape memory properties will be investigated.
This project is supported by the NSF DMREF Grant 1334658.

P05:

Organization of Quantized Clusters of Nanoparticles by Fine Tuning Self-Assembly Kinetics in a DNA-Mediated Self-Assembly System

Alisha Lewis, Mathew M. Maye
Department of Chemistry, Syracuse University, Syracuse New York 13244

Nanoparticles can be organized into unique nanoscale architectures through a biomimetic self-assembly process using DNA. In this project, we aim to assemble discrete groupings or clusters of nanoparticles. Here, we describe the use of kinetic controls to limit cluster size. Assembly kinetics were tailored by controlling DNA length and sequence, as well as the nanoparticles diameter. AuNP kinetic and thermodynamic assembly parameters have been characterized through UV-Vis spectroscopy (UV-Vis) while assembly size and shape has been monitored through dynamic light scattering (DLS) and transmission electron microscopy (TEM).

P06:

Development of Bioabsorbable, Thermoplastic Elastomers

Erin McMullin, Hannah Rebar, and Patrick T. Mather
Department of Biomedical and Chemical Engineering, Syracuse Biomaterials Institute, Syracuse University

There is a current need to develop a bioabsorbable, thermoplastic elastomer as it could have many uses in the body (bioabsorbable sutures, scaffolds, seals, stents, etc.) and none are commercially available. Our approach is to synthesize linear polyurethanes consisting of a biodegradable polymeric diol (polyol) that serves as the soft segment, alternated with POSS as the hard segment. Here, POSS is the unique inorganic-organic hybrid moiety, polyhedral oligosilsesquioxane, which provides physical crosslinking required for elastomeric behavior. Our report will highlight recent progress, including syntheses of elastomers whose POSS content is systematically varied and whose soft segment composition was varied to control both degradability and elasticity.

P07:

A Molecular Approach to Determine the Blood Brain Barrier Tight Junctions

Flaviyan Jerome Irudayanathan, J P Trassati*, Pankaj Karande* & Shikha Nangia
Department of Biomedical and Chemical Engineering, Syracuse University,*Center for Biotechnology and Interdisciplinary Studies, Rensselaer Polytechnic Institute

The Blood brain barrier (BBB) is a key interface in the human body that prevents blood-borne chemicals from entering the brain. Claudin-5 is the critical protein that governs the permeability of the BBB by forming tight junctions between two adjacent cells in the BBB interface. Here we explore the self-assembly of Claudin-5 tight Junction complex in lipid bilayers using molecular dynamics. Simulations show self-assembly of Claudin-5 into stable dimers which correlate with the observed experimental results. Determining how claudin-5 dimers form tight junctions will help us in designing strategies to selectively regulate permeability of the BBB, critical for finding cures for neurodegenerative diseases.

P08:

Tuning Lipidoid-Based Nanoparticles for Intracellular Protein Delivery

Xu Wang, Ph.D.; Changying Shi, Dandan Guo, Alexa Bodman, M.D.; H. Hans Salamanca, Ph.D.; Juntao Luo, Ph.D.,

Department of Pharmacology, Upstate Cancer Research Institute, SUNY Upstate Medical . Department of Neurosurgery, SUNY Upstate Medical. College of Medicine, SUNY Upstate Medical

Lipid-like nanoparticles as protein delivery vehicles offer enhanced cell membrane permeability for proteins to reach the intracellular targets, which facilitates safe and efficient protein therapy. However, precise control on the size of lipid-like nanoparticles that is critical for deeper tumor penetration remains a challenge due to the aggregation nature of lipids. Herein we present a facile strategy to engineer sub-60 nm lipid-like nanoparticles by introducing telodendrimers made from poly(ethylene glycol), and cholic acid and/or cholesterol. Preliminary results indicated these nanoparticles could efficiently deliver model proteins into cancer cells. Next step of our research will focus on therapeutic protein delivery via the nanoparticles for cancer treatment.

P09:

Functionalization of Nanoparticles with Smart Polymers for Controllable Self- Assembling Systems

Jay Tinklepaugh, Simon Pun, Mathew M. Maye

Department of Chemistry, Syracuse University

The functionalization of gold nanoparticles with smart polymers has a diverse range of applications in drug delivery, sensing, and self-assembly. Smart polymers are specifically designed to respond to select changes in temperature, pH, chemical environment or other external stimuli. Using the well understood atom transfer radical polymerization mechanism, triblock copolymers were synthesized from monomers with amide, carboxylic acid, and pyridyl functional groups. The resulting copolymers pN-isopropylacrylamide-co-pAcrylamide-co-pAcrylic Acid and pN-isopropylacrylamide-co-pAcrylamide-co-p4'vinylpyridene are sensitive to changes in temperature and pH. Ultraviolet-visible light spectroscopy and dynamic light scattering was used for temperature and pH effect studies and HNMR for structural determination. After the polymers were designed, synthesized, and characterized they were used to functionalize gold nanoparticles, which results in smart nanoparticles. Results indicate that functionalization was successful and that 'smart' characteristics are retained, with changes in temperature and pH affecting the surface plasmon resonance of the particles.

P10:

The DNA Mediated Assembly and Ultracentrifugation Based Purification of Multi-color Qdot Clusters

Kaitlin Coopersmith, Mathew M. Maye
Department of Chemistry, Syracuse University

Abstract: In this presentation, we describe recent work on the purification and assembly of purpose built CdSe/ZnS quantum dots (qdots) functionalized with oligonucleotides (ssDNA). To achieve this, the qdots were synthesized via organometallic methods, and then encapsulated in an amphiphilic polymer and purified using a sucrose gradient-based ultracentrifugation method. The isolated qdot/polymer species were then conjugated with ssDNA using EDC/NHS coupling. The addition of a purification step improved qdot optical properties and increased the density of ssDNA. A DNA-mediated assembly approach using a solid support was employed to create stoichiometrically controlled multi-color qdot clusters with defined emission wavelengths. The clusters were characterized by fluorescence spectroscopy, FRET analysis, FTIR and DLS. These qdot cluster assemblies can be utilized in optical barcode sensing to simultaneously detect multiple targets.

P11:

Cell Viability Studies of Modified and Standard Poly-Vinyl Alcohol Hydrogels

Robin Danielle Ramos, Michelle Blum
Department of Mechanical and Aerospace Engineering,
Syracuse University

In the development of high performance hydrogels for orthopedic application, research can yield the appropriate application of the scaffolds based on their cell viability properties. The purpose of these experiments is to determine whether novel boundary lubricant tribologically enhanced poly-vinyl alcohol hydrogels are best suited for use as a tissue-engineering scaffold or implant. Preliminary experiments will be conducted using L929 fibroblast cells to test and streamline cell-seeding protocol. After the seeded hydrogels undergo cell viability studies, the data will determine their use as a tissue-engineering scaffold or implant. If the hydrogels produce significant cell viability then the experiments will be conducted using cartilage chondrocytes.

P12:

Novel Crosslinked Hyaluronic Acid Networks Designed For Axonal Stretch

Pushkar S. Varde, Dr. Julie Hasenwinkel
Department of Biomedical and Chemical Engineering,
Syracuse University

The goal of this work was to develop and characterize a unique polymeric biomaterial that can be used to enhance axonal regrowth and repair by providing mechanical stimulation. The shear thinning property of hyaluronic acid (HA) provided a perfect platform to store retractive stress in a rapidly crosslinked network under shear flow. This stress was then controllably released to achieve shrinkage of the network scaffold along a desired axis. We investigated two strategies to achieve this goal. The retractive stress trapped in the crosslinked network was released either by manipulating the main backbone HA chains or by selectively cleaving the crosslinks.

P13:

Shape Memory Actuated Polyelectrolyte Multi-layer Wrinkles

Ariel Ash-Shakoor, James H. Henderson, Patrick T. Mather
Biomedical and Chemical Engineering Department, Syracuse University

Currently, there is a need to understand the synergistic effects of surface topography and chemistry on cell behavior in order to improve implant biocompatibility and to understand cell-surface interactions. This work seeks to address this need with a novel active cell culture platform consisting of intrinsic shape memory polymer (SMP) mechanical actuation on polyelectrolyte multi-layers (PEM). Wrinkle patterns are formed by recovering strained SMPs first spin-coated with PEMs. Not only is this the first work to combine SMPs and PEMs. It is also the first to create topographical polyelectrolyte substrates. Unlike many static cell culture substrates, this dynamic system can be used to explore changes in cell motility at the time of a programmed change in temperature. We can control the wrinkle pattern features to explore the cell-surface interactions for anti-fouling, bone stem cell differentiation, and wound healing applications.

P14:

Investigating Telodendrimer Based Cancer Drug Delivery Micelles

Wenjuan Jiang, Juntao Luo, and Shikha Nangia
Department of Pharmacology, SUNY Upstate Cancer Institute, SUNY Upstate Medical University, Syracuse, NY 13210
Department of Biomedical and Chemical Engineering, Syracuse University, Syracuse NY 13244

Polymeric micelles are a promising class of drug delivery carriers in field of cancer therapy due to their tunable physiochemical properties. Typically, drug delivery nanocarriers are prepared from self-assembled amphiphilic block copolymers that have a biocompatible hydrophilic shell and a hydrophobic core capable of encapsulating cancer drugs such as paclitaxel (PTX). Designing optimal nanocarriers, however, is challenging due to stringent design requirements such as stability, drug-loading capacity, size distribution, and target specificity. Here we adopted a collaborative computational and experimental approach to evaluate the

micellar assembly of polyethylene glycol-b-dendritic oligo(cholic acid) copolymer called telodendrimer. The modular triblock PEG-LYS-CA telodendrimer is a highly tunable drug delivery platform. Computational and experimental results indicate that the facial amphiphilicity of the CA building block is critical for the PTX loaded micelle along with 5 kDa molecular weight PEG chains. Among the possible telodendrimeric structures studied, the simulations showed that PEG5kCA8 telodendrimer forms stable monodisperse micelles with 19.1±0.7 nm diameter (experimental 21±4.0 nm) and highest drug loading capacity 25% w/w (experimental 20-36% w/w). The excellent agreement between the computational and experimental results is encouraging for future collaborative research. This research demonstrates that computational methods are powerful and can greatly reduce the time and the cost associated with optimizing cancer drug delivery nanocarriers.

P15:

Synthesis and Characterization of Arylcalciumphosphonates for Bone Therapeutic Applications

Valerie Lopez, Matthew Lijewski, and Karin Ruhlandt
Chemistry Department, Syracuse University

The quest for bioactive and biocompatible materials for bone therapy is of growing importance, as currently used materials display significant limitations. Our work consists of utilizing bisphosphonates, a chemical entity used in common drugs to treat bone disorders, and combine them with calcium to obtain biocompatible and bioactive three-dimensional metal organic frameworks (MOFs). The work presented describes synthetic conditions for the synthesis of novel calcium phosphonates and lastly it will discuss recent results of three novel calcium phosphonate compounds, focusing on the different substitution patterns of the phosphonate moieties on the aryl, and their effect on the overall geometry of the new materials.

P16.

Effects of 3D Modeling Parameters on Dimensional Accuracy of 3D-Printed Anatomical Structures Derived from CT Data

Can Aslan 1,2, Nathaniel Ordway 3, Gwen Tillapaugh-Fay 4, Dalanda Diallo 4, Kent M. Ogden 4, and Pranav Soman 1,2

1.Department of Biomedical and Chemical Engineering, 2. Syracuse Biomaterials Institute, Syracuse University; 3. Department of Orthopedic Surgery, 4. Department of Radiology, SUNY Upstate Medical University

Orthopedic surgery is an obvious area for development of 3D printer applications, and there are important issues that should be addressed when using 3D-printed models for applications that may affect patient care; in particular, the dimensional accuracy of the printed parts needs to be high to avoid poor decisions prior to surgical or therapeutic procedures. The purpose of this study was to examine the effects of changing certain parameters, available at different stages of the 3D model creation process, on the final accuracy of the 3D-printed model. The results revealed key parameters and settings to focus on when converting patient CT data into a 3D-printable model.

P17:

Mechanics of the Organ of Asymmetry in the Zebrafish Embryo

Craig Fox, M. Lisa Manning and Jeffrey Amack
Department of Physics, Syracuse University

Asymmetries in our bodies come about during development. Interruption of the proper left-right patterning of the heart and gut leads to congenital disease, one of the most common birth defects in the United States. Dr. Amack's lab studies a transient organ called Kupffer's vesicle (KV) in zebrafish, a vertebrate model organism. The proper formation of the KV is a vital component in left-right patterning of the embryo, but little is known about how the organ achieves the necessary shape to cause the correct patterning to occur. Working with data obtained at SUNY Upstate, I have a unique opportunity to apply both physical modeling and image analysis techniques to investigate the origin of asymmetry in zebrafish.

P18:

Surface Stiffness Affects Bacterial Adhesion and Antibiotic Susceptibility of Attached Cells

Fangchao Song 1,2, and Dacheng Ren 1,2,3,4
1. Department of Biomedical and Chemical Engineering, 2. Syracuse Biomaterials Institute, 3. Department of Civil and Environmental Engineering, 4. Department of Biology, Syracuse University

Bacterial biofilm formation is a leading cause of chronic infections. Although numerous studies have been conducted to investigate how material properties (such as surface chemistry, roughness, and hydrophobicity) influence biofilm formation, the effects of surface stiffness have only been scarcely explored. Here we report that surface stiffness is an important material property and increase in surface stiffness of PDMS may present a stress to attached cells, which can lead to reduced surface coverage, slow growth, and enhanced antibiotic tolerance.

P19:

Self-Reinforced Composites for Prevention of Fretting Corrosion of Biomedical Alloys: Electrochemistry and Surface Characterization

Eric S. Ouellette 1,2, Jeremy L. Gilbert 1,2

1. Department of Biomedical and Chemical Engineering, Syracuse University 2. Syracuse Biomaterials Institute, Syracuse, NY

Mechanically assisted crevice corrosion of modular tapers in orthopedic devices continues to present considerable challenges for manufacturers. On the one hand, modularity offers many surgical benefits, but on the other, it poses the risk of device failure due to complications related to fretting corrosion. This work is aimed at exploring the electrochemical behavior of modular tapers sleeved with Self-Reinforced Composite Poly(Ether Ether Ketone) (SRC-PEEK) films during incremental cyclic fretting corrosion (ICFC) testing and more fundamental pin on disk fretting corrosion testing. Surface morphology and chemistry of the SRC-PEEK films was explored after testing. Tapers fitted with SRC-PEEK linings showed significant reduction in fretting currents compared to control CoCrMo/CoCrMo junctions at physiologic loads (~.1 μA vs. ~3.5 μA, $p < 0.05$). Similar electrochemical results were observed in pin on disk testing. SRC-PEEK film surfaces showed, via EDS, minor transfer of alloy (primarily oxide) to the film surface during pin on disk testing, but no detectable alloy transfer from ICFC testing. Polymer transfer to alloy surfaces was not observed as confirmed by EDS. These results suggest that SRC-PEEK may be one potential solution to the issues posed by modularity in orthopedic devices.

P20:

Exploring a Single Engineered Protein Nanopore with an Enzymatic Domain

Avinash Thakur 1,2 and Liviu Movileanu 1,2

1.Department of Physics, Syracuse University, 2.Structural Biology Biochemistry and Biophysics Program, Syracuse University,

Understanding the real-time kinetics of protein-protein interactions is essential for both a better mechanistic and quantitative knowledge in protein dynamics as well as in biomedical applications. Here, we engineered E.coli ferric hydroxamate uptake component A (FhuA) pore, to obtain a functional nanopore with a movable catalytic domain, barnase (Ba), a bacterial ribonuclease. Our primary goal is to probe the interactions of tethered Ba with barstar (Ba*), which is its inhibitor. The unitary conductance of the engineered nanopore was 1.35 ± 0.37 nS in 300 mM KCl (n=6). This preliminary investigation serves as solid evidence that tethering a medium-size protein to the engineered nanopore did not impact its pore-forming ability. In the past weeks, we discovered that a slow-dialysis refolding protocol was helpful in obtaining quiet single-channel electrical signatures of the engineered nanopore. These quiet signatures remained unaltered under various experimental contexts.

P21:

Defect Proliferation in Active Nematic Suspension.

Prashant Mishra, Mark J. Bowick, Luca Giomi, Rastko Sknepnek and M. Cristina Marchetti

Physics Department, Syracuse University, SISSA, Italy, University of Dundee, UK, Physics Department & Syracuse Biomaterials Institute, Syracuse Univesity

The rich structure of equilibrium nematic suspensions, with their characteristic disclination defects, is modified when active forces come into play. The uniform nematic state is known to be unstable to splay (extensile) or bend (contractile) deformations above a critical activity. At even higher activity the flow becomes oscillatory and eventually turbulent. Using hydrodynamics, we classify the active flow regimes as functions of activity and order parameter friction for both contractile and extensile systems. The turbulent regime is marked by a non-zero steady state density of mobile defect pairs. The defect density itself scales with an ``active Ericksen number'', defined as the ratio of the rate at which activity is injected into the system to the relaxation rate of orientational deformations.

P22:

Modulation of phosphoinositide Monolayer Compressibilities by Physiological Levels of CA2+

Adolphe Kazadi Badiambile 1,2; Martin B. Forstner 1,2
1. Physic Department, Syracuse University 2. Syracuse Biomaterials Institute, Syracuse University

Phosphoinositides (PIPs) play a crucial role in many cellular processes that occur at the plasma membrane such as calcium release, exocytosis or involve mechanical membrane deformations. Thus, the question arises how mechanical properties of membranes of negatively charged lipids (as they occur at the cytosolic leaflet) are modulated by physiological bivalent ions. We investigated the effect of bivalent ions on the compressibility of monolayers of Phosphatidylinositol (PI), Phosphatidylinositol 4,5-bisphosphate (PIP2) , 1,2-dioleoyl-sn-glycero-3-phospho-(1'-rac-glycerol) (DOPG) and 1-palmitoyl-2-oleoyl-sn-glycero-3-phosphocholine (POPC); we also present a theoretical framework that describes the relationship between electrical surface potentials and compressibilities which shows good agreement with our experimental findings.

P23:

Complex Patterns Formed by Liquid Crystals in Circular and Annular Geometries.

Kyle Lawlor, Oksana Manyuhina, Mark Bowick and Cristina Marchetti
Physics Department, Syracuse University

Developing an understanding of the rules governing matter present in biological systems is of fundamental importance for being able to interact with and build structures on those scales. Here in our work, we look to provide theoretical insight into various types of structures in two-dimensional liquid crystals. Our work is motivated by recent experiments with a well-known biological liquid crystal, called the FD-Virus. The experiments looked at the effect of two types of geometries, circles and donuts, on the structures formed by liquid-crystalline FD-Virus. Through energetic considerations, we are able to gain insight into the preference of liquid-crystals to form certain structures in circular and annular regions that are consistent with experimental results.

P24:

Propagating Stress Waves During Epithelial Expansion

Kazage J. C. Utuje, Shiladitya Banerjee and M. Cristina Marchetti
Department of Physics/ Syracuse University, James Franck Institute/The University of Chicago, Department of Physics and Syracuse Biomaterals Institute/ SyracuseUniversity

Coordinated motion of cell monolayers during epithelial wound healing and tissuemorphogenesis involves mechanical stress generation. Here we present a continuum model of epithelial expansion that couples mechanical deformations in the tissue to contractile activity in the cells. A new ingredient of our model is a feedback between local strain and contractility that naturally yields a mechanism for viscoelasticity and effective inertia in the cell monolayer. Using a combination of analytical and numerical techniques, we demonstrate that our model quantitatively reproduces many experimental findings, including the build-up of intercellular stresses, and the existence of traveling mechanical waves guiding th monolayer expansion

P25:

Design of a CNC Tribological Bioreactor

Michelle M. Blum, Ryan Olson, Gabriel Smolnycki
Syracuse University, Mechanical and Aerospace Department

A CNC tribological bioreactor was designed in order to be able to replicate the 6 axes of motion of the human knee. This device quantifies the frictional and wear response of different combinations of materials of bioengineering interest while being able to maintain a lubricated contact interface. The device is able to collect particles worn off of the contacting surfaces for further analysis. This device actively maintains a constant vertical load against a contact interface while actuating the interface in 5 axes and measuring the resultant forces applied to one of the interface materials.

P26:

Self-Reinforcement of Poly(lactic acid) Fibers

Julia Tumbic, Patrick T. Mather
Biomedical and Chemical Engineering Dept., Syracuse University

Self-reinforcement of fibers is a technique used to improve on the mechanical properties of a material where crystalline polymer fibers are compacted near their melting points. However, the temperature at which the fibers are compacted can affect thermal and mechanical properties of the resulting material, as well as the crystallinity.
These effects on compacted poly(lactic acid) (PLA) are examined through the use of differential scanning calorimetry (DSC), dynamic mechanical analysis (DMA), and wide-angle x-ray scattering (WAXS). Scanning electron microscopy (SEM) is also utilized to look at the crystalline structures within the PLA fibers.

P27: Tracking Golgi on 2-D Substrates

Giuseppe Passucci, Megan E. Brasch, Nicholas O. Deakin, Christopher E. Turner, James H. Henderson, M. Lisa Manning
Department of Physics, Syracuse University, IGERT Fellow,
Syracuse Biomaterials Institute

Collective cell behavior is present in a multitude of environments, yet is a phenomena that is not well understood. In order to explain this behavior using a physical model, one of the key elements is the polarization of the cell, i.e. which direction the cells move in. Tracking of cell organelles from experimental images is a critical tool in this endeavor. Previous work by Baker et al focused on a tracking algorithm for cell nuclei. I have developed a method to concurrently track Golgi bodies which will yield information regarding cell polarization when combined with the ACTIVE nuclei tracking. Quantitative measures of polarization will be key in developing a self propelled particle model to describe cell motion.

P28:
Design and Characterization of a Tribologically Enhanced Hydrogel Construct for Articular Cartilage Repair

Allen Osaheni, Michelle M. Blum, Rebecca A. Bader, Patrick T. Mather
Syracuse University, Department of Mechanical & Aerospace Engineering

Recently, there has been a considerable amount of interest in the development of a synthetic material capable of repairing focal chondral defects in articular cartilage. Poly (vinyl alcohol) hydrogels are an attractive option due to their inherent biomimetic properties. However, their use for motion bearing applications is limited due to their inferior tribological properties compared to that of articular cartilage. This presentation will report on current progress in the investigation of two approaches for enhancing the tribological properties of PVA hydrogels: 1) the development of a zwitterionic polymer blend and 2) the development of a zwitterionic polymer brush.

P29:

Poly(ε-caprolactone) Shape Memory Polymer for Filling Critical-Sized Defects

Richard M. Baker, James H. Henderson, Patrick T. Mather
Syracuse Biomaterials Institute and the Department of Biomedical and Chemical Engineering, Syracuse University

The gold standard for filling critical-size defects remains bone autografts – transplants from a patient's own body - which have several drawbacks including second site morbidity and limited bone for harvesting. As a result, much effort has been spent in developing synthetic substitutes for filling critical size defects. Here, we have developed a shape memory scaffold capable of expanding under physiological conditions to fill critical-size defects. Heat-triggered expansion at body temperature was achieved through macromolecular design of the system's composition along with systematic variation in the shape programming conditions. Scaffold characterization revealed a highly porous and interconnective architecture with excellent shape memory characteristics. Preliminary in vitro cell studies show the scaffold is non-cytotoxic and a good candidate for in vivo studies. Our results demonstrate the potential for shape memory constructs to be employed for minimal invasive, space-filling applications.

P30:

Tracking and Analyzing Cells over Long Timescales in Complex In Vitro Biomaterial Environments

Megan E. Brasch, Richard M. Baker, M. Lisa Manning, and James H. Henderson
Department of Biomedical and Chemical Engineering, Syracuse Biomaterials Institute, NSF IGERT Program

Understanding cell motility behavior is foundational to research efforts in development, disease pathology, and wound healing. Innovations in cell tracking are being driven, in large part, by the use of in vitro biomaterial microenvironments of increasing complexity. To elucidate subtle differences in cell behavior despite cell variability, we introduce a new algorithm, Automated Contour-based Tracking for In Vitro Environments (ACTIVE), designed to track large numbers of cells for long timescales. ACTIVE is distinct from existing software because it accommodates both image intensity variability and multi-cell interactions. We present cell motility analysis for thousands of cells studied at varying densities on shape-memory-polymer-based nanotopographies.

P31:

Establishing a Co-culture between Pseudomonas Aeruginosa and IB3-1 Epithelial Cells for Evaluation of New Treatment Strategies

Elizabeth Luke, Patricia R. Wardwell, Ben Lundgren, Christopher T. Nomura, Rebecca A. Bader
Onondaga Community College, Department of Biomedical & Chemical Engineering and Syracuse Biomaterials Institute, Syracuse University, Department of Chemistry, SUNY ESF

The goal of this study was to establish a Pseudomonas aeruginosa (PAO1)-IB3-1 epithelial cell co-culture as an in vitro model of cystic fibrosis (CF). IB3-1 cells were passaged into a well plate and grown to confluency. PAO1 were added to transwell inserts over a range of concentrations and placed in indirect contact with underlying IB3-1 cells. After 24 hours, visual inspection revealed only a minor amount of cell death. To establish a direct contact co-culture, the bacteria will be added directly to the wells containing IB3-1 cells. Thus far, we have demonstrated that a CF model can be established.

SYRACUSE
BIOMATERIALS
INSTITUTE

SYRACUSE UNIVERSITY
The College of Arts and Sciences

SYRACUSE UNIVERSITY
ENGINEERING
& COMPUTER
SCIENCE

UPSTATE
MEDICAL UNIVERSITY

ESF
State University of New York
College of Environmental Science and Forestry