Biomaterial Interfaces
Room: Central Hall - Session BI-TuP

Biomaterial Interfaces Poster Session

BI-TuP1 Response of Mesenchymal Stem Cells to Nano-Scale Rippled Silicon Surfaces, *O.Z. Andersen, A. Keller, D.C.E. Kraft, F. Besenbacher,* ***M. Foss***, Aarhus University, Denmark

Proliferation of stem cells has been observed to be affected by surface roughness in the micro and nanometer range. Furthermore, when cultured on line patterns with dimensions in the sub-micrometer regime these have been found to adopt elongated morphologies and align with respect to patterns, often called contact guidance. Contact guidance has been observed to induce stem cell differentiation towards neurogenic and myogenic lineages. We have investigated the effect of rippled silicon substrates with different height and periodicity in the nanometer range on the behavior of human derived adult stem cells.

The substrates were prepared by irradiating silicon substrates with xenon ions with different energies and fluxes at angles of either 65 or 67º with respect to the surface normal. From this, substrates with nanoripples of different heights (h) and periodicities (λ) were obtained. As determined by AFM measurements the prepared substrates had ripple features ranging from h=3 nm with λ=50 nm up to h=70 nm with λ=650 nm. The cellular response towards these surfaces was investigated using human dental pulp stem cells (hDPSC). The cells (2,500 cell/cm^2) were cultured for periods of 1, 3 and 4 days, fixed and used for assessing cellular proliferation, morphology, alignment with respect to the ripple structures and expression of the osteogenic markers Runx2 and ALPL and the myogenic markers GATA4 and MyoD1.

It is found that the ripple structures influenced cellular proliferation. An increase in proliferation was observed up until ripple structures with h=8 nm and λ=170 nm followed by a decrease as the ripples structures further increased in size. The decrease in proliferation for larger ripple structures was found to correlate with an increasing number of cells undergoing contact guidance. Furthermore, it was found that the cells cultured on the ripple surfaces with features larger than h=8 nm and λ=170 nm had up-regulated expression of the myogenic markers.

The increasing ripple size is associated with larger RMS roughness values. Hence, the increase in cellular proliferation as the ripples grows in size, correlate well with literature on cellular behavior on rough samples. The decrease in proliferation observed with the larger ripple structures correlates with the increasing degree of contact guidance observed for these samples. We speculate that it could be related to changes in the cellular expression profiles. This is supported by the data from the immunohistochemistry. Especially the finding that the expression of MyoD1 is up-regulated with the larger ripple structures as this regulatory protein is known to be associated with cell cycle arrest.

BI-TuP2 *In Vitro* Cytotoxicity of Poly(*N*-isopropyl acrylamide), ***M.A. Cooperstein****, H.E. Canavan*, University of New Mexico

Poly(*N*-isopropyl acrylamide) (pNIPAM) is a thermoresponsive polymer that undergoes a conformation change in a physiologically relevant temperature range. Above its lower critical solution temperature (LCST, ~32°C), pNIPAM is relatively hydrophobic, and cells can be easily cultured on pNIPAM-grafted surfaces. When the temperature is lowered, the polymer's chains extend and cells detach in intact sheets. It has previously been demonstrated that the NIPAM monomer is toxic; however, there are conflicting opinions as to whether the polymerized form of NIPAM is toxic. Since the cell sheets detached from pNIPAM could ultimately be used on humans, it is crucial to assess the cytotoxicity of surfaces coated with pNIPAM. Very few (<10) studies exist that investigate the cytotoxicity of pNIPAM, and their results are conflicting. Furthermore, the published studies are not comprehensive. Instead, they focus on isolated cell lines cultured on pNIPAM films generated using different methods, and use different assays to determine the degree of cytotoxicity. In this work, we present a comprehensive investigation of the cytotoxicity of pNIPAM-grafted surfaces. The cytotoxicity of pNIPAM is evaluated using different cell lines (endothelial, epithelial, smooth muscle, and fibroblasts), polymerization (free radical and commercially available pNIPAM) and deposition (spin coating and plasma polymerization) techniques, and cytotoxicity tests (MTS, Live/Dead, plating efficiency). The pNIPAM-coated surfaces are evaluated using X-ray photoelectron spectroscopy and goniometry. We find that there is lower cell viability on pNIPAM surfaces when compared to controls. The viability also seems to be deposition type dependent. This work will have valuable insights into the cytotoxicity of pNIPAM-coated surfaces, and therefore into the applicability of cells grown on these surfaces for use in human subjects.

BI-TuP3 Functionalization of Cerium Oxide Nanoparticles with Biocompatible Molecules to Prevent Surface Modification by Phosphate Ions, ***P. Mendez****, S. Das, A. Kumar, S. Sudipta*, University of Central Florida

Cerium oxide nanoparticles (CNP's) are a promising catalytic antioxidant in biological systems, exhibiting superoxide dismutase and catalase mimetic, and nitric oxide radical scavenging activity. Nanoceria exhibits redox activity by switching between Ce 3+ and 4+ depending on environment. CNPs have also been shown to protect cells against oxidative stress. Specific formulation of cerium oxide nanoparticle is non-toxic, non-immunogenic and well tolerated both *in vitro* and *in vivo* model, which provide the rational/platform for its biological applications. Recently CNPs have become increasingly popular in biological work, both in vivo and in vitro. We have previously shown these CNPs have some potential to treat wound care, cancer therapy, retinal protection and neurodegenerative diseases. However there are several factors to consider, one being its interaction with biological molecules in different buffers, media, and serum. The common anions are phosphate, sulfate and carbonate. In our previous work, CNPs interaction with sulfate and carbonate are proven not to alter the surface chemistry of CNPs, whereas phosphate anions do. The CNPs properties are surface dependent and phosphate anions are shown to modify the surface. Current study focuses on preventing the CNPs surface modification by phosphate buffer through functionalization. Dextran and polyethylene glycol (PEG) were used to functionalize CNPs. The functionalized CNPs were incubated with phosphate ions and changing their absorbance and emission characteristic was analyzed by Ultraviolet-visible spectroscopy (UV) and photoluminescence spectroscopy (PL). The results show that CNPs functionalized with Dextran prevented interaction with PBS (phosphate ions) and preserved the redox property of the nanoparticle. However, PEG coating fails to do so. Varying pH levels in the range of 6-8 had no significant effect on the phosphate ion interaction with CNPs surface. We further investigated the surface interaction of PEG-CNPs with phosphate, while varying the concentration (5% to 40%) and the chain length (300 molecular weight to 6000 molecular weight) of PEG. The results showed that increasing the concentration or chain length of PEG did not have any effect on phosphate and cerium surface interaction. Looking into the surface charge and morphology of PEG and Dextran will allow us to gain further insight into what is occurring on the surface of these nanoparticles with phosphate ions. This basic study will help to engineer CNPs, which will be effective in biological applications and overall to prevent modification of CNPs surface.

BI-TuP4 Surface Topographic Patterns Functionalized with Different Biomaterials for Studying Neural Cell Behaviors, ***Y.P. Lu****, M.Y. Lin*, National Applied Research Laboratories, Taiwan, Republic of China

Micro- and Nano-patterned substrates functionalized with extracellular matrix (ECM) have been recognized as powerful tools for regulating cell behaviors and functions, because biomimetic features enable the study of cellular responses to specific external stimulations. Surface topography in micro- or nano-scale contributes to provide a physical niche to resemble the physiological environment, whereas biomolecules in ECM can provide a cell-favorable environment in the artificial materials. Independent combination of topographical fabricated scaffolds and biomaterials with bioactive features have provided a suitable *in vitro* cellular function study system. We developed two different characteristics of polymer chips with microstructure and functionalized peptide, including polydimethylsiloxane (PDMS) chip modified with poly-D-lysine (PDL) peptide on the surface and silicon wafer modified with laminin-1 peptide on the surface. The PDMS chip was composed of ridges and grooves around 10 μm in width to form a stripe pattern with micro-meter scale. Another silicon substrate was prepared from micro-meter stripe pattern with nanorods in the grooves region. Neuron-like PC12 cells were then cultured on these 3D substrates and stimulated to manifest different behaviors, and induced cell differentiation with nerve growth factor (NGF) treatment. PC12 cells were cultured in biomimetic substrates impacted in several properties: Cells displayed contact guidance on both substrates and became elongated along the grating axis of scaffolds. When neuron cells cultured on the PDMS substrate, soma and neurite grew on the ridge, groove, or even lateral wall and formed the overlappin g distribution. On the other hand, PC12 cells grew on the nanorod substrate functionalized with laminin and displayed contact guidance and became parallel elongated along the flat ridge plane. Some neurites were able to cross groove through the nanorod-supported laminin bridge. Results gained from this study provide the manipulation of neuron cell fate by using enhanced patterning techniques and would be

valuable in various biomedical applications, including tissue engineering, neuron regeneration, and basic cell biology.

BI-TuP5 Nanoscale Characterization of Acid and Thermally Treated Collagen Fibrils and its Effects on the Cellular Responses of Osteoblast, ***Y.J. Park***, KAIST, Republic of Korea, *G.J. Choi*, *S.H. Kim*, *J.H. Hahn*, *T.G. Lee*, KRISS, Republic of Korea, *W.J. Lee*, KAIST, Republic of Korea, *D.W. Moon*, KRISS, Republic of Korea

Type I collagen is a major extracellular matrix component and its hierarchical structure plays an important role in the regulation of cellular behavior. In order to study the effect of structure, surface chemistry, and mechanical properties change of collagen fibril on the cellular response, various collagen structures were prepared by different degrees of acidic and thermal treatment of native collagen fibrils. First, to study the microstructure and morphology of collagen, atomic force microscopy (AFM) was used due to its high spatial resolution and surface morphology specificity. Second, we applied time-of-flight secondary ion mass spectrometry (ToF-SIMS) to study the surface chemistry changes of collagen fibrils by utilizing the capability of providing molecular surface chemical information. Third, to observe the changes in the mechanical properties during acidic and thermal treatment of collagen fibrils, contact-resonance force microscopy (CR-FM) was applied because of its ability to provide not only nanoscale spatial resolution but also quantitative information about the mechanical properties. It was demonstrated that the change of microstructure, surface chemistry, and mechanical property of collagen induced by acidic and thermal treatment could be observed in molecular level using AFM, ToF-SIMS, and CR-FM. The structural, chemical, and mechanical properties of acid and thermally treated collagen fibrils could be correlated with the cellular responses such as cell morphology, cytoskeleton organization, and viability.

BI-TuP6 Comparison between Fabrication Techniques for Glass Microfluidic Microchannels, ***C. Vélez***, *S. Silva*, Universidad de los Andes, Colombia, *X. Wang*, University of Florida, *A. Gonzalez-Mancera*, *C. Leidy*, *J.F. Osma*, Universidad de los Andes, Colombia, *F. Ren*, University of Florida

This work presents a comparison between three microfluidic fabrication techniques for shallow channels (less than 20µm depth) on glass including laser scribing, wet chemical etching using photoresist as a mask, and wet chemical etching using copper deposition as a mask. The purpose of this device is to perform optical particle tracking using a Four Roll Mill configuration. A JPSA excimer UV laser system was used to perform the laser scribing process. This process proves to be the fastest, allows for better control over the etching rate, and produces smallest angles at the edges. On the other hand, wet etching with copper as a mask uses hydrofluoric acid to produce the channels, and the process proves to be better than etching with photoresist mask. Wet etching with copper as mask also shows better transparency at the bottom of the microchannels, which is perfect for optical tracking and a more homogeneous etching than laser scribing; however, it uses more time and there is less control over the etching rate. Complex geometrical patterns as semicircles and intersections were better obtained using wet etching with copper than the other two fabrication techniques. Liquid flowing inside complex geometry patterns was simulated with Comsol Multiphysics V 4.2. Final fabricated devices were tested with two micro-particle solutions: alginate particles and lipid vesicles in aqueous solutions.

BI-TuP7 Ceria-Gold-Chitosan Nanosystem with Improved Redox Activity and Enhanced Imaging, ***S. Barkam***, *S. Das*, University of Central Florida, *P. Kulkarni*, *S. Mallik*, North Dakota State University, *S.S. Seal*, University of Central Florida

Research advances in nanoparticles constructs intended for biomedical applications have proved to be of major importance. This often presents serious challenges in terms of imaging or tracking of the nanoparticles. Our research aims at developing a system that has the effective characteristics of therapeutics and imaging modality. It is well known that Reactive oxygen species (ROS) and nitrogen species play a critical role in many oxidative stress associated disorders like cancer, neurodegeneration, radiation induced tissue damage. Ceria nanoparticles (CNPs) have proved to be potential redox active radical scavenging agents which also exhibit superoxide dismutase and catalase mimetic activity. These nanoparticles can potentially act as antioxidant which is attributed to its redox nature of switching the oxidation states from +3 to +4 mediated at the oxygen vacancies on the surface. Recent research has shown progress in the study of enhancing the contrast in imaging using gold nanoparticles by various microscopy techniques such as TEM, Computed tomography (CT) etc. Its marker ability is attributed to the strong plasmon enhanced absorption and increased light scattering ability which gives detailed information of the location of gold particles by combining optical and electronic microscopy. It is also proven to be non toxic and biocompatible *in vivo*. Our research attempts on providing a formulated coupling of the above notions to form a CNP-Chitosan-Gold integrated system. Addition of Chitosan helps in the reduction of $HAuCl_4$ to form gold nanoparticles and this polymer also enables the biocompatibility of the imaging agent. The activity of CNPs can be improved by surface modification through selective functionalization thereby enhancing the redox behavior and stability of the system.

BI-TuP8 The Effect of Light-Induced Surface Modification of Functionalized Ceria Nanoparticles towards Killing of Skin-Derived Cancer Cells, *S. Barkam*, *S. Das*, *V.P. Perez*, ***S.S. Seal***, University of Central Florida

Malignant melanoma is the sixth most common cancer diagnosed in the United States. Surgery, chemotherapy and radiation are some of the successful techniques in killing tumor cells. However, in these techniques, it is not easy to distinguish tumor cells from the healthy once which inadvertently get exposed to chemical agent/radiation. Therefore it is required to develop an anti-cancer agent which selectively kills the cancer cells, while still protecting the normal tissues. In our preliminary work, we have shown that Dextran (1000Da) coated Cerium oxide nanoparticles (Dex-CNPs) selectively kills the cancer cells (50% killing at a concentration of 150µM) without inducing toxicity to normal cells. However, the mechanism involved on how CNPs/Dex-CNPs attain the selectivity and efficiently kill the tumor cells is still unknown. In this study we have synthesized Dextran coated ceria nano particles (Dex- CNPs) with different surface oxidation state ratio (Ce^{4+}/Ce^{3+}) but similar shape and size. This will provide an in depth understanding of the key chemical and physical properties of the system that can improve its efficacy. The varied surface oxidation of the particles is achieved by exposing Dex-CNPs to light which initiates a color change from dark to pale yellow indicating the reduction of Ce^{4+} to Ce^{3+}. Interestingly we have found that the Dex-CNPs exposed to light have reduced cytotoxicity towards squamous cell carcinoma cell line (CCL30) compared to the protected once. Characterization of the same revealed that Dex- CNPs exposed to light have decreased Ce^{4+}/Ce^{3+} surface oxidation ratio compared to the other. This provides more insight in useful synthesis of Dex-CNPs in terms of storage and handling. In summary, higher Ce^{4+}/Ce^{3+} surface oxidation ratio is more efficient in hindering tumor growth by effectively hindering the tumor-stoma interaction.

BI-TuP9 Stability and Dispersion Characterstics of Ceria Nanoparticles in Biological Media, ***P. Munusamy***, *T. Suntharampillai*, *D.R. Baer*, Pacific Northwest National Laboratory

Although nanoparticles have wide variety of biomedical applications, the characteristics that produce beneficial or toxic effects are not well understood. Some ceria nanoparticles have gained high visibility for their redox active properties which appear to serve as free radical scavengers. Toxicity measurements of various types and sizes of ceria nanoparticles tested with a variety of *in-vitro* and *in-vivo* studies have many apparent inconsistencies. To accurately evaluate *in-vitro* and *in-vivo* testing results it is important to understanding the properties and behaviors of the ceria particles in the media in which the tests are conducted. In this work, ceria nanoparticles prepared by thermal hydrolysis process are used as a model nanoparticle to study there stability and dispersion characteristics. The particles behaviors in biological media such as aggregation and sedimentation rates were systematically evaluated by aggregation kinetic analysis and sedimentation studies. As one example, fetal bovine serum (FBS) which consists of multiple proteins components was found to be an effective dispersion agent forming a relatively robust surface layer with 24 hours. Data on mixtures of common biological media solutions show a variety of differing impacts. The type of kinetic data we have collected provides important information regarding behavior of nanoparticles in different dispersion media which valuable in understanding toxicity and other biological impact studies.

BI-TuP10 An Anti-biofilm Formation Design Strategy Based on Fibrous Topographical Cues, ***M. Kargar***, *A.S. Nain*, *B. Behkam*, Virginia Tech

Biofilms tend to be significantly less responsive to antimicrobial stressors, compared with planktonic bacteria. Studies on the natural antifouling surfaces have shown that most of them have well organized micro/nanoscale surfaces features. This work aims at improving the current understanding of the effects of well-defined sub-micron surface topographies on microorganism-surface interactions with the ultimate goal of developing a bioinspired antifouling design framework based on topographical cues. To this end, model surfaces with well-defined surface topographies in form of highly aligned polystyrene nano fibers at controlled separation distances (diameter (D_f). 90 nm-900 nm and Separation distance (S_f): 0 nm-5000 nm) were fabricated using our previously developed pseudo-dry spinning method. *Pseudomonas aeruginosa* strain PAO1 (diameter (D_b)≈ 500nm, length (L_b)≈ 1800nm) was then presented on the nanofibrous surfaces in a 2.5-hour static retention assay. Scanning electron

microscopy was utilized to quantify linear attachment density (number of bacteria/fiber length) and the degree of alignment between bacteria and fibers for all combination of fiber diameters ($D_f < D_b$,$D_f \approx D_b$, $D_f > D_b$) and spacing ($S_f < D_b$,$S_f \approx D_b$, $D_b < S_f < L_b$, $S_f > L_b$) at single cell level. Our experimental results demonstrate the presence of an optimum antifouling geometrical condition related to the minimum experimental adhesion density. This optimum condition occurs when the fiber diameter is close to the bacteria diameter ($D_f \approx D_b$) and the spacing is less than the bacteria diameter ($S_f < D_b$)). Comparing to the bare surface this geometrical combination reduces bacterial adhesion by more than 40%. Additionally, the SEM images show that bacteria developed microcolonies (onset of biofilm formation) on the bare samples while the engineered surface inhibited colony formation. Our data reveal strong similarity between thermodynamic underpinnings of bacteria – surface interactions and vesicle– surface interactions. The thermodynamic principles governing the vesicle-rigid surface interactions were used to interpret the experimental data and explain the experimentally observed optimum antifouling topographical condition using an energy-based approach. Furthermore, a systematic design methodology for empirical determination of the optimum antifouling topographical condition for nanofiber textured surfaces is outlined.

BI-TuP11 Synthesis of Redox Active Cerium Oxide Nanoparticle with Varying Size and Shape by Manipulating the Chain Length of PEG, ***S. Das***, *C. Neal, A. Kumar,* University of Central Florida, *A.S. Karakoti,* Pacific Northwest National Laboratory, *S.S. Seal*, University of Central Florida

The objective of this study is to ascertain the role of different molecular weights polyethylene glycol (PEG) solvents on the redox property of cerium nanoparticles. PEG with molecular weight of 300, 600, 1500, 3400 and 6000 were selected in this study for preparing 5mM cerium oxide nanoparticles (CNPs) in 20% PEG medium. The size and morphology of the particles were analyzed using TEM. Interestingly, the size and shapes of the nanoparticles were observed different in different chain length of the PEG nanoparticles from round to star shaped. The red-ox state of the samples was accessed at regular intervals, until stability was observed, using UV-Vis spectroscopy. Absorbance of each sample was recorded in the range of 250nm to 600nm. All the PEG-CNPs sample revealed stable peak at 298nm (characterstic of Ce^{3+}) with additional minor peak observed at 380nm for 1500, 3400 and 6000 PEG-CNPs sample. The biological activity measured by superoxide dismutase mimetic assay was found to be similar for all the PEG-CNPs. The current research suggests that by changing the chain length of the PEG it is possible to synthesize different size and shape of the PEG-CNPs with similar redox activity for specific applications.

BI-TuP12 In Vitro Protein-Biofilm on Nanoparticles Characterizated by ToF-SIMS, STEM and TEM, ***H.P. Wiesmann***, *J. Neunzehn,* Technische Universität Dresden, Germany, *F. Draude, H.F. Arlinghaus*, University of Muenster, Germany

Time-of-flight secondary ion mass spectrometry (ToF-SIMS) was applied to detect and characterize different nano scaled protein coatings on gold nanoparticles. After washing the nanoparticles by various steps, the gold particles (diameter of about 10 to 20 nm) were coated with the proteins collagen type I and fibronectin and also different protein combinations in thin mono layers. The different nano-scaled protein layers on the cleaned gold nanoparticle surfaces were identified by detection of the protein typical amino acid mass peaks by time-of-flight secondary ion mass spectrometry.

In addition, the protein-coated particles were investigated by transmission electron microscopy to get information about the proteins structure and their layer thickness on the particle surfaces. It was possible to distinguish the protein coatings by their molecule thicknesses and to evaluate the different particle agglomeration influenced by the used proteins by the use of scanning transmission electron microscopy.

BI-TuP13 A Novel Method for the Bio-conjugation of Catalytic Nanoparticles, ***R. Draper***, *S. Das, S.S. Seal*, University of Central Florida

This paper explores the possibility of using bio-conjugation to disperse nanoparticles into composite matrices for catalytic purposes. Solid state catalysis is a complex mechanism which can be drastically affected by catalyst size, morphology, surface condition, concentration, dispersal, and location to critical reaction sites. To better understand these mechanisms, as well as to tune solid catalysts to have the greatest specific effect, it is sometimes desired to arrange them into difficult to achieve, high free energy formulations. To overcome their natural characteristics, templating bio molecules can be used to arrange the particles into these difficult formulations to more completely understand the kinetics of the catalysis. One of the more prevalent methods of nanoparticle conjugation involves Watson-Crick base pairing, a method not suitable for aggressive solvents, or for conjugating many types of particles. Here we explore a novel method for biomolecule based nanoparticle conjugation with application to dispersion of catalytic particles in a solid matrix. The effects of these various dispersions are then studied using microscopic, spectroscopic, and colorimetric methods.

BI-TuP14 A Microfluidic Study of the Interaction of Haematopoietic Stem Cells with their Microenvironment, ***M. Hanke***, *C. Christophis, C. Leinweber,* Institute for Functional Interphases, KIT, Karlsruhe, Germany, *N. Baran, I. Taubert, P. Wuchter, A. Ho,* University Hospital Heidelberg, Inner Medicine V, Germany, *A. Rosenhahn*, Institute for Functional Interphases, KIT, Karlsruhe, Germany

A microfluidic adhesion assay has been developed to quantitatively investigate the interaction of cells with interfaces under well defined flow conditions.[1] The device was applied to the study of the interaction of leukaemic cells and haematopoietic stem cells with hyaluronic acid surfaces. We found that beyond a critical shear stress the cell surface receptor CD44 mediates a catch bond, flow induced rolling of the cells on the surfaces[2], similar as observed for leukocytes during the extravasation process.[3] A similar rolling phenomenon occurred on mesenchymal stroma cells, which are present in the bone marrow niche creating the microenvironment required for haematopoietic stem cells to endlessly proliferate. The mesenchymal stroma cells inter alia secrete the stroma-cell-derived factor-1 alpha which has been reported to activate stem cell migration, mobilization and homing.[4] The effect of this chemokine on the movement of haematopoietic stem cells was also studied utilising a novel microstructured niche model.

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BI-TuP16 Nonfouling Amphiphilic Polysaccharides, ***S. Bauer***, *M.P. Arpa-Sancet,* Ruprecht-Karls University Heidelberg, Germany, *J. Finlay,* University of Birmingham UK, *N. Aldred,* Newcastle University, UK, *M.E. Callow, J.A. Callow,* University of Birmingham UK, *A.S. Clare,* Newcastle University, UK, *A. Rosenhahn*, Karlsruhe Institute of Technology, Germany

The potential of polysaccharides for fouling-resistant coatings lies in their chemical structure: due to the presence of ether- and hydroxyl-groups, they are highly hydropihilic and able to form water-storing hydrogels. In this study, the free carboxyl-groups of two surface-tethered polysaccharides, hyaluronic acid (HA) and chondroitin sulfate (CS) were postmodified with the hydrophobic trifluoroethylamine. This strategy was chosen to study different effects: a blocking of free carboxyl groups to prevent complexation of bivalent ions and to preserve the resistance of these coatings in the marine environment, a shifting of the contact angle towards the minimum in the Baier curve and the introduction of amphiphilic properties due to the hydrophobic fluoro-groups. The coatings were tested towards their protein resistance and with different fouling relevant species to evaluate their resistance properties. Settlement and adhesion strength of the marine bacteria *Cobetia marina* and the two algae species *Ulva linza* and *Navicula perminuta* were reduced by the modification in case of HA based coatings. However, in case of CS coatings, the adverse effect was observed.

BI-TuP18 STM Characterization of Chemically Prepared Peptide-Functionalized Monolayers, ***A. Raigoza***, *L. Webb*, The University of Texas at Austin

Proteins are able to express catalytic and sensing functions that current technologies are unable to reproduce. Instead, efforts have been focused on properly integrating this functionality with non-biological materials. Unfortunately, proteins are generally observed to lose function because of unfolding, aggregation, and overall loss of structure that occurs when a soft, solution-phase material is placed in the harsh structural and electrostatic environment that occurs on and near surfaces. To improve protein-surface interactions, we create a surface that is composed of peptides, which can be tailored for specific protein attachment. Here, we present scanning tunneling microscopy (STM) images of peptide-terminated monolayers on a gold surface created by functionalizing alkanethiol self-assembled monolayers. A Huisgen cycloaddition "click" reaction is used to tether the peptides to the surface at reactive locations that line up with modified residues on the peptide. STM is used to image the surface at each reaction step with molecular resolution. A complete surface reaction would generate a peptide density of approximately 0.6 peptides/nm^2, based on the distance between reactive azide functional groups and the theoretical size of our

peptide. We estimate 0.4 peptides/nm^2 based on the area covered by peptides in our images.

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