The outcome of the rigorous bio-resistance tests presented here highlights the critical importance of processing temperature on the surface graft density of electrostatically driven PLL-g-PEG. The temperature induced assembly process can be effectively and easily implemented for a range of biomedical and biotechnological applications.


The development of versatile and robust strategies for the surface modification of multiple classes of materials has proven challenging, with few generalized methods. Many available methods have limitation for widespread use due to the need for specific surface chemistries and/or laborious multistep procedures. A protocol to deposit brominated plasma polymer (Brpp) thin films on a variety of substrate surfaces (silicon wafers, glass, gold, Teflon) has been developed. These coatings are highly adherent and exhibit good stability in aqueous, biphasic and autoclaving conditions. The Brpp coating was found to be a useful platform for secondary reactions and exhibit good stability in aqueous, biphasic and autoclaving conditions. The Brpp coating was found to be a useful platform for secondary reactions and exhibit good stability in aqueous, biphasic and autoclaving conditions.

9:40am BI-MoM2 Temperature-Induced Electrostatic Assembly of Poly (Ethylene Glycol) Co-Polymer for Non-Fouling Biomedical Applications: How Low Can You Go?. R. Ogaki, O. Zoffmann Andersen, K. Koeller, O.C.E. Kraft, M. Foss, Aarhus University, Denmark

Development of long-term stable surfaces that resist bio-adhesion continues to stimulate the field of biomedical and biological research. While numerous strategies have been developed over the last several decades, the challenge remains in the creation of surfaces that can provide long-term zero bio-adhesion from a variety of biological entities that spans lengths of days to years. The PLL-g-PEG surfaces prepared at various temperatures (20 to 80°C) have been characterized by X-ray photoelectron spectroscopy (XPS). The temperature induced assembly process can be effectively and easily implemented for a range of biomedical and biotechnological applications. Our approach to engineer cellular environments is based on self-organizing spatial positioning of single signaling molecules attached to synthetic extracellular matrices, which offers the highest spatial resolution with respect to the position of single signaling molecules. This approach allows tuning tissue with respect to the most relevant properties, i.e., viscoelasticity, peptide composition, nanotopography and spatial nanopatterning of signaling molecule. Such materials are defined as “nano-digital materials” since they enable the counting of individual signaling molecules, separated by a biologically inert background. Within these materials, the regulation of cellular responses is based on a biologically inert background which does not initiate any cell activation, which is then patterned with specific signaling molecules such as peptide ligands in well defined nanoscopic geometries. This approach is very powerful, since it enables the testing of cellular responses to individual, specific signaling molecules and their spatial ordering. Detailed consideration is also given to the fact that protein clusters such as those found at focal adhesion sites represent, to a large extent, hierarchically-organized cooperativity among various proteins. We found that the surface of the extractable material, including the functional packing density which is defined by an integrin-integrin spacing of approximately 68 nanometers. Such critical spacing values vary as matter of transmembrane receptor choice of interest. We have also developed methods which allows the light initiated activation of adhesion processes by switching the chemical composition of the extractable material. This enables us to quantify the frequency of leader cell formation in collective cell migration as a function of initial cell cluster pattern size and geometry. Moreover, “nano-digital supports” such as those described herein are clearly capable of involvement in such dynamic cellular processes as protein ordering at the cell’s periphery which in turn leads to programming cell responses.

8:40am BI-MoM3 Spatially and Temporally Coordinated Processes of Cells at Molecular to Cellular Scales. J.P. Spatz, Max Planck Institute for Intelligent Systems & University of Heidelberg, Germany

Our approach to engineer cellular environments is based on self-organizing spatial positioning of single signaling molecules attached to synthetic extracellular matrices, which offers the highest spatial resolution with respect to the position of single signaling molecules. This approach allows tuning tissue with respect to the most relevant properties, i.e., viscoelasticity, peptide composition, nanotopography and spatial nanopatterning of signaling molecule. Such materials are defined as “nano-digital materials” since they enable the counting of individual signaling molecules, separated by a biologically inert background. Within these materials, the regulation of cellular responses is based on a biologically inert background which does not initiate any cell activation, which is then patterned with specific signaling molecules such as peptide ligands in well defined nanoscopic geometries. This approach is very powerful, since it enables the testing of cellular responses to individual, specific signaling molecules and their spatial ordering. Detailed consideration is also given to the fact that protein clusters such as those found at focal adhesion sites represent, to a large extent, hierarchically-organized cooperativity among various proteins. We found that the surface of the extractable material, including the functional packing density which is defined by an integrin-integrin spacing of approximately 68 nanometers. Such critical spacing values vary as matter of transmembrane receptor choice of interest. We have also developed methods which allows the light initiated activation of adhesion processes by switching the chemical composition of the extractable material. This enables us to quantify the frequency of leader cell formation in collective cell migration as a function of initial cell cluster pattern size and geometry. Moreover, “nano-digital supports” such as those described herein are clearly capable of involvement in such dynamic cellular processes as protein ordering at the cell’s periphery which in turn leads to programming cell responses.

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10:00am BI-MoM5 Chemically Defined Synthetic Surfaces for Mesenchymal Stem Cell Expansion. L. Meagher, H. Thiesen, P. Pasic, R.A. Evans, S. Pereira, K. Tsang, V. Glattauer, K. Styu, C.L. Be, D. Haylock, CSIRO Materials Science and Engineering, Australia

Interest in surface initiated polymerisation (SIP) for biomedical applications has increased rapidly recently, particularly the use of “living” free radical polymerisation mechanisms as highly defined coating properties/architectures can be achieved. Here we demonstrate that advantages of using a single chain transfer agent approach and that such coatings can be used for the effective control of cell-surface interactions, an essential requirement in a broad range of applications in biomaterials and regenerative medicine. In the expansion of stem cells for therapeutic applications, fully synthetic, chemically defined materials are a requirement. Polymeric coatings which contain synthetic cell signalling molecules are key to ongoing progress in the generation of cells as therapies. Coating characterization was carried out using X-ray photoelectron spectroscopy (XPS) and colloidal probe atomic force microscope (AFM). Cell culture studies were carried out using bone marrow derived human mesenchymal stem cells (hMSCs) using standard techniques. Differentiation of hMSCs was carried out using standard protocols in induction medias and the presence of characteristic cell surface markers was determined using flow cytometry. Substrate materials were silicon wafers or tissue culture polystyrene (TCPS).

In this study, we focus on a surface initiated Radical Addition-Fragmentation chain Transfer (RAFT) approach and present data demonstrating that dense polymer brushes can be prepared via surface immobilized macro-RAFT agents. The brush nature of the coatings was confirmed using a combination of XPS analysis and direct interaction force measurements with the AFM colloid probe technique. The properties of the coatings could be fine tuned using a variety of parameters such as the RAFT agent surface density, the polymerisation conditions, the monomer feed composition and the conjugation of cell attachment motifs such as cyclic peptides which interact with cell surface integrins. For example, the combination of a low cell adherent, low protein adsorbing polymer brush containing a conjugated peptide which interacted with alpha-beta, integrins resulted in a surface which supported the expansion of hMSCs in a xeno-free, chemically defined, serum replacement media. In addition the expanded cells expressed cell surface markers typical of undifferentiated
hMSCs and the expanded cells were able to differentiate along adipogenic, osteogenic and chondrogenic pathways.


11:00am Bi-MoM6 Binary Colloidal Crystal Structures Combined with Chemical Surface Modification to Achieve Superior Control Over Biointerfacial Interactions, P. Koegler, Swinburne Univ. of Tech., Australia, P. Pasic, J. Gardiner, V. Glattauer, CSIRO Materials Science and Eng., Australia, A. Clayton, Swinburne Univ. of Tech., Australia, H. Thissen, CSIRO Materials Science and Eng., Australia, P. Kingshott, Swinburne Univ. of Tech., Australia

Biointerfacial interactions play a major role in the field of biomedical materials and regenerative medicine and are of tremendous importance to in vivo and in vitro applications. Cell-material interactions are mediated by surface parameters including the materials surface chemistry and topography. Colloidal lithography represents a promising tool to modify surface topography. However, complex processes operating at the interface often remain poorly understood. To get an insight into these processes, we investigated the role played by surface ion equilibration in defining interactions between an implant material (TiO2) and components of blood (in this case, platelets), because blood is the first tissue that foreign materials come into contact with when inserted into the body and because platelet response is crucial in defining the implant’s fate.

Titanium is a widely used biomaterial. Its success is in part due to the favorable biocompatibility properties conferred by its oxide, TiO2. We have previously shown that Ca2+-TiO2 interactions affect the distribution of phospholipid phosphatidyl serine (PS) in model lipid membranes prepared on TiO2. This allowed us to hypothesize that platelet activation will be affected by these interactions as well.

Platelets are anuclear cell fragments circulating in blood. Activated at wound sites, they aggregate and provide a catalytic surface for the formation of a fibrin-based clot that stops the bleeding. Recently, platelets have been recognized to participate in inflammation, wound healing, tissue regeneration, and immune responses. Activation of platelets by foreign surfaces is detrimental to blood-contacting implants but beneficial for osteoimplants. Upon activation, platelets expose on their surface and secrete a number of markers. These include PS, activated form of GPIb-IIIa, and proteins CD62P and CD63 that are found in the membranes of the intracellular α- and dense granules of quiescent platelets. To assess the state of platelet activation on TiO2, we assayed for the expression of these markers. In order to isolate a clear cause-and-effect relationship between Ca2+-TiO2 interactions and platelet activation, we focused on purified platelets.

Our main finding is that the platelet activation profile on TiO2 depends on the presence of Ca2+. Furthermore, in the absence of Ca2+, the α- and dense granule secretion is differentially regulated on titania. The differential granule secretion by platelets, as regulated by the surface properties, can be applied towards controlled release of molecules from platelets by nanoparticles or implants in drug delivery applications.
Authors Index

Bold page numbers indicate the presenter

Andersen, O.Z.: BI-MoM11, 2
Be, C.L.: BI-MoM5, 1
Besenbacher, F.: BI-MoM11, 2
Bottiger, J.: BI-MoM11, 2
Caruso, F.: BI-MoM1, 1
Chen, R.: BI-MoM1, 1
Clayton, A.: BI-MoM6, 2
Evans, R.A.: BI-MoM1, 1; BI-MoM5, 1
Foss, M.: BI-MoM11, 2; BI-MoM2, 1
Gardiner, J.: BI-MoM6, 2

Glattauer, V.: BI-MoM5, 1; BI-MoM6, 2
Gupta, S.: BI-MoM10, 2
Haylock, D.: BI-MoM5, 1
Kingshott, P.: BI-MoM6, 2
Kloss, F.: BI-MoM11, 2
Koegler, P.: BI-MoM6, 2
Kolind, K.: BI-MoM2, 1
Kraft, D.C.E.: BI-MoM11, 2; BI-MoM2, 1
McLean, K.M.: BI-MoM1, 1
Meagher, L.: BI-MoM5, 1
Muir, B.W.: BI-MoM1, 1
Offermanns, V.: BI-MoM11, 2
Ogaki, R.: BI-MoM2, 1
Pasic, P.: BI-MoM5, 1; BI-MoM6, 2
Pereira, S.: BI-MoM5, 1
Postma, A.: BI-MoM1, 1
Reviakine, I.: BI-MoM10, 2
Siillassen, M.: BI-MoM11, 2
Spatz, J.P.: BI-MoM3, 1
Such, G.K.: BI-MoM1, 1
Thissen, H.: BI-MoM5, 1; BI-MoM6, 2
Tsang, K.: BI-MoM5, 1
Zoffmann Andersen, O.: BI-MoM2, 1