Monday Evening Poster Sessions, November 2, 1998

Biomaterial Interfaces Group Room Hall A - Session BI-MoP

Biomaterial Interfaces Poster Session

BI-MoP1 Molecular Structure of Protein-Resistant Plasma-Deposited Oligoglyme, Dioxane, and Crown Ether Films, *E.E. Johnston*, *B.D. Ratner*, University of Washington

Poly(ethylene oxide)-like (PEO-like) films are of interest as biomaterials for their ability to resist protein adsorption and cellular attachment.@footnote 1,2@ Here we compare the chemistry and molecular structure of PEO-like films that were plasma deposited from linear and cyclic ether rich precursors. The plasma precursors consist of a series of four linear oligo ethylene glycol dimethyl ethers (oligoglymes) (CH@sub 3@-O-(CH@sub 2@CH@sub 2@O)@sub n@-CH@sub 3@, n = 1-4) and a corresponding series of cyclic oligomers -(CH@sub 2@CH@sub 2@O)@sub m@-: dioxane, (m=2); 12-crown-4 ether, (m=4); and 15-crown-5 ether (m=5). Analysis by x-ray photoelectron spectroscopy (XPS), and time of flight SIMS (TOF-SIMS) will be reported. The view emerging from the analysis is that oligoglyme plasma deposited films consist of a carpet of randomly branched, methylterminated chains of -(CH@sub 2@CH@sub 2@O)- repeat units. The films are generally free of hydroxyl groups and hydrocarbonaceous domains. Films from larger molecular weight precursors contain longer fragments of intact monomer suggesting that the films are more loosely crosslinked. Proposed models of the oligoglyme PDF surface structure can account for many aspects of the high mass TOF-SIMS spectra. Interpretation of the crown ether PDF spectra was more difficult than that of the oligoglyme films. On the basis of the (45/43+45) positive ion ratio analysis and adventitious binding of sodium and potassium cations it is concluded that the outermost surface of crown ether films consist predominantly of intact cyclic fragments. TOF-SIMS analysis of dioxane films suggests the presence of hydroxyl groups pendant to an unsaturated hydrocarbonaceous matrix and the presence of ether-carbon bearing precursor fragments. @FootnoteText@ @footnote 1@ L@aa o@pez, G. P.; Ratner, B. D.; Tidwell, C. D.; Haycox, C. L.; Rapoza, R. J.; Horbett, T. A. J. Biomed. Mater. Res. 1991, 26, 415-436. @footnote 2@ Johnston, E. E., PhD dissertation, University of Washington, 1997.

BI-MoP2 Curvature-Induced Domain Formation in Lipid Bilayer Membranes, C.D. Keating, T.G. D'Onofrio, M.J. Natan, P.S. Weiss, Pennsylvania State University

A number of studies have suggested the importance of domain formation in biological membranes. We describe recent results concerning the effect of lipid bilayer lateral heterogeneity on model membrane function in single unilamellar vesicles. Initial work has focused on preparation and imaging of lipid membranes of various curvatures, and manipulation of these membranes in flowing solution by optical trapping. Several methods have been applied to alter liposome morphology, from encapsulation of materials (both biological and nonbiological) to stretching vesicles using multiple optical traps. Fluorescence microscopic data on lateral domains as a function of membrane curvature will be discussed.

BI-MOP3 In Situ AFM Study of Myoglobin Monolayers on Bare and Modified Graphite, M.J. Giz, IQSC/University of Sao Paulo, Brazil; S. Boussaad, N.J. Tao, Florida International University

We have examined with the atomic force microscopy (AFM) technique the structure of myoglobin (Mb) monolayers on graphite. This protein adsorbs weakly and slowly on bare graphite. The formation of a Mb monolayer can take up to 80 minutes. Furthermore, the molecules of Mb form a rod like assemblies randomly distributed on the surface of graphite. The length and the width of a single rod are 50 and 8 nm, respectively. The value of the width is similar to the dimension of a single protein. However, on graphite (DDAB) or Lauric acid (LA), the Mb is well ordered. The AFM images show that the protein preserves the rod-like assembly. In the case of DDAB, the Mb rods are aligned and almost parallel to each other, whereas on LA the rods are arranged into a V-type structure. In addition, the rods formed on modified graphite (70-80 nm) are much longer then their counter part on bare graphite. The Mb rods can be viewed as chains of 5-10 molecules and their formation can be attributed to an interaction between the proteins.

BI-MoP4 Nanofabricated Structures for Laser Induced Fluorescence, M.E. Foquet, A. Lopez, S.W. Turner, H.G. Craighead, Cornell University

Fabrication techniques of microfluidic systems are being developed for use in laser induced fluorescence studies of macromolecules. Devices with submicrometer size capillaries have been fabricated on glass substrates for the study of electrophoretic motion of biopolymers. The motion of individual DNA molecules can be observed and their speed estimated. Other devices integrating both optical waveguides and capillaries have been fabricated. The waveguides are included to perform fluorescence using lasers as light source, allowing for the excitation of very small volume combined with a very high intensity and a perfect alignment to the capillary. Gratings defined by electron-beam lithography are used for the coupling of light into the waveguide. The same fabrication process can readily be used to fabricate capillaries with dimensions down to 0.1 μ m. Light has been coupled into the waveguide and the patterns of scattered light have been recorded. Excitation of fluorescent solution in the capillaries can be observed. We are now characterizing the efficiency and the optical properties of these structures.

BI-MoP5 Effects of Surface Finish on the Corrosion of NiTi Shape Memory Alloy, S. Trigwell, VG Scientific; G. Selvaduray, San Jose State University

NiTi (nitinol) alloys have become very attractive to biomedical applications because of their unique shape memory and superelastic properties. Due to the high Ni content of the alloy (up to 55%), concern has been expressed as to its biocompatibility. Nickel is known to cause toxic reactions in the body and be a possible carcinogen in cases of long term exposure, such as in implants. In this study, coupons of an equiatomic alloy were prepared by four methods (mechanically polishing, electropolishing, chemically etching, and plasma etching) to produce various levels of roughness and surface chemistry, as examined by AFM, SEM, XPS, and AES. The corrosion current (rate) for each finish was determined in Hank's Balanced Salt Solution at 37°C. The correlation between surface finish and corrosion susceptibility was determined that may be important in the preparation of NiTi for biomedical applications.

BI-MoP6 Second-Harmonic Generation in Thin Films of Bacteriorhodopsin: Sensor for Organic Electronic Devices, N.V. Didenko, A.A. Fedyanin, T.V. Murzina, E.P. Lukashev, O.A. Aktsipetrov, Moscow State University, Russia

The nonlinear-optical method of second-harmonic generation (SHG) that has been shown to be a sensitive probe for studying surfaces, interfaces and thin films is suggested as a new non-destructive pH-sensor for biological display elements and readout of information for photochromic optical storage. The pH-induced changes of quadratic susceptibility of oriented micron-thick bacteriorhodopsin D85N films obtained for basic titrations (pH range 5-11.5) have led to drastic (more than an order of magnitude) variations in the SHG response. The photo- and electroinduced effects in SHG and Hyper-Rayleigh Scattering (HRS) in solid films of native bacteriorhodopsin are shown to be quite sufficient to distinguish by means of SHG and HRS quazistable states of bacteriorhodopsin molecule which can be used as functional states of memory storage elements. The output of a Q - switched YAG laser at the wavelength of 1064 nm that has been used as a fundamental radiation is shown not to cause the destruction of the samples and switching the memory element as well.

BI-MOP7 Observation of Infected Lymphocyte Cells by Atomic Force Microscopy, A. Cricenti, R. Generosi, M. Girasole, Consiglio Nazionale delle Ricerche, Italy; C. Colizzi, S. Bach, Universita' di Roma Tor Vergata, Italy; P. Perfetti, Consiglio Nazionale delle Ricerche, Italy

The interaction between lymphocyte cells and HIV virus have been studied at the membrane level by Atomic Force Microscopy in the repulsive regime of contact mode. Morphological characteristics of non infected lymphoid cells and HIV infected cells were easily imaged in fixed and dried cell preparations. After HIV exposure we observed a decrease in surface protrusions (loss of microvilli) and the creation of many dips. Some particles, presumably of viral origin (120 - 130 nm size), were also observed in proximity of the cell surface. Similar changes have been observed by AFM on cells exposed to intense electromagnetic field thus indicating that such cells undergo modifications of their morphology upon suffering from an external agent.

BI-MoP8 Enhancing the Sensitivity and Selectivity of the Solid-Phase Immunoassay Using Water Soluble Polymer Coatings, M. Natesan, S. Metzger, Geocenters, Inc.; R.J. Colton, G.U. Lee, Naval Research Laboratory Immunoassays have gained acceptance as both a bioanalytical technique and diagnostic tool due to the availability of antibodies from a variety of

Monday Evening Poster Sessions, November 2, 1998

species against a wide range of analytes. These assays are often conducted on a solid surface to facilitate separation of the enzymes or radioisotopes that are typically used to amplify the antibody-analyte reaction. The antibody is usually immobilized on a hydrophobic surface by spontaneous adsorption, which is a process driven by molecule-surface interactions and/or conformational changes. The complex nature of this spontaneously adsorbed film can lead to erroneous signal due to the unwanted adsorption of assay constituents or antibody conformational changes. In this presentation we will describe two new schemes for directly immobilizing antibodies at a surface using a monolayer of water-soluble polymer that resists adhesion of proteins and cells. One technique uses direct covalent immobilization of the antibody to the polymer film while the other uses a molecular recognition interaction for assembly. We will describe the physical properties of the polymer films and compare the activity of the polymer immobilized antibodies to spontaneously adsorbed antibodies.

BI-MoP9 Time-of-Flight Cluster Static SIMS, XPS and XRD Studies of Calcium Phosphate Phases, C.C. Chusuei, D.R. Justes, M.J. VanStipdonk, E.A. Schweikert, D.W. Goodman, Texas A&M University

Calcium phosphate phase identification is of interest in the modeling of bone growth on metal oxide surfaces. Ostwaltd's step rule suggests that various phases of calcium phosphate will form first prior to that of the principal phase found in bone, hydroxyapatite (HAP). XRD has been shown to be effective in distinguishing between brushite, octacalcium phosphate, amorphous calcium phosphate, alpha-tricalcium phosphate, betatricalcium phosphate and HAP. However, this technique is not sensitive to microscopic amounts of material. The effectiveness of ToF cluster SSIMS and XPS methods in the qualitative analysis of standard calcium phosphate powders are compared with XRD. In addition, results of SIMS and XPS studies the solid-liquid uptake of calcium phosphate on UHV prepared metal oxide are presented.

BI-MoP10 Surface Analysis of Anodic Behavior of 316L SS in SRB-Containing Seawater, *G. Chen*, Constellation Technology Corporation, US; *D.C. White, R.J. Palmer,* University of Tennessee/Oak Ridge National Laboratory; *S.S. Cristy,* Lockheed Martin Energy Systems

Type 316L stainless steel concentric electrodes were exposed to pure cultures of Desulfovibrio desulfuricans, of Vibrio harveyi and the coculture of these bacteria. A 1 microA/cm@super 2@ current was applied for 3 days while the chemostats were closed systems. Subsequently, aerated fresh medium was added. Impedance spectroscopy detected pitting of the coculture-exposed electrodes after addition of fresh medium. X-ray photoelectron spectroscopic analysis after current application and at the end of the experiment revealed that oxygen reduction induced pitting by: (a) formation of a SO@sub 4@@super 2-@, S@sub 2@O@sub 3@@super 2-@ and SO@sub 3@@super 2-@ mixture, (b) oxidation of relatively stable compounds such as Cr(OH)@sub 3@ and, (c) causing sulfides to penetrate the passive film.

5:30 PM

Author Index

-A-Aktsipetrov, O.A.: BI-MoP6, 1 — B — Bach, S.: BI-MoP7, 1 Boussaad, S.: BI-MoP3, 1 - C -Chen, G.: BI-MoP10, 2 Chusuei, C.C.: BI-MoP9, 2 Colizzi, C.: BI-MoP7, 1 Colton, R.J.: BI-MoP8, 1 Craighead, H.G.: BI-MoP4, 1 Cricenti, A.: BI-MoP7, 1 Cristy, S.S.: BI-MoP10, 2 — D — Didenko, N.V.: BI-MoP6, 1 D'Onofrio, T.G.: BI-MoP2, 1 — F — Fedyanin, A.A.: BI-MoP6, 1 Foquet, M.E.: BI-MoP4, 1

Bold page numbers indicate presenter

— G — Generosi, R.: BI-MoP7, 1 Girasole, M.: BI-MoP7, 1 Giz, M.J.: BI-MoP3, 1 Goodman, D.W.: BI-MoP9, 2 — J — Johnston, E.E.: BI-MoP1, 1 Justes, D.R.: BI-MoP9, 2 -K-Keating, C.D.: BI-MoP2, 1 - L -Lee, G.U.: BI-MoP8, 1 Lopez, A.: BI-MoP4, 1 Lukashev, E.P.: BI-MoP6, 1 -M-Metzger, S.: BI-MoP8, 1 Murzina, T.V.: BI-MoP6, 1 -N-Natan, M.J.: BI-MoP2, 1

Natesan, M.: BI-MoP8, 1 — P — Palmer, R.J.: BI-MoP10, 2 Perfetti, P.: BI-MoP7, 1 — R — Ratner, B.D.: BI-MoP1, 1 — S — Schweikert, E.A.: BI-MoP9, 2 Selvaduray, G.: BI-MoP5, 1 -T-Tao, N.J.: BI-MoP3, 1 Trigwell, S.: BI-MoP5, 1 Turner, S.W.: BI-MoP4, 1 -v-VanStipdonk, M.J.: BI-MoP9, 2 - w -Weiss, P.S.: BI-MoP2, 1 White, D.C.: BI-MoP10, 2