Tuesday Afternoon, November 1, 2005

Biomaterial Interfaces
Room 311 - Session BI1-TuA

Sensors/Diagnostics

Moderator: M.J. Tarlov, National Institute of Standards and Technology

2:00pm **BI1-TuA1 Fluorescent Conjugated Polyelectrolytes: Superquenching, Biosensing and Biocidal Activity**, ***D.G. Whitten,*** University of New Mexico **INVITED**

The talk will focus on the photophysics of fluorescent conjugated polyelectrolytes and their very high sensitivity (superquenching) to quenching by small molecules that can associate with the polymers and interact via energy or electron transfer. Superquenching occurs for the polymers in solution and also when they self-assemble on microspheres or nanoparticles. The application of superquenching to biosensing has provided a means for high sensitivity detection of enzyme activity, proteins and nucleic acid hybridization. It has also been found that these polymers have biocidal activity towards bacteria and bacterial spores. The origin of the light-induced biocidal activity will be discussed.

2:40pm **BI1-TuA3 Toward Improved Biosensors: Studies of Protein Immobilization on Polymerized Planar Supported Lipid Bilayers**, ***J. Joubert,*** *E.H. Elandaloussi, S.S. Saavedra,* University of Arizona

Planar supported phospholipid bilayers maintain high resistance to nonspecific protein adsorption, which is a useful attribute for biosensor surfaces. However, their instability to drying is a factor reducing their commercial implementation. By crosslinking polymerizable lipid monomers (e.g., bis-sorbylphosphatidylcholine, bis-SorbPC) bilayer stability can be increased while maintaining biofouling (i.e., nonspecific protein adsorption) resistance. Further, the properties of this poly(bis-SorbPC) platform can be modified to study nonspecific and specific interactions with proteins for biosensing applications. One modification for studying nonspecific interactions involves adding various percentages and types of nonpolymerizable lipid to the bilayer before polymerization and drying to introduce a varying number and size of defect sites with differing polarities (hydrophobic for exposed lower lipid leaflet and hydrophilic for exposed glass) in a controlled manner. Studies of nonspecific protein binding to this variety of defects in these bilayers can aid in understanding fouling and subsequent failure of biosensors. Another set of modifications for analyzing specific protein interactions is aimed at immobilizing analyte-specific receptor proteins onto the bilayer and analyzing the degree to which sensing activity is retained. These modifications include doping into the bilayer a polymerizable lipid with a reactive (e.g., primary amine) headgroup for protein receptor attachment or microcontact printing the protein receptor onto the polymerized bilayer. This talk will discuss development of such methodologies to attach proteins to poly(lipid) bilayers to study protein-lipid and protein-protein interactions on such surfaces.

3:00pm **BI1-TuA4 Gallium Nitride-based BioFETs for Label-free Biosensing**, ***K. McCoy,*** University of Florida*; J.C. Sullivan, J.C. Culbertson, E. Snow,* Naval Research Laboratory*; S.J. Pearton,* University of Florida*; L.J. Whitman,* Naval Research Laboratory

Biologically modified field effect transistors (BioFETs) have the potential to directly detect biochemical interactions in aqueous solutions for a myriad of applications. In order for these devices to be useful, they must satisfy three major criteria. The bioFET must be stable in aqueous solutions across a range of pH and salt concentrations, be sensitive to biochemical interactions on the surface of the device, and be able to probe specific biochemical interactions. BioFETs that we are developing based on AlGaN/GaN quantum well devices can potentially satisfy all of these requirements. These charge-sensitive devices are being functionalized with receptors to stochastically sense the binding of target molecules in aqueous samples. The sensing is based on device geometries whereby the stochastic binding of individual biomolecules above a device will cause a change in conductance. It has already been demonstrated that these AlGaN/GaN quantum well devices can sense small changes in pH of electrolyte solutions. It is our goal to functionalize the surface in such a manner that the sensitivity of the device is not severely reduced. We are evaluating two reaction schemes to accomplish this task. The first involves modifying the surface with a SAM, then attaching a polymer to that SAM which can couple to biological probes. The second method employs a proprietary scheme to functionalize the surface with a layer of avidin that can then be coupled to biotinylated probes. The reaction schemes have been characterized in both UHV (XPS) and solution (cyclic voltammetry, fluorescence microscopy). The effect of these schemes on the electrical properties of the devices will be discussed, along with our progress toward determining the ultimate sensitivity of this biosensor system.

3:20pm **BI1-TuA5 Increasing Immunosensor Responses: from Antibody Fragments and 3D Substrates to Functionalized Nanoparticles**, ***K. Bonroy,*** IMEC and K.U. Leuven, Belgium*; F. Frederix,* IMEC, Belgium*; P. Cliquet,* R.U. Gent, Belgium*; G. Reekmans, H. Jans, T. Ghoos, R. De Palma, W. Laureyn,* IMEC, Belgium*; B. Goddeeris,* K.U. Leuven and R.U. Gent, Belgium*; P. Declerck,* K.U. Leuven, Belgium*; G. Borghs,* IMEC, Belgium

Researchers are continuously seeking for new transduction principles and biosensor interfaces. Both the transducer and biochemical interface contribute to the sensor signal. However, over the years it became clear that a lot of these approaches lack sensitivity for some applications. In this paper we report on several modifications at the (bio)chemical interface in order to increase/tune the immunosensor signal. Two important routes were investigated; the increase of the amount of active/well-oriented receptormolecules on the surface and the use of functional nanoparticles for signal amplification. In this paper we present some of our approaches to control the amount of immobilized molecules and to mitigate non specific adsorption of proteins. Different mixed thiol SAMs, indirect assay formats, immobilization methods, 3D nanoparticle films, 3D porous gold surfaces, and size-reduced receptormolecules such as ScFvs and Fab antibody fragments were optimized, characterized and their influences on the sensor response were evaluated. We will show that some of these modifications at the level of the interface can generate a considerable increase in the response of immunosensors such as SPR, QCM and electrochemical sensors. In addition, we also optimized some of the above-mentioned enhancement approaches towards one application i.e. antibiotic detection. Therefore, a new antibiotic modified disulfide was synthesized and evaluated on gold substrates and nanoparticles. The characterization and optimization was performed using XPS, SPR, IR, CA, CV and TEM. The antibiotic tailored surfaces and nanoparticles were also evaluated in the final biosensing application. In conclusion, we will show that (bio)chemical modifications of the immunosensor interface can be used to manipulate and control the final sensor signal. In addition, we will show that interface modifications could offer a platform from which application-specific sensitivity problems can partially be addressed.

3:40pm **BI1-TuA6 Fluidic Force Discrimination Assays in Complex Media**, ***S.P. Mulvaney,*** *A.A. Glaser, M. Malito, C.R. Tamanaha, J.C. Rife, L.J. Whitman,* Naval Research Laboratory

We are developing a highly sensitive and selective biosensor system that uses giant magnetoresistive sensors arrayed in a Bead ARray Counter (BARC) microchip to directly detect magnetic microbead labels. The beads are used both to label biorecognition events in a binding assay and to reduce background through a process known as fluidic force discrimination (FFD). FFD is a controlled bead removal procedure that leverages the strength of biomolecular recognition against fluidic forces to selectively remove nonspecifically bound beads and beads labeling nonspecifically bound analyte. FFD not only reduces the background label density, thereby improving the analytical sensitivity of the binding assay, but also lowers the occurrence of false positives. Highly sensitive DNA assays (<10 fM) and immunoassays (<1 ng/mL) have been demonstrated in less than 30 minutes at room temperature, without amplification or concentration steps (i.e. PCR). Successful assays have also been run in serum, plasma, whole blood, and complex environmental matrices. We'll discuss mitigation steps (i.e. addition of chelating agents, filtration, etc.) required to achieve detection in complex media as well the overall impact on detection levels. We'll also examine the ability to minimize sample handling by incorporating simple processing capabilities into the microfluidics cartridge. @FootnoteText@ S.P.M., A.A.G., and M.M. are employees of Nova Research Inc., Alexandria, Va.

Author Index

Bold page numbers indicate presenter