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RUTGERS

New Jersey Center for Biomaterials

QSENSE WORKSHOP

ABSTRACTS OF GUEST SPEAKERS

PROVIDED BY: Nanoscience Instruments

WHEN: June 4, 2019

WHERE: Rutgers University
New Jersey Center for Biomaterials
Piscataway, NJ

EVENT SCHEDULE

8:30-9:30	Registration, Welcome, Opening Remarks
9:30-10:00	Dr. Joachim Kohn, Rutgers University
10:00-10:40	Dr. Archana Jaiswal, Nanoscience Instruments
10:40-11:20	Dr. Songyan Zheng, Bristol-Myers Squibb
11:20-12:00	Dr. Jennifer Chen, Drexel University
12:00-1:00	Lunch
1:00-1:40	Dr. Sanjeeva Murthy, Rutgers University
1:40-2:20	Dr. Connor Bilchak, University of Pennsylvania
2:20-3:00	Dr. Detlef Matthias Smilgies, Cornell University
3:00-3:40	Dr. Robert Mosley, Rowan University
4:00-5:00	Instrument demonstrations

ABSTRACTS

An overview of the use of QCMD at the New Jersey Center for Biomaterials

Dr. Joachim Kohn
Director, New Jersey Center for Biomaterials, Rutgers University

Using QCM-D for Detergent Cleaning Efficiency and Degradation Studies

Dr. Archana Jaiswal
Nanoscience Instruments

Impact of Interfacial Interactions in Biological Drug Product Development

Dr. Songyan Zheng
Bristol-Myers Squibb

The Use of Dissipation Monitoring of the QCM-D to Study Cell-Substrate Adhesion and Cell Signaling

Dr. Jennifer Chen
Drexel University

Using QCM-D to Study the Kinetics of Adsorption of Proteins and Nanospheres

Dr. Sanjeeva Murthy
New Jersey Center for Biomaterials, Rutgers University

Gas Transport of High-Performance Polymer Composite Membranes: Insights from QCM-D Technology

Connor R. Bilchak
Departments of Chemistry and Materials Science & Engineering, University of Pennsylvania

QCM-D Applications in Food Science and Plasmonics

Dr. Detlef Matthias Smilgies
Smith School of Chemical and Biomolecular Engineering, Cornell University

Using the Quartz Crystal Microbalance to Model Surface Interactions of Complex Drug Delivery Nanoparticles

Dr. Robert Mosley
Department of Biomedical Engineering, Rowan University

AN OVERVIEW OF THE USE OF QCMD AT THE NEW JERSEY CENTER FOR BIOMATERIALS

Dr. Joachim Kohn
Director, New Jersey Center for Biomaterials, Rutgers University

Our collaboration with QCMD started with a random meeting with Dr. Bengt Herbert Kasemo on a beach in Hawaii as part of the 2000 World Biomaterials Congress. After a few months of negotiation, the NJCMB became a Center for QCMD Excellence and we purchased our very first QCMD instrument. Since then, the instrument offerings have become increasingly powerful and much easier to use. At the same time, our QCMD related research became more sophisticated, resulting in a total of 11 publications so far. A few highlights of our nearly 20-year collaboration with QCMD are:

(1) A series of publications describing the use of QCMD to optimize the protein adsorption properties of polymers that were part of our resorbable stent program

(2) A study describing the use of QCMD to monitor the viscoelastic properties of skin in liquid environments
While all of the early studies focused on protein adsorption phenomena, our more recent work uses QCMD to study the adsorption of nanoparticles to specific test surfaces.

This presentation will highlight some of the important results obtained by the use of QCMD at the New Jersey Center for Biomaterials.

USING QCM-D FOR DETERGENT CLEANING EFFICIENCY AND DEGRADATION STUDIES

Dr. Archana Jaiswal
Nanoscience Instruments

Detergent formulations incorporate many functional ingredients, such as enzymes, surfactants, buffers, chelating agents, polymers, optical brighteners and fragrances. Their performance is evaluated by the efficiency in removing different types of soils from a surface for example, glassware, dishes or fabric. The main objective of a new formulation is to completely remove a soil without harming the original surface, while at the same time remaining cost efficient and environmentally friendly. The cleaning efficiency of a detergent is affected by several factors including individual component concentration, temperature, and water hardness. Understanding the soil removal process under various conditions is important in development, screening and ranking of detergent formulations. Very few standard methods exist today for evaluation of detergent cleaning efficiency.
The QCM-D technique offers real-time monitoring of the surface cleaning process under various conditions. A desired soil mimic can be prepared onto a variety of different types of QCM-D sensor surfaces, and it's removal by detergents can be monitored by recording time-resolved data. Several examples of real-time monitoring of soil removal, and detergent screening based on cleaning efficiencies will be presented in this talk.

IMPACT OF INTERFACIAL INTERACTIONS IN BIOLOGICAL DRUG PRODUCT DEVELOPMENT

Dr. Songyan Zheng
Bristol-Myers Squibb

THE USE OF DISSIPATION MONITORING OF THE QCM-D TO STUDY CELL-SUBSTRATE ADHESION AND CELL SIGNALING

Dr. Jennifer Chen
Drexel University

The quartz crystal microbalance (QCM) has been utilized as a label-free, real-time, biosensing system for over fifty years. Its unique capability of monitoring the cell-substrate interaction non-invasively in real time has led to the emergence of its applications in areas of fundamental cell biology and medical research. Both measurement of the QCM-D, changes of resonance frequency (△f) and changes of energy dissipation (△D), have been applied in studies of cells. This talk will focus on how the changes in energy dissipation can be used as an approach to the study cell adhesion, cell mechanics, and cell signaling, all of which can potentially be applied to medical diagnosis and/or pharmaceutical development. In addition, this talk will also provide information on the practical aspects of QCM-based cell studies.

USING QCM-D TO STUDY THE KINETICS OF ADSORPTION OF PROTEINS AND NANOSPHERES

Dr. Sanjeeva Murthy
New Jersey Center for Biomaterials, Rutgers University

The structure of proteins and nanoparticles can change upon their adsorption onto surfaces. The degree and the kinetics of this change is of practical (drying paint), technological (physical vapor deposition) and biological (biocompatibility) importance. This phenomenon can be studied in real time by taking advantage of the ability of Quartz Crystal Microbalance with Dissipation (QCM-D) to monitor the mass and the viscosity changes on a time scale of a few seconds. Data obtained from some common blood plasma proteins, albumin and fibrinogen, will be presented along with those of the nanospheres used in drug delivery applications. The conformation of the proteins in the adsorbed layer depends both on the nature of the substrate and the protein concentration. The state of the nanosphere has also been found to depend on the composition of the substrate and the nanosphere concentration. Implications of these results on cell adhesion and drug delivery will be discussed.

GAS TRANSPORT OF HIGH-PERFORMANCE POLYMER COMPOSITE MEMBRANES: INSIGHTS FROM QCM-D TECHNOLOGY

Dr. Connor R. Bilchak
Departments of Chemistry and Materials Science & Engineering, University of Pennsylvania

Polymer-based membranes play a key role in several industrially important gas separation technologies, e.g., removing CO2 from natural gas, with enormous economic and environmental impact. While significant strides have been made to improve on existing technologies, there are several important design shortcomings that must be overcome before polymer membranes may be successfully implemented in large-scale industrial applications.

Here, we will discuss recent advances in membrane technology realized through materials comprised of inorganic nanoparticles grafted with polymer chains. In particular, we will focus on the structure of nanocomposite membranes and how the underlying properties of the materials, which are measured through novel use of QCM-D technology, are fundamentally altered through variations in the grafted polymer parameters—including the molecular weight, functionality, and presence of ungrafted polymer. The result is a means to rationally design polymeric membrane materials with properties exceeding the current best for a number of material classes and gas separation processes.

QCM-D APPLICATIONS IN FOOD SCIENCE AND PLASMONICS

Dr. Detlef Matthias Smilgies
Smith School of Chemical and Biomolecular Engineering,
Cornell University

Synthetic food colors have been implicated in attention deficits in children. Natural food colors such as beet juice extract or berry juice would be a healthier alternative, however, they lack the color stability of their synthetic counterparts. We have found that certain polysaccharides stabilize natural colors. We investigated the interaction of common polysaccharides and natural food colors using QCM-D and correlated the findings with the color stability.

Plasmonics is concerned with the interaction of localized plasmons. We have used gold nanoparticles with single-stranded DNA (ssDNA) ligands. ssDNA behaves like a polyelectrolyte, and hence the average distance between the gold cores can be controlled by the counterion concentration in the buffer. We used QCM-D to quantify the surface coverage and adsorption kinetics of such gold nanoparticles on functionalized silicon oxide under different counterion concentrations.

USING THE QUARTZ CRYSTAL MICROBALANCE TO MODEL SURFACE INTERACTIONS OF COMPLEX DRUG DELIVERY NANOPARTICLES

Dr. Robert Mosley
Department of Biomedical Engineering, Rowan University

We have developed a gold nanoparticle (AuNP) functionalized with nucleic acids to carry a high payload of Daunomycin for selective delivery to cancer cells. Short nucleic acids (ANC) act as anchor points onto which we can conjugate larger nucleic acids or aptamers. We can control loading of both anchor DNA layers and larger conjugated DNA oligonucleotides. We also have shown the ability to load a very high payload of Daunomycin with controlled release modulated by aptamer sequence engineering. In this presentation, we observe the formation of this particle through the quartz crystal microbalance with dissipation (QCM-D). We first see how salt (NaCl) can be employed to increase the density of ANC bound to the sensor surface. We observe hybridization of longer, linear DNA sequences onto the ANC layer and further use QCM-D reports to test polymerization of double stranded complexes using the Klenow enzyme. We also observe the interactions of Daunomycin with the ANC-oligonucleotide layer. We use ANC layers of increasing density to observe hybridization with a characterized aptamer – furthermore, we see evidence that Daunomycin intercalation can stabilize the aptamer structure. Using the QCM-D, we observe self-assembly of functional layers of nucleic acids on a gold surface. We detect multiple mechanisms of drug loading and see evidence that intercalating drugs may stabilize the double stranded regions of aptamer sequences. This tool has allowed us to draw conclusions about the organization of AuNPs functionalized with DNA and further assisted in optimizing this system for maximum drug loading and targeting capabilities.


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ABOUT NANOSCIENCE INSTRUMENTS

Nanoscience Instruments is a trusted supplier of high-quality laboratory instrumentation for microscopy, surface science characterization, and nanomaterial synthesis. We partner with innovative instrument manufacturers around the world to provide expert support and service in North America. Our sales, applications and service teams work together to provide expert advice and solutions to our customers.