NANOSENSORS

Session co-chairs: Angela Violi, University of Michigan, and Ian Kinloch, University of Manchester

Nanotechnology is enabling the development of devices in a scale ranging from one to a few hundred nanometers. At this scale, novel nanomaterials and nanoparticles show new properties and behaviors not observed at the microscopic level. The aim of nanotechnology is on creating nanodevices with new functionalities stemming from these unique characteristics. One of the early applications of nanotechnology is in the field of nanosensors, devices that make use of the unique properties of nanomaterials and nanoparticles to detect and measure new types of events in the nanoscale. For example, nanosensors can detect chemical compounds in concentrations as low as one part per billion, or the presence of different infectious agents such as virus or harmful bacteria. This session will offer a broad overview of the state-of-the-art work done on nanosensors in academia and at national laboratories in US and EU.

D. Ivan Vlassiouk from Oak Ridge National Laboratory will discuss various detection schemes using both electrical and ionic currents modulation through precisely engineered nanostructures. He will cover applications of nanopores and nanochannels in various sensing nanofluidics approaches for detection of a variety of biomolecules. Ionic transport through nanopores and ion channels in cell membranes exists in virtually all biological cells and is important in such things as the regulation of heart function, nerve signals, and delivery of nutrients to the cell. Nanopores have also started to play a major role in contemporary biotechnology, because many separation and sensing proesses require pores with nanometer-sized openings. The examples of nanosensors for detection of specific DNA and anthrax will be given. These emerging sensors are based on local changes of the surface charge on walls of nanochannels induced by binding of an analyte. The specific analyte binding is detected as a change of the ion-current rectification of single nanopores defined as a ration of currents for voltages of one polarity, and currents for voltages of the opposite polarity. In the second part of the presentation, he will discuss versatile nanosensors based on emerging 2D material – grapheme. Various gas nanosensors with ultra-low detections limits will be presented.

Prof. Andrew de Mello, Department of Chemistry and Applied Biosciences at ETH Zurich, will talk about his development of microfluidic devices for high-throughput biological and chemical analysis, ultra-sensitive optical detection techniques, nanofluidic reaction systems for chemical synthesis, novel methods for nanoparticle synthesis, the exploitation of semiconducting materials in diagnostic applications, the development of intelligent microfluidics and the processing of living organisms. He will also discuss how his work has been taken into Molecular Vision Ltd, a spin-out company developing low-cost diagnostic devices for use in the doctor's surgery and in the home.

Prof. Fredrik Höök, Department of Applied Physics, Chalmers University, will discuss his development of quartz crystal microbalance (QCM) systems. These systems have found a wide range of applications from understanding metal deposition through to protein and enzyme absorption. He co-founded Q-Sense AB, a leading manufacturer of QCMs which has a unique technology which measures the dissipative energy of the vibrations, allowing areas such as protein desorption and polymer brushes to be studied.

Dr. Conrad D. James, Principal Member of Technical Staff at Sandia National Laboratories will be talking about population-based comprehensive health monitoring that is necessary to combat infectious disease and bioterror threats. The detection of biological threats prior to hosts becoming symptomatic is a key technological breakthrough that will allow for rapid diagnoses and thorough disease surveillance. In his talk he will present an innovative method for detecting disease states of hosts using microfabricated peptide microarrays. By using >100K arrays of random and targeted 15-20mer peptides, we have demonstrated the ability to distinguish disease states in human samples with very high specificity and sensitivity. These arrays have been fabricated using a photolithographic process to ensure manufacturability, reliability, and a high density of peptides. This technology is robust and flexible (dry or fresh blood, saliva samples), and specifically has been used to identify early stages of bacterial and viral infections. Future applications include predicting vaccine efficacy and host prognosis.