Fabrication and Characterization of Polymeric Surfaces for Bacterial Adhesion in a Whole Cell Biosensor

With the advancement of technology, biosensors have emerged as a leading technology in the application of analyte detection and analysis. In the year 2003, a $7.3 billion world market was covered by biosensors, which is expected to grow to $10.8 billion by the year 2007. The goal of this research is to develop a whole cell biosensor in the form of a chip-like device to detect the presence of trichloroethylene. TCE is a volatile organic compound, and is a suspected carcinogen in humans. The bioluminescent bacteria *Pseudomonas putida* (strain TVA8) has been genetically engineered to contain a tod-lux gene fusion, which detects the presence of trichloroethylene (TCE) in the environment by emitting light [1]. As bacteria are fairly mobile, it was necessary to immobilize them in such a way that they remain attached to the desired substrate. Bacterial adhesion depends on many factors, such as surface chemistry, hydrophobicity, and surface roughness of the substrate. In this work, Plasma Enhanced Chemical Vapor Deposition (PECVD) was used to fabricate biocompatible, hydrophobic fluorocarbon films. The films were deposited at different plasma conditions (i.e., 10/90 pulsed plasma, and 40W continuous plasma) using fluorinated methacrylate precursors with different fluorocarbon groups, such as trifluoroethyl methacrylate (TFMA), pentafluoropropyl methacrylate (PFMA) and heptafluorobutyl methacrylate (HFMA). Since all the precursors have a distinct fluoroalkyl chain, the films deposited from these precursors will have different hydrophobicities. The deposited films showed evidence of retention of the desired fluorine functional groups as observed in the FTIR spectra. The absence of any olefin bonding in the FTIR spectra suggests that all the precursors undergo free radical plasma polymerization. To find the surface concentration of fluorine, carbon and oxygen in the films, XPS analysis was performed. Fluorine content was maximized in the HFMA films, followed by PFMA and TFMA films, following the trend of fluorine content in the precursor molecules. AFM results showed that the modified surfaces were extremely smooth having roughnesses between 0.2 nm and 0.3 nm. Contact angle measurements were used to determine the hydrophobicity of the surfaces and were directly proportional to the fluorine content of the films. Finally, bacterial adhesion experiments were carried out on the modified hydrophobic surfaces as well as on a bare silicon surface as a control. Optical microscopy and image analysis software were used to analyze the number of bacteria attached to the surfaces; results demonstrated that bacteria attached effectively to more hydrophobic surfaces in contrast to the unmodified control surface.

1. Applegate B, Kehrmeyer S R, Sayler G. 1998. A chromosomally based tod-luxCDABE whole-cell reporter for benzene, toluene, ethybenzene, and Xyene(BTEX) sensing. Applied and Environmental Microbiology 64(7) 2730-2735