Argonne NATIONAL LABORATORY | ENERGY SYSTEMS DIVISION

Photoelectrochemical Biochips for Biodetection Applications

Electrochemical biosensors have gained increasing attention in recent times because of their sensitivity and ease of miniaturization that has enabled their adaptation to hand held platforms. Among these immunosensors that can be used to detect biothreat agents, food pathogens and cancer biomarkers are the focus of modern electrochemical biosensors.

The Challenge

There is a great demand for biodetection technologies that can detect miniscule quantities of biothreat agents, food pathogens and cancer biomarkers with high selectivity at the point of care. A biodetection technology that can easily fit on a hand held platform, can be operated by unskilled personnel and is relatively inexpensive can revolutionize the field of biodetection.

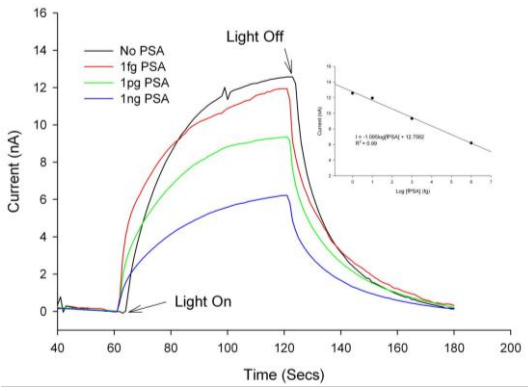
The Solution

Argonne researchers are developing a **PEChem biochip** that is based on the microfabricated lab-on-a-chip technology combined with photoelectrochemical properties of ligand-sensitized Titanium oxide (TiO_2) nanoparticles. These TiO_2 nanoparticles are visible light active and also act as a linker for functionalization with antibodies for biodetection. Binding of antigens to the nanoparticles lowers the photoelectrochemical current in a concentration-dependent manner that is measured on the lab-on-a-chip.

The Results

The Argonne team has developed a prototype PEChem biochip using state-of-the art microfabrication protocols at the CNM. TiO_2 nanoparticles 5nm in diameter were electrophoretically deposited selectively on the working electrodes of the biochip. Immobilized particles were then sensitized with dopamine and with monoclonal antibodies specific towards free Prostate Specific Antigen (fPSA), the biomarker for prostate cancer. We have demonstrated that a photoelectrochemical current is produced when the biochip is excited with an appropriate light source. This photoelectrochemical current was shown to decrease after the biochip was exposed to a solution containing fPSA. The biochip was able to detect fPSA concentrations in the femtogram range.

Bioengineer Aeraj ul Haque inspects a biochip before preparing it for detecting prostate specific antigen.



Photoelectrochemical detection of the prostate cancer biomarker using the PEChem biochip technology.

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