Abstract #2807, 224th ECS Meeting, © 2013 The Electrochemical Society

Nanobiosensing Technology for Foodborne Pathogen and Toxin Detection

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Food safety is a worldwide issue for public health. The estimated cost of foodborne illness in the United States is approximately $77 billion a year, which indicates that foodborne illness continues to be a significant problem in the United States. Although a conventional microbiological method for cell counting is accurate for foodborne bacteria detection, this method is laborious and takes time for the results. Also, the detection method currently being used for serotype identification is based on PCR that requires trained expertise. Rapid detection and identification of pathogenic microorganisms naturally occurring during food processing are important in developing intervention and verification strategies.

The current rapid methods to detect microbial pathogens focus on immunological or genetic characteristics to detect the presence of specific foodborne pathogenic bacteria. Several molecular methods such as immunomagnetic capture, nucleic acid hybridization, PCR and DNA microarray have been used for detection of foodborne pathogens. Although these methods have advantages each method also has limitations. Optical method is a good candidate for real-time, in-situ foodborne pathogen detection. Hyperspectral microscope imaging for evaluation of foodborne pathogens could enhance the presumptive-positive screening method by reducing labor and increasing detection speed.

Recently, advances in nanotechnology are having a significant impact on the field of medical and animal diagnostics. Fabrication and characterization of nanosubstrates have allowed the ability to tailor their binding affinities for various biomolecules through surface modifications. The promise of improved specificity, sensitivity and speed makes diagnostics with nanotechnology an appealing alternative to current molecular diagnostic techniques for pathogen and toxin detection.

Subsequently, many different nanotechnologies, such as surface-enhanced Raman scattering (SERS), quantum dots, and antibody conjugated fluorescent nanoparticles, could become next generation of diagnostic tools which could detect and identify the target organisms within minutes with high level sensitivity. Our previous research on bio-functionalized Au/Si nanorods has also demonstrated for detection of Salmonella with high sensitivity and selectivity of a single cell. Thus, nanoscale science and technology for food research has focused on detection technologies for enhancing food safety and quality. In this presentation, imaging spectroscopy and applied nanotechnology for foodborne pathogen and toxin detection will be discussed.

Specifically, the following nanobiosensing methods will be introduced for food safety and food defense applications; Bio-functionalized nanosubstrate-based biosensor for Salmonella detection; Label-less, fast single molecule recognition system for ricin detection with highly-integrated atomic force microscope (AFM); SERS for detection of foodborne pathogenic bacteria using silver nanorod (AgNR) array substrates as well as biopolymer encapsulated with silver nanoparticles (BeSN); and Nanobiosensor for toxins detection using DNA aptamers with AFM and surface plasmon resonance (SPR) as well as Hyperspectral microscope imaging for foodborne pathogen identification with spectral ‘fingerprints’.