Peptide array biosensor for high throughput and multiplexed detection of foodborne pathogens

Project Rationale

The increased incidence of pathogen-contaminated food places a new emphasis on the rapid detection and quantification of foodborne pathogens. Conventional pathogen detection methods involve enriching the sample and performing various media-based metabolic tests. These detection methods are elaborate and typically require two to seven days to obtain results. Therefore, we are developing a surface plasmon resonance (SPR) imaging biosensor for the rapid, label-free, high throughput detection of foodborne pathogens. This device integrates an SPR imaging system with a biosensor array immobilized onto the sample surface containing specific short peptide ligands. A group of short peptides, identified from phage display libraries and specific to certain pathogenic bacteria, will be microcontact-printed on a gold chip in linear patterns. This peptide-imprinted gold chip functions as a biosensor array for the specific detection of unknown foodborne pathogens. To determine what fraction of pathogenic bacteria are live or dead and to confirm the SPR results, we have created a novel hybrid SPR/molecular imaging portable system.

The device would offer a commercial advantage to the food processing industry. It is miniaturized, has fewer components, and is easier to use compared to the current detection systems. This biosensor could detect foodborne pathogens present in <100 CFU/g of contaminated food within ten minutes.

Project Objectives

- Synthesize and characterize peptides.
- Fabricate and characterize the peptide biosensor array.
- Design and assemble a compact SPR imaging device.
- Achieve real-time detection of foodborne pathogens by SPR imaging.
- Optimize the device for high throughput and multiplexed detection.
- Use antibodies instead of peptides to capture pathogens.

Project Highlights

We have designed a hybrid microfluidic biochip to perform multiplexed detection of single-celled pathogens using a combination of SPR and fluorescence imaging. The device consists of an array of gold spots, each functionalized with a capture biomolecule targeting a specific pathogen. This biosensor array is enclosed by a polydimethylsiloxane microfluidic flow chamber that delivers a magnetically concentrated sample to be tested. The sample is imaged by SPR on the bottom of the biochip and epi-fluorescence on the top. This prototype instrument was able to image antibody-captured Escherichia coli O157:H7 bacteria by SPR and fluorescence imaging.

The efficiency of capture of these bacteria by the magnetic particles was determined using spectrophotometric ferric oxide absorbance measurements. We used NIH ImageJ software to measure the percent of the gold spot area upon which the E. coli was bound. This hybrid imaging approach of pathogenic E. coli detection coupled with an estimate of relative infectivity was shown to be a working example of a testing device for potential foodborne pathogens.

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