

Food for the Twenty-First Century Bioprocessing and Biosensing Center

Fall 2009 Seminar Series

PRESENTER: Dr. Shantanu Bhattacharya, Assistant Professor
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TITLE: Bioinspired Microsystems for Clinical Diagnostics and Detection

ABSTRACT: Design and development of microsensor platforms, microfluidics and Lab on Chip technologies for biodetection and diagnostics are buzzwords for modern-day diagnostics. These approaches are used by medical professionals to enable point-of-care diagnostics; an industry worth billions of dollars. Another area in sensing/diagnostics delves into the uniqueness offered by nanostructured materials and surfaces. Such nanotechnology mediated approaches can be widely used for sensing biological entities where questions such as mobility enhancement of nucleic acids, electrophoresis on a capillary, or on a nanostructured surfaces are studied for technology development activities related to diagnostics. Dr. Bhattacharya's work currently focuses on three principle topics where the goal is to establish rapid diagnostics using MEMS and microfluidic technologies. These areas are the following:

(1) Developing new Lab-on-chip platforms for sensitive and rapid Biodetection/diagnostics of biological entities like Bacterial Cells (Food pathogens): In this category the contribution has been a micro-PCR (Polymerase chain reaction) based diagnostic setup for detection of food pathogens. PCR is a gene amplification technique which gives a highly sensitive molecular detection of biological entities. Microchip PCR is the translation of PCR technologies from the conventional lab scale to a microchip scale. In this module a real time PCR microreactor has been fabricated, tested, and combined with a rapid cell manipulation/concentration technology called Dielectrophoresis (DEP).

(2) Developing Novel Bilayered Asymmetric micromixer designs: In this module we have performed a comparative between three distinctly different designs of third generation micromixers with staggered herringbone like structures in the top and bottom surface of a microchannel which are symmetrically or asymmetrically placed. The distribution of staggered herringbone features on both the channel surfaces result in development of centers of flow rotation, thereby creating lamination and enhancing mixing through chaotic advection. Fluorescence microscopy and computational fluid dynamics modeling has been performed and the extent of mixing has been closely compared and the best alternatives have been evaluated. We observe an overall increase in the mixability by increase in the asymmetry level.

(3) Surface electrophoresis of Nucleic acids over nanostructured surfaces: DNA fractionation through size based electrophoresis have been regularly used for variety of diagnostic activities like gene sequencing, gene mapping, and clinical analysis/diagnosis. Starting from the advent of the human genome project in early 1990's a great need was felt for rapid separation resulting in shorter analysis time. Gel electrophoresis [1], Zone electrophoresis [2, 3], Capillary electrophoresis [4, 5] (in long micron sized capillaries), and micro fabricated electrophoresis platforms for performing electrophoresis [6, 7] were developed because of this great need for rapidity. However a major limitation of all these techniques has been the inability to separate at higher fragment sizes typically greater than 10 kilo base pairs. An alternative approach developed in late ninety's used the electrostatic interaction between molecules and charged surfaces for performing their fractionation. This technique is known as surface electrophoresis. Surface electrophoresis gives an alternative to all the earlier developed techniques for separating higher base pair sizes of DNA molecules.

BIOGRAPHICAL:

Dr. Bhattacharya received a Ph.D. in Biological Engineering from the University of Missouri, Columbia in 2006; a Masters degree in Mechanical Engineering from Texas Tech University, Lubbock, Texas; and has Post Doctoral experience at Birk Nanotechnology Center at Purdue University, West Lafayette. Bhattacharya joined the Department of Mechanical Engineering at the Indian Institute of Technology at Kanpur in 2007 and was instrumental in setting up a MEMS program at IIT Kanpur and a Microfabrication facility.

DATE • TIME • LOCATION:

October 6, 2009, 4:00 PM, 105 Agricultural Engineering Building

UNIVERSITY OF MISSOURI
DIVISION OF FOOD SYSTEMS AND BIOENGINEERING

The Food for the 21st Century (F21C) program at the University of Missouri (MU) was established in the mid-1980's through state funding. The overall goal of the program is to help Missouri food producers and processors maintain their competitive edge in the global marketplace by conducting cutting-edge research in a number of food-related areas. The program involves faculty researchers from multiple colleges including College of Agriculture, Food and Natural Resources; College of Arts and Sciences; College of Engineering; School of Medicine; College of Human Environmental Sciences; and College of Veterinary Medicine. Based on the research emphases, the researchers are grouped into four Clusters: Plant Biotechnology; Animal Reproduction; Bioprocessing and Biosensing Center; and Human Nutrition.

Bioprocessing and Biosensing Center was formed in 1986. The Center currently consists of 27 faculty members, plus collaborators, support staff, and graduate students from six departments in the College of Agriculture, Food and Natural Resources and College of Engineering. These departments include Biological Engineering; Food Science; Animal Sciences; Chemical Engineering; Electrical Engineering; and Mechanical and Aerospace Engineering. This seminar is one of the educational activities in the Bioprocessing and Biosensing Center.

Cluster Co-Leaders: Drs. Fu-hung Hsieh and Jinglu Tan

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