IOWA STATE UNIVERSITY
Department of Mechanical Engineering

Microfluidic Applications of AC Electrokinetic Phenomena

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Seminar host: Jaime Juárez

Abstract

We present experimental and theoretical research on manipulation of colloidal particles and biological cells in microfluidic systems using AC electric fields. Electrophoresis, dielectrophoresis (DEP) and AC-electroosmosis are introduced, and their dominance in the frequency domain are determined using an experimentally validated scaling analysis. DEP is frequently used for manipulating biological cells in microfluidic systems. However, the method loses its effectiveness in high conductivity buffers, and often requires sample dilution to adjust the medium conductivity. In addition, biological cells suspended in low conductivity buffers exhibit time dependent changes in their dielectric properties, making determination of the applied DEP frequency difficult. Our group addressed the first problem by fabricating fractal-electrodes using electrochemical deposition of gold nano-particles, and showed that DEP response can be maintained in high conductivity physiological buffers. The second problem was addressed by development of a microfluidic impedance spectroscopy technique that enables real-time measurements of dielectric properties of biological cells. Using enhanced electrodes and the impedance spectroscopy data, we demonstrate separation of prostate cancer cells from blood.

Dr. Ali Beskok received his BS in Mechanical Engineering from Middle East Technical University, Ankara, Turkey in 1988. He received an MS degree in Mechanical Engineering from Indiana University Purdue University in Indianapolis in 1991, and M.S. and Ph.D. degrees from Princeton University, Mechanical and Aerospace Engineering in 1994 and 1996, respectively. Dr. Beskok was a Visiting Scholar at Brown University, Center for Fluid Mechanics from 1994 to 1996, and a Post Doctoral Research Associate at Massachusetts Institute of Technology, Research Laboratory of Electronics from 1996-1998. He joined Texas A&M University Mechanical Engineering Department as an Assistant Professor in 1998, and became an Associate Professor in 2004. In 2007, he moved to Old Dominion University, Mechanical and Aerospace Engineering Department as the Batten Endowed Chair Professor of Computational Engineering. He was the founding director of the ODU Institute of Micro and Nanotechnology. In August 2013, he moved to Southern Methodist University as the chair of the Mechanical Engineering Department.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.