Interfacing chip-based nanofluidic-systems to surface-desorption mass spectrometry

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Project Summary:

Proteomics provides new understanding of cellular mechanisms that genomic information alone does not explain. However, unlike DNA analysis, the analysis of proteins is a much more complex problem due to the variety of proteins present and low concentration. To meet the high separation capacity and ultrasensitivity requirements, we propose to develop a robust method to interface a chip-based protein separation method to surface-desorption mass spectrometry. Successful development of an interface will accommodate high data throughput required in cell lysate protein separation, be compatible with the vacuum environment for mass spectrometric analysis, and allow minimal sample cross contamination.

One aspect of the interface is the on-chip protein sample transportation and subsequent nanoscale chemical reaction. To accomplish this, we investigated electrowetting as the method of shuttling discrete droplet reaction vessels among different regions of the chip-based device. The attached figures (excerpted from [1]) illustrate the characterization and application of electrowetting phenomenon by which individual droplets in an immiscible medium can be transported with ease. New aspects of microfluidic phenomenon (see [2]) and new fabrication procedure (see [3]) were reported and developed by Kuo and others during the course of this project. Ms. Gina Fiorini is a graduate student that works with Jason Kuo. She has worked on materials issues that relate to the interfacing of microfluidics with mass spectrometry. Her work is still in progress and is in preparation for publication.

Publications, Presentations and Proposals:

1) *Langmuir* **2003**, 19, 250-255
   Title: "Electrowetting-Induced Droplet Movement In An Immiscible Medium"
   Authors: Jason S. Kuo, Paolo Spicar-Mihalic, Indalesio Rodriguez, Daniel T. Chiu*
2) Appl. Phys. Lett (in press):
   Title: "Dynamic Formation of Ring-Shaped Patterns of Colloidal Particles in Microfluidic Systems
   Authors: David S. W. Lim, J. Patrick Shelby, Jason S. Kuo, Daniel T. Chiu*
3) *Anal. Chem*. **2003**, 75, 1578-1583
   Title: "Selective Electroless and Electrolytic Deposition of Metal for Applications in Microfluidics: Fabrication of a Microthermocouple"
   Authors: Peter B. Allen, Indalesio Rodriguez, Christopher L. Kuyper, Robert M. Lorenz, Paolo Spicar-Mihalic, Jason S. Kuo, Daniel T. Chiu*

Figures:

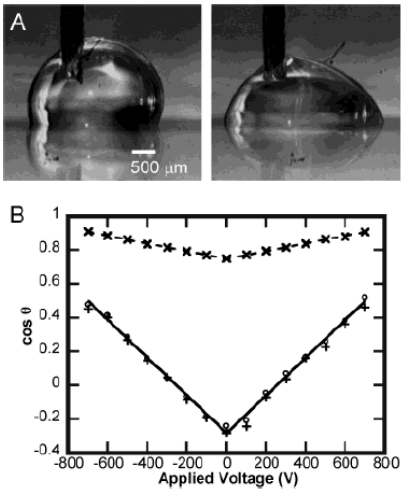

Figure 2. (A) Before (left) and after (right) the application of −500 V that causes the 100 mM KCl droplet to flatten out. (B) Equilibrium contact angle measurements for DI water (○), 100 mM KCl (+), and olive oil (×). Virtually no difference was observed in the electrowetting behaviors of DI water and 100 mM KCl. To perform the measurement, the droplet is placed on top of a disk-shaped electrode with a 38-μm thick PDMS layer spun coated on top. A grounding electrode is inserted into the droplet to complete the circuit.

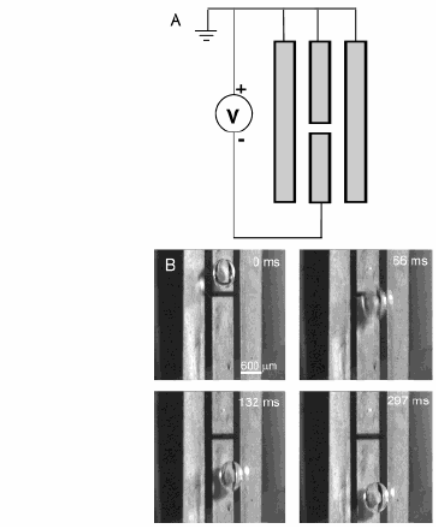

Figure 6. (A) Schematic of the electrode design used to demonstrate the gliding of a KCl droplet in olive oil. (B) Successive video frames showing the gliding of the KCl droplet with the application of −700 V to the bottom electrode.