Organization(s): Stanford University

Title: Quantitative Development of Biomolecular Databases, Measurement Methodology, and Comprehensive Transport Models for Bioanalytical Microfluidics

MTO **Composite CAD**

Duration of Effort: July 2000 – July 2003

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Objective

The goal of this project is the development of fully-validated, multidisciplinary models for the design of microfluidic bioanalytical systems. The project will produce advancements in the areas of methodologies for the extraction of both transport and reaction/binding kinetics data as well as comprehensive multi-physics, modeling of bioanalytical assays. Two major results of these advancements will be the assembly of a database of reaction/bindign rates and flow transport quantities as well as an experimentally validated multi-physics simulation package.

Technical Approach

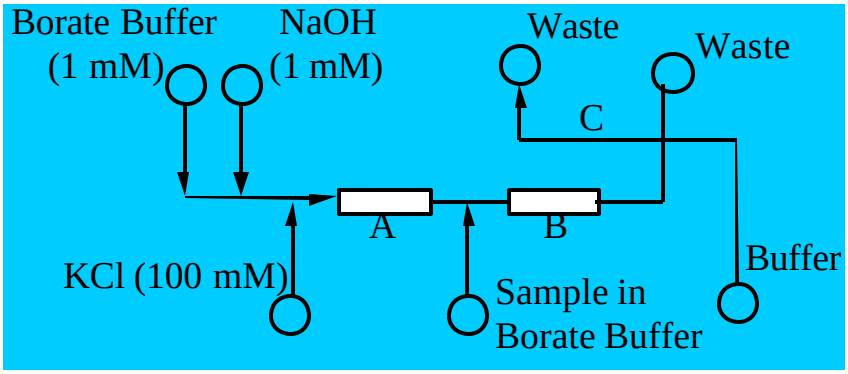
- Develop extensions of traditional methods for obtaining electroosmotic and electrophoretic transport data as well as binding rate and affinity measurements for antibody/antigen systems.
- Develop methodologies for flow and reaction/binding data extraction that the scientific community can apply to the widely different biomolecules and microparticles that are being considered.
- Apply state-of-the-art technologies for extracting diffusivity and binding affinity and rate information for biological macromolecules including analytical ultracentrifugation (AUC) and BIACORE (a technique that uses surface plasmon resonance to monitor binding reactions in real-time without the need to label proteins).
- Develop a fully-validated transport modeling tool with the capability to simulate dielectrophoretic, dielectrophoretic, and convective transport; model biomolecular reactions; and create reduced-order modeling capability for mixing and surface chemistry. A prototype library of examples will be established.
- Perform a full, system-level multi-physics experiment in order to compare experimental data to a full, system-level simulation.

Major Challenges

- Experimental validation of multi-physics models
- Modeling a wide variety of biological agents involved in biological weapons detection both pathogens and receptor molecules.

6th Month Milestones

- Build novel flow-through microfluidic systems specifically for the purpose of obtaining large data sets of transport and reaction/binding rates as a function of relevant parameters including buffer concentration, buffer pH, ion density, and sample concentration.
- Develop transport models for bioanalytical microfluidics.
- Prototype acrylic microchannel systems.
- Perform initial BIACORE measurements.


Borate Buffer
(1 mM)
NaOH
(1 mM)
Waste
Waste
C
A
B
KCl (100 mM)
Sample in
Borate Buffer
Buffer