Interfacial Field Velocity Measurements at the Sub-Micron Scale

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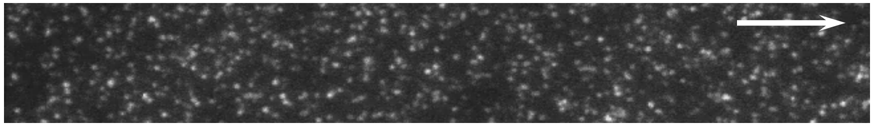
Goals and Potential Impact if Successful

Goals:

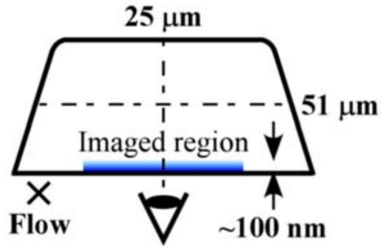
- Develop robust, accurate and nonintrusive flow measurement techniques at sub-micron/nanoscale
- Develop scaling laws to extend experimental results in microchannels to nanoscale transport
- Study how surface chemistry and roughness affect near-wall transport (*i.e.*, slip)

Potential Impact:

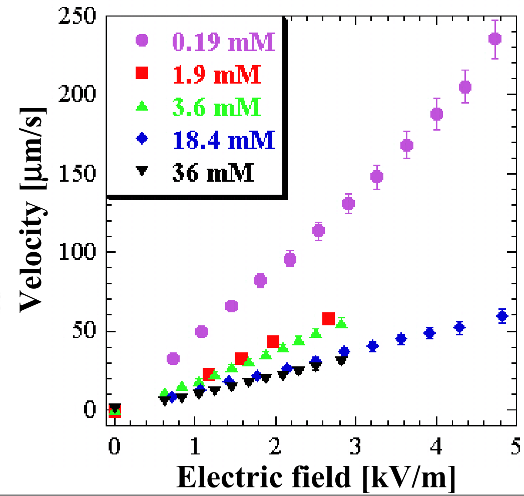
- Rapid design optimization of micro-/nanoscale devices
- Nonintrusive on-line sensing and control of transport (*e.g.* mixing, throughput) in micro- and nanoscale devices



Nano-PIV image (110 × 16 μm) and results in steady EOF



Channel cross-section



Approach and/or Accomplishments

- Developed nano-particle image velocimetry (nPIV): novel technique to measure near-wall velocity fields using fluorescent colloidal particle tracers excited by evanescent-wave illumination
- First velocity measurements in electroosmotic flow in 5–25 μm rectangular channels within 100 nm of wall
- Measured electroosomotic mobilities verified by analytical predictions and independent experimental data
- Evaluated impact of Brownian diffusion on accuracy of nPIV data
- Designing fiber-optic-based source/sensor for evanescent-wave illumination and imaging

Bottlenecks and Open Research Questions

Bottlenecks:

- Lack of diagnostic techniques at micro- and nanoscale hampers model development
- From design/fabrication perspective, current models adequately predict "all" measurable quantities
- "Culture" gap between device end users, designers, researchers

Open Research Questions:

- How do we efficiently control transport in micro-/nanoscale devices?
- What is the new physics (*e.g.* slip, continuum breakdown) in micro-/nanoscale transport?