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Dancing with the Particles: Direct Measurement of Near-Surface Transport Phenomena in the Nanoscale

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An important characteristic of micro- and nanofluidic systems is their large surface-area-to-volume ratios. On the one hand, such large channel surface area offers a distinct advantage in increasing the efficiency of surface-based chemical reactions and reagent sensing, and is particularly beneficial to biomedical applications. On the other hand, the physical phenomena that take place at or near the channel surface would also have a larger influence on the bulk flow properties. Thus for modeling and optimizing system designs, it is critical to understand the near-surface behaviors of fluidic motion and colloidal particles as they are critical to conducting and measuring micro- and nanoscale mass transport.

To investigate near-surface fluidic and colloidal dynamics, we developed a three-dimensional total internal reflection velocimetry (3D-TIRV) technique, which combines evanescent field fluorescent imaging and particle tracking velocimetry, to directly measure near-surface transport phenomena in the nanoscale. In this presentation, I will demonstrate the uses of micro- and nanoparticles to optically observe hindered diffusion of isolated colloidal particles, aqueous solution slip at hydrophilic and hydrophobic channel surfaces and bio-molecular adhesion of white blood cells. With Brownian motion being the dominant mechanism of nanoscale mass transport, statistical analysis must be incorporated to extract flow information from the particles' random-walk dances. Other critical aspects of measurements and future research directions are also discussed.

Dr. Huang received his B.A. degree in Physics from Cornell University (2000), and his M.S. (2002) and Ph.D. (2006) degrees in Engineering from Brown University. His research interest encompasses the field of micro- and nanofluidics, including noninvasive sensing techniques, micro- and nanoscale mass transport, and lab-on-a-chip systems for biomedical applications. His dissertation research focused on image-based velocimetry techniques and nanoscale mass transport, and he is currently working in projects aiming to optically diagnose cancer cells through *in vivo* flow cytometry.

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