Stevens Institute of Technology

Nanotechnology Graduate Program

Optoelectric Micro/Nano Particle Manipulation

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Babbio 122, 11 am

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Recently our research group has developed an innovative method for capturing, concentrating, manipulating and sorting populations of particles ranging from single particles to thousands of particles (Lab-on-a-Chip, 2008; Microfluidics and Nanofluidics, 2008) using a simple parallel plate electrode configuration. Transparent electrodes comprised of Indium Tin Oxide (ITO) on glass substrates were used to generate an electric field in the fluid but also to allow light into and out of the fluid. Near-IR optical illumination causes subtle localized heating—small in absolute magnitude but large in spatial gradient. This localized heating creates electric permittivity and conductivity gradients that in turn drive a microscopic toroidal vortex. The vortex efficiently transports particles to a preferred location, usually the surface of the electrode. This vortex flow is characterized as a function of the AC signal frequency and the strength of electric field using conventional microscopic imaging along with 3-dimensional micro particle image velocimetry (μPIV). μPIV measures the velocity of a flow by tracking the motion of sub-micron tracer particles carried by the flow. To measure high velocity, small length scale flows, high speed lasers and interline transfer CCDs are used in conjunction with a microscope to image the tracer particles with sub-microsecond temporal resolution. The application of this technique to several typical micro systems, including the optoelectric vortex described earlier, will be presented and the results discussed. Recent trends in μPIV have increased the spatial resolution of the technique such that sub-micron domains can now be measured in a spatially resolved manner.

Professor Wereley completed his masters and doctoral research at Northwestern University studying macroscopic Taylor-Couette flows as filtration aids. He joined the Purdue University faculty in August 1999 after a two-year postdoctoral appointment at the University of California Santa Barbara. During his time at UCSB he focused exclusively on developing diagnostic techniques for microscale fluid systems, work which ultimately led to developing, patenting, and licensing to TSI, Inc., the micro-Particle Image Velocimetry technique. His current research interests include designing and testing microfluidic MEMS devices, investigating biological flows at the cellular level, improving micro-scale laminar mixing, and developing new micro/nano flow diagnostic techniques. Professor Wereley is very active in the field of micro/nanoscale fluid mechanics, delivering invited lectures, short courses and consulting, in addition to performing scholarly research in the area. Professor Wereley is the co-author of Fundamentals and Applications of Microfluidics (Artech House, 2002 and 2006) and Particle Image Velocimetry: A Practical Guide (Springer, 2007). He is on the editorial board of Microfluidics and Nanofluidics Journal and Experiments in Fluids and is an Associate Editor of ASME's Journal of Fluids Engineering. Professor Wereley has edited Springer's recent Encyclopedia of Microfluidics and Nanofluidics and Kluwer's BioMEMS and Biomedical Nanotechnology.

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