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TITLE, ABSTRACT: Electro-kinetic Designs for Medical Diagnostics

The recent success of miniature blood glucose detection kits for diabetics is only the tip of the iceberg for a major growth industry in miniature medical diagnostic/delivery kits for blood cells, bacteria, cancer cells, toxic drugs etc. Due to the small dimensions of these devices, intense DC, AC and pulsed electric fields can be established with a small power source to meter, transport, control and separate biofluids and bioparticles. Such electrokinetic mechanisms are effective because biofluids are relatively strong electrolytes whose ions can be driven by electromigration into the nm-thick surface double layers of the channel and bioparticles. Faradaic reactions on electrodes offer another interfacial polarization mechanism. Through matched asymptotics, time-averaging and multi-scale numerics, we are able to solve the pertinent Poisson and dynamic ion transport equations within the double layer to obtain the correct effective Maxwell stresses on the surfaces. Such analyses have led to the understanding and discovery of several new nonlinear electrokinetic phenomena and the design of several new microfluidic devices for diagnostics: superfast nonlinear electrophoresis, long-range colloid/protein traps, AC and DC electro-osmotic mixing vortices, AC micro-fluidic pumps without moving parts and bubble generation, AC electrosprays etc. Bacteria sensing by magnetic and fluorescent nano-particles are being integrated with these micro-fluidic designs based on electro-kinetics.

Tuesday, April 6, 2004, 4:00pm, AG ENGR Bldg. 105
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