Newtonian Fluid Slip during Electrokinetic Flows in Surface-Modified Microfluidic Devices

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Understanding the electrokinetic microflow is a key aspect in the research of micro-chip technology. With the fused silica rectangular microcapillary of 52 micrometers width, a hydrophobic channel surfaces obtained by coating with a monolayer of octadecyltrichlorosilane. From the measurements of average fluid velocity and apparent velocity slip, we found a higher apparent viscosity would be predicted if the slip is neglected. We examined the effects of the electric double layer and the zeta potential of channel surface upon the velocity as well as the electroviscous behavior. To verify experimental results, we present a finite difference solution for electrokinetic flow with Navier's slip boundary condition. The externally applied body force originated from the nonlinear Poisson-Boltzmann field as well as the flow-induced electric field is employed in the equation of motion. It is evident that liquid slip counteracts the effect by the electric double layer and induces a larger flow rate. We observe the velocity profile by applying the particle flow imaging technique. The velocity profile for low ionic concentration is influenced by the electric double layer, where the fluid velocity decreases as the solution ionic concentration decreases.