459a Plenary: near-Wall Measurements in Electroosmotic Flow and inside the Diffuse Electric Double Layer

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Electroosmosis, where ions in a conducting fluid are driven by an electric field, is commonly used in microfluidics to drive aqueous electrolyte solutions. Strictly speaking, however, the electric field only drives the flow within the electric double layer next to the charged wall. Under appropriate conditions, the fluid velocity and the perturbation electric potential (compared with the wall ζ-potential) are proportional, *i.e.*, similar, in electroosmotic flow. In this talk, we describe a novel technique, nano-particle image velocimetry, using evanescent-wave illumination, that can measure velocities, and hence changes in ζ-potential, within 250 nm of the wall. Mobilities were measured for the electroosmotic flow of sodium tetraborate buffers at molar concentrations C = 20 μM to 36 mM through 5–25 μm channels. In all cases, the results are in very good agreement with analytical predictions. Comparisons with analytical predictions at the two lowest concentrations of 20 μM and 36 μM suggest that the velocity data are obtained *inside* the double layer. These results are believed to be the first experimental measurements inside the diffuse electric double layer in electroosmotic flow of an aqueous solution. This work demonstrates that the Debye length underestimates the double layer thickness by up to an order of magnitude over a thousand-fold variation in ionic strength—and suggests that the double layer is accessible using current diagnostic techniques.

At higher concentrations, the mobility decreases with increasing concentration, following a power-law relation. At C = 20 μM and 36 μM, however, mobility increases with concentration, even after correcting the experimentally obtained mobility values to reflect bulk velocity values.