Dispersion Due to Electroosmotic Flow Through a Circular Channel With Non-uniform Zeta Potential and Wall Slip

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Abstract: The hydrodynamic dispersion due to steady electro-osmotic flow in a circular channel with longitudinal step changes of zeta potential and hydrodynamic slippage is analyzed in this study. The channel wall is periodically micro-patterned along the axial position with alternating slip-stick stripes of distinct zeta potentials (Fig. 1.). A homogenization analysis is performed in this study to derive the hydrodynamic dispersion coefficient without subject to the long-wave constraint of lubrication approximation. The flow and the hydrodynamic dispersion coefficient are calculated numerically using the packages MATLAB and COMSOL, as functions of controlling parameters including the period length of the wall pattern, the area fraction of the slipping region (EOF-suppressing) in a periodic unit, the ratio of the two zeta potentials, the intrinsic hydrodynamic slip length, the Debye parameter, and the Péclet number. The dispersion coefficient is found to show notable, non-monotonic in certain situations, dependence on these controlling parameters. It is noteworthy that the existence of hydrodynamic slippage will generate much richer behaviors of the hydrodynamic dispersion than the situation with no-slip boundary condition, as slippage interacts with zeta potentials in the either likewise or oppositely charged EOF-suppressing and EOF-supporting regions.

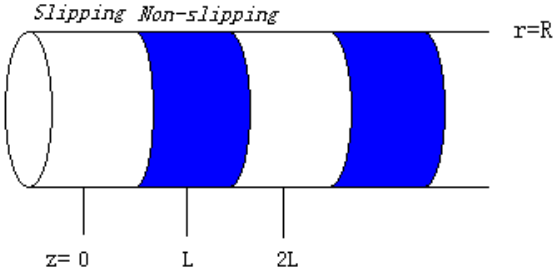

Figure 1. Definition Sketch.

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