Electrokinetic Slip Flows through a Micropatterned Circular Tube

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Abstract: A semi-analytical study is conducted on electrohydrodynamic flows through a circular tube, of which the wall is micropatterned with a periodic array of longitudinal or transverse slip-stick stripes. Using the methods of eigenfunction expansion and point collocation, the Onsager relations for the fluid and current fluxes are deduced for the present problem with mixed electrohydrodynamic boundary conditions. The theoretical limits for some special kinds of wall patterns, which are available in the literature only for a plane channel, are extended in this work to the case of a circular channel. In particular, with oppositely charged slipping stripes, local recirculation or a net reversed flow is possible, even when the wall is on the average electropositive or neutral.

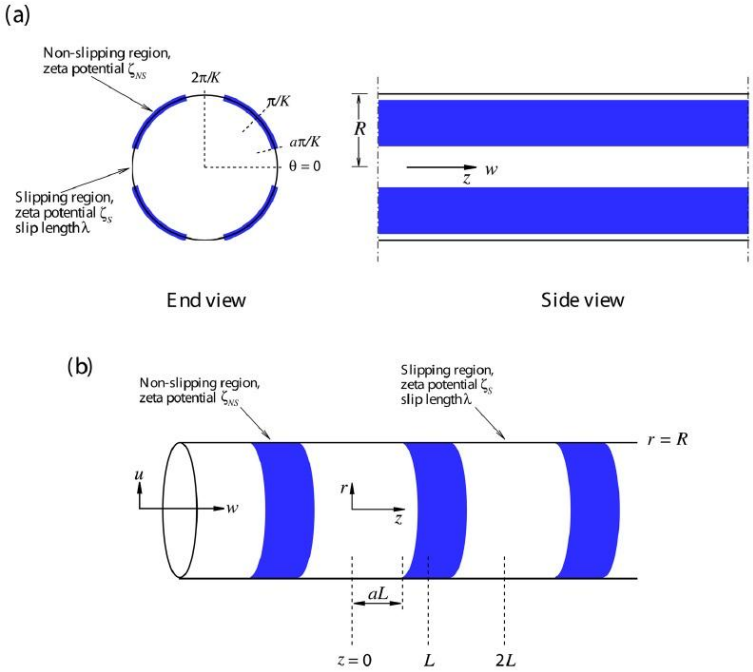

Figure 1. Electrokinetic flow through a circular tube, where the wall is patterned with a periodic array of (a) longitudinal stripes or (b) transverse stripes. With longitudinal stripes, the flow is unidirectional and purely along the z-direction; and with transverse stripes, the flow is two-dimensional in the (r,z) plane. In (a), one periodic unit is from θ=0 to θ=2π/K, where K is the number of periodic units on the wall. In (b), one period unit is from z=0 to z=2L. In either case, the area fraction of the slipping region is denoted by a.

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References

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