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Suppression of Electrokinetic Flows by Surface Roughness[1]
ROBERT MESSINGER, TODD SQUIRES, University of California, Santa Barbara — In microfluidic systems, electro-osmotic flows are a promising alternative to mechanical pressure-driven flows, since electrokinetic flow rates are independent of microchannel dimensions and may enable the design of portable (e.g., battery-operated) devices. We show that nanoscale surface roughness, which commonly occurs on microfabricated metal electrodes, can significantly suppress electro-osmotic flows when excess surface conductivity is appreciable. We demonstrate the physical mechanism of electro-osmotic flow suppression due to surface curvature, compute the effects of varying surface conductivity and roughness amplitude on the slip velocities of a model system, and identify scalings for flow suppression in different regimes of surface conduction. We suggest that surface roughness may be one factor that accounts for large discrepancies between classical electrokinetic theory and modern microfluidic experiments.

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