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Electro-osmotic Flow over a Charged Super-hydrophobic Surface

HUI ZHAO, University of Nevada Las Vegas — A super-hydrophobic surface has a large effective hydrodynamic slip length compared to a smooth hydrophobic surface and holds the promise of enhancing electrokinetic flows that find many applications in microfluidics. However, recent theoretical studies suggested that electro-osmotic flows over a weakly charged, super-hydrophobic surface can only be enhanced when liquid-gas interfaces are charged. So far there is little work reported when the zeta potential of the surface is comparable or even larger than the thermal potential. Here we numerically investigate electro-osmotic flows over a periodically striped slip-stick surface by solving the standard Poisson-Nernst-Planck equations. Our results indicate that at large zeta potentials, even if liquid-gas interfaces are charged, the non-uniform surface conduction due to the mismatch between surface conductions over no-shear and no-slip regions leads to electric field lines penetrating the double layer and thus the non-uniform surface conduction weakens the tangential component of the electric field which primarily drives electro-osmotic flows. Our results imply that in the presence of strong non-uniform surface conduction, enhanced electro-osmotic flows over a super-hydrophobic surface are possible only in certain conditions. In particular, the enhancement due to the slip can potentially be lost at large zeta potentials.

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