Frequency response in surface-potential driven electrohydrodynamics

Using a Fourier approach we offer a general solution to calculations of slip velocity within the circuit description of the electrohydrodynamics in a binary electrolyte confined by a plane surface with a modulated surface potential. We consider the case with a spatially constant intrinsic surface capacitance where the net flow rate is, in general, zero while harmonic rolls as well as time-averaged vortexlike components may exist depending on the spatial symmetry and extension of the surface potential. In general, the system displays a resonance behavior at a frequency corresponding to the inverse RC time of the system. Different surface potentials share the common feature that the resonance frequency is inversely proportional to the characteristic length scale of the surface potential. For the asymptotic frequency dependence above resonance we find a omega(-2) power law for surface potentials with either an even or an odd symmetry. Below resonance we also find a power law omega(alpha) with alpha being positive and dependent of the properties of the surface potential. Comparing a tanh potential and a sech potential we qualitatively find the same slip velocity, but for the below-resonance frequency response the two potentials display different power-law asymptotics with alpha=1 and alpha similar to 2, respectively.

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