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The Role of Hydrodynamics in the Polarization of the Double Layer Surrounding a Nanosize, Cylindrical Particle[1] HUI ZHAO, HAIM BAU, University of Pennsylvania — The polarization of, the forces acting on, and the flow field around a charged, cylindrical, dielectric particle submerged in an electrolyte solution and subjected to an alternating electric field are calculated as functions of electrolyte concentration and electric field frequency by solving the linearized Poisson-Nernst-Planck (PNP) equations. Consistent with dielectric spectroscopy measurements and with previous theoretical works, we find that at relatively low frequencies, the polarization coefficient is nearly frequency-independent; but once the Strouhl number $St_1 = \frac{a^2}{D^*\omega^*}$ increases above 1, the polarization coefficient increases as the frequency increases, attains a maximum, and then decreases. When $St_2 = \frac{1}{1+Du}\frac{\lambda^{*2}}{D^*\omega^*} > 1$, the polarization coefficient decreases rapidly as the frequency is further increased. In the above, a is the particle's radius; λ^* is the Debye screening length; D^* is the diffusion coefficient of the electrolyte; ω^* is the electric field frequency, and Du is the Dukhin number. The major contributor to the force acting on the particle is the drag induced by the electroosmotic flow around the particle. The work helps clarify the effect of double layer polarization on dielectrophoresis.

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