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A Numerical Study on Electrophoresis of a Soft Particle with Charged Core Coated with Polyelectrolyte Layer

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Abstract : Migration of a core-shell soft particle under the influence of an external electric field in an electrolyte solution is studied numerically. The soft particle is coated with a positively charged polyelectrolyte layer (PEL) and the rigid core is having a uniform surface charge density. The Darcy-Brinkman extended Navier-Stokes equations are solved for the motion of the ionized fluid, the non-linear Nernst-Planck equations for the ion transport and the Poisson equation for the electric potential. A pressure correction based iterative algorithm is adopted for numerical computations. The effects of convection on double layer polarization (DLP) and diffusion dominated counter ions penetration are investigated for a wide range of Debye layer thickness, PEL fixed surface charge density, and permeability of the PEL. Our results show that when the Debye layer is in order of the particle size, the DLP effect is significant and produces a reduction in electrophoretic mobility. However, the double layer polarization effect is negligible for a thin Debye layer or low permeable cases. The point of zero mobility and the existence of mobility reversal depending on the electrolyte concentration are also presented.

Keywords : debye length, double layer polarization, electrophoresis, mobility reversal, soft particle
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