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Dielectric Decrement Effects on Nonlinear Electrophoresis of Ideally Polarizable Particles JEFFREY L. MORAN, WAI HONG RONALD CHAN, CULLEN R. BUIE, Massachusetts Institute of Technology, BRUNO FIGLIUZZI, Ecole des Mines de Paris — We present numerical simulations of nonlinear electrophoresis of ideally polarizable particles that specifically include the effects of a spatially non-uniform dielectric permittivity near the particle surface. Models for this dielectric decrement phenomenon have been developed by several authors, including Ben-Yaakov et al. [J. Phys. Condens. Matter 2009] Hatlo et al. [EPL 2012], and Zhao & Zhai [JFM 2013]. We extend this work to ideally polarizable particles and include the effects of surface conduction and advective transport in the electric double layer. By numerically solving for the coupled velocity field, electric potential, and ionic concentration distributions in the bulk solution surrounding the particle, we demonstrate that the dielectric decrement model predicts ionic saturation around the particle and thus physical implications that resemble those resulting from the steric model developed by Kilic et al. [PRE 2007], albeit with differences that reflect the nonlinearity of the modified Poisson-Boltzmann equation. In addition, we develop a generalized condensed layer model that approximates both the steric and dielectric decrement models in the limits of strong electric fields and negligible surface conduction to obtain more physical insights into these models. We demonstrate that the mobility in both models asymptotically scales as the square root of the electric field at high fields, recovering the result of Bazant et al. [Adv. Colloid Interface Sci 2009].

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