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A New Theory for Dielectrophoresis due to Polar Double-Layer Charging and Tangential Electro-Migration at Large Fields.[1] HSIEN-HUNG WEI, National Cheng Kung University, SHAU-CHUN WANG, National Chung Cheng University, Taiwan, HSUEH-CHIA CHANG, University of Notre Dame, USA — A charged particle with a thin double layer generally renders the Debye screening effect that prevents normal penetration of the external field. However, this screening can break down at the poles, leading to normal charging or extension of the double layer locally, when the applied field is sufficiently large. With the aid of a scaling analysis, we identify that the DEP crossover frequency ω is not only size-dependent, but also exhibits three different scales that depend on the field. At fields insufficient to drive polar charging but still large enough to induce tangential migration, ω is the inverse of diffusion time across the particle D/a^2. At intermediate fields that permit polar charging but does not extend the local double layer, ω is still relaxed by tangential diffusion, but further modulated by the field and the double layer thickness. At strong fields, the extended double layer and charging at the pole will furnish a strong electro-migration flux for tangential conduction and ω becomes the inverse Maxwell-Wagner relaxation time ε/σ attenuated by the square-root of the field. For the first time, diverse experimental results for different bulk conductivity, particle size and field strength can be explained and unified under the same theoretical framework.

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