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Electrophoretic mobility of spherical nanoparticles confined in nanochannels YU-WEI LIU, TOM WYNNE, SUMITA PENNATHUR, CARL MEINHART, UCSB — We investigate the mobility of a charged spherical nanoparticle driven by weak electric fields that are confined in nanochannels. Factors affecting mobility include particle zeta potential, electrolyte concentration, and channel size. Classic models for electrophoretic mobility (e.g. Smoluchowski and Huckel) are valid only in the linear regime of small particle zeta potential, and for an unbounded fluid domain. The classical models fail to predict electrophoretic mobility estimated from experiments using $\sim$ 42 nm diameter particles confined in a $\sim$ 100 nm nanochannel. We adopt the asymptotically-expanded formulations of Khair and Squires (Phys. Fluids, 2009), and solve the fully-coupled equations on a well-resolved 3D finite element domain. For a charged 42 nm diameter nanoparticle, confined in a 100 nm high nanochannel, the electrophoretic mobility increases nonlinearly when particle zeta potential is greater than thermal potential $k_B T/e$. When the channel size is decreased from 2.5 um to 100 nm, the mobility is reduced by up to 20%. The result suggests that particle/wall interactions, including overlapping double layers may affect electrophoretic mobility in a non-linear manner.

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