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Particle Manipulation in Microfluidics: the Role of Dielectrophoresis, Electrohydrodynamics and AC Electrokinetics

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The movement of particles suspended in aqueous solutions subjected to non-uniform ac electric fields is examined. The ac electric fields induce movement of polarizable particles, a phenomenon known as dielectrophoresis. The high strength electric fields often used in separation systems can give rise to fluid motion, which results in viscous drag on the particle. The electric field generates heat, leading to volume forces in the liquid. Gradients in conductivity and permittivity give rise to electrothermal forces; gradients in mass density to buoyancy. In addition, non-uniform ac electric fields produce forces on the induced charges in the diffuse double layer on the electrodes. This gives a fluid motion termed ac electroosmosis. The effects of Brownian motion are also discussed in this context. The orders of magnitude of the various forces experienced by a particle are discussed in relation to experiments and the relative influence of each type of force is described.

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