Fluctuation of drift velocity in electrophoresis of charged particles


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Fluctuation of drift velocity 
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Electrophoresis is one of the most important methods for separating colloid particles and biological molecules such as DNA and proteins in terms of their charge. This method relies on the correlation between the particle drift velocity and the charge. For a high-resolution separation, we need to minimize fluctuations of the drift velocity of particles or molecules. For a high throughput, on the other hand, we need a concentrated solution, in which many-body electrostatic and hydrodynamic interactions may increase velocity fluctuations. Thus, it is crucial to reveal what physical factors destabilize coherent electrophoretic motion of charged particles. However, this is not an easy task due to complex dynamic coupling among particle motion, hydrodynamic flow, and motion of ion clouds. Here we study this fundamental problem by numerical simulations, fully incorporating these couplings. We reveal that addition of salt screens both electrostatic and hydrodynamic interactions, but in a different manner. This allows us to control the electrophoretic behavior in terms of salinity. We demonstrate that the fluctuations of the particle drift velocity can be minimized for a particular salinity.

References


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