Conference on Advances in Microfluidics and Nanofluidics
The Hong Kong University of Science & Technology
Jan 05-07, 2009, Hong Kong

Optical Tweezer-Based DEP Force Spectroscopy

We report a quantitative characterization of the dielectrophoretic forces imparted on individual colloid particles in an aqueous suspension. The motion of suspended particles relative to the solvent resulting from polarization forces due to an inhomogeneous electric field is known as the dielectrophoresis (DEP). In the case of colloidal particles in aqueous suspension, the Claussius-Mossotti (CM) function, containing the frequency dependence of the dielectric behavior of the particle, the particle's surface charge and the ion cloud around the particle, and the dielectric property of the medium, dictates the direction and magnitude of the resulting DEP force. In the range of RF frequencies, the relaxation of the surface ions is primarily responsible for the frequency dependence of the magnitude of the DEP force which approaches zero as the frequency approaches the point of cross-over and switches direction. Using optical tweezers as force sensor we have successfully characterized the frequency dependent DEP force with a spatial resolution in the micron range and a force resolution of a fraction of 1pN. To achieve this, we used an AM modulation to administer the RF electric field so we could a phase lock-in detection method to monitor the phase and amplitude of the displacement of the particle while it was held by the optical tweezers and acted on by the DEP force. The optical tweezers based DEP force spectroscopy presents a way to understand the fundamental parameters that dictate the DEP response function at the microscopic level.

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