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Path of microparticles in a microfluidic device employing dielectrophoresis for hyperlayer field-flow fractionation

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Abstract: This article details the development of a validated dynamic model for predicting the path of microparticles subjected to a dielectrophoretic field, on a microfludic device, for hyperlayer field flow fractionation; the model is subsequently used for parametric study. The electrode configuration consists of multiple finite sized electrodes placed on the bottom surface of the microchannel and an infinitely long electrode located on the top surface of the same microchannel. The model consists of two sets of equations; the first set deals with the electrical parameters inside the microchannel while the second set describes the microparticle?s motion inside the microchannel. The governing equations describing the path of microparticles are based on Newton?s second law and depend on geometric and operating parameters including microparticle radius, actuation voltage, microchannel height, volumetric flow rate, and electrode/gap length. The influence of the forces due to gravity, buoyancy, drag, virtual mass, and dielectrophoresis are included in the equations of motion. The path of the microparticle consists of two phases?transient and steady state. During the transient phase all parameters are influential. The steady state vertical displacement is dependent on microchannel height, actuation voltage, and electrode/spacing length and independent of microparticle radius and volumetric flow rate above a threshold value. Steady state levitation does not exist when the volumetric flow rate is below its threshold.