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DEP and EWOD Forcing for Application in Digital Microfluidics

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Accurate descriptions of actuation forces and resultant droplet velocities must be available when designing a microfluidic device makinguse of discretized flows. Currently, the most promising methods of droplet actuation in microfluidic devices are electrowetting on dielectric (EWOD) for conductive droplets and dielectrophoresis (DEP) for electrically insulating droplets, where in both cases droplets are transported by sweeping an applied voltage along a microchannel. Numerical modeling of the droplet dynamics for EWOD and DEP configurations has been done using approximations of the electrostatic effect, but incorporation of the electrostatic force density into a direct simulation of the fluid mechanics is desired. This talk focuses on the relationship between EWOD and DEP. The equations that govern the forcing of both mechanisms are presented in detail, including a resolution of the seemingly contradictory model of forcing in DEP; that being the Korteweg-Helmholtz and Kelvin polarization formulations. Numerical results are presented that compare the net force and force distribution in EWOD and DEP. The effect of electrode size and patterning on the total imposed force on the droplet is presented.

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