Electrophoretic motion of a charged droplet near the oil-air interface

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Electrophoresis of charged droplets (ECD) has been proposed as a new method to actuate droplets in a microfluidic system. Droplet manipulation near the oil-air interface could have several advantages such as ease of coalescence and convenient post-processing of the droplets. However, the effect of the interface on the motion of a charged droplet has not investigated yet. When a charged droplet is translated between two electrodes near the oil-air interface, the pathway of droplet is not a straight line but an upwardly concave parabolic pathway. If the interface is close to the droplet, curvature of the pathway increases and the droplet is away from the interface at the center of the pathway. Electric field effect is noted as the cause of this phenomenon. By using the leaky dielectric model, it has been verified that this phenomenon is caused by the distorted electric field due to the difference in electric permittivities. The curvature of the pathway is further increased by the accumulated charges on the interface due to the difference in the electric conductivities of oil and air.