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Transient Reduction of the Drag Coefficient of Charged Droplets via the Convective Reversal of Stagnant Caps B.S. HAMLIN, W.D. RISTENPART, University of California at Davis — Droplets are frequently observed to move as if they were solid rather than liquid, i.e. with no slip at the liquid-liquid interface. This behavior is usually explained in terms of the so-called "stagnant cap" model, in which surfactants accumulate at the trailing edge of the droplet, immobilizing the surface and increasing the observed drag coefficient. Here we show that the drag coefficient for charged droplets is temporarily reduced by reversing the direction of an electric driving force. Using high speed video we simultaneously track the velocity and relative interfacial velocity of individual aqueous droplets moving electrophoretically through oil. The observed surface behavior is highly sensitive to the surfactant concentration. For sufficiently low or sufficiently high surfactant concentrations, upon reversal of the electric field the droplet rapidly accelerates in the opposite direction but then decelerates, concurrent with a transient rearrangement of tracer particles on the droplet surface. In contrast, droplets with intermediate surfactant concentrations exhibit no deceleration nor tracer particle rearrangement. We interpret these observations in terms of convectively dominated rearrangement of the stagnant cap, and we discuss the implications for precise electrophoretic control of droplet motion in lab-on-a-chip devices as well as droplet charge estimation through velocimetry.

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