Controlling Bubbles with Electric Fields

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The wetting of a surface by a droplet of a dielectric liquid can be controlled using surface fabricated interdigitated electrodes and an applied voltage to create an electric field which decays with depth of penetration into the liquid.[1] This interface-localized liquid dielectrophoresis (L-DEP) introduces a dielectrophoretic energy stored in the liquid near the interface in addition to the interfacial energies from the liquid-solid, solid-liquid and liquid-vapor interfaces. Thus, an applied voltage can be used to control the wetting of the surface – an effect called dielectrowetting.[1-3] Here, we show that in the complementary situation of an air-bubble attached to a surface immersed in a dielectric liquid, the extent of wetting can also be fully controlled including inducing bubble detachment. We then control the vertical position of the bubble close below the surface and induce bubble reattachment to the surface. The thickness of the liquid film preventing reattachment is shown to have a logarithmic dependence on the magnitude of the applied voltage. We describe these experimental results by developing a theory that considers the energy balance due to liquid-dielectrophoresis and the buoyancy of the liquid-bubble system. This work provides a new method of bubble control that has the potential to control flow in channels and to manage dry patches in heat exchangers.

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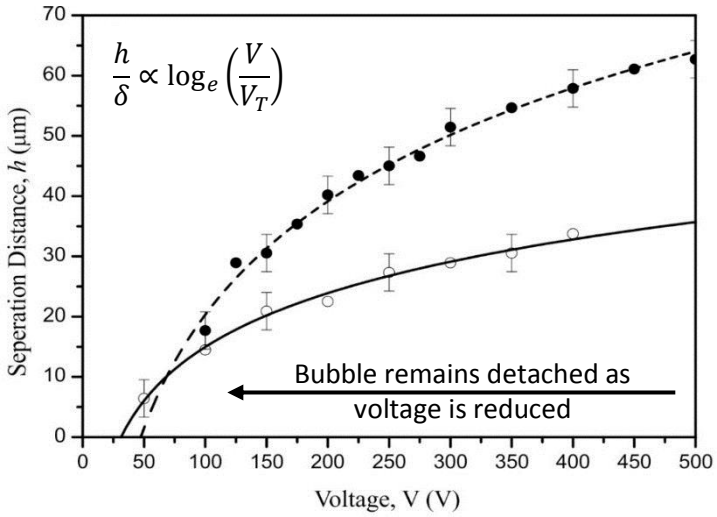

Figure 1: Experimental data and fit for reattachment for two electric field penetration depths, δ.

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