Public Abstract

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Title:Modeling of Droplet and Bubble Detachment Assisted by Electrowetting-on-Dielectric (EWOD)

This work reports both theoretically and numerically a novel mechanism of electrowetting-induced jumping droplet and bubble detachment. Electrowetting-on-dielectric (EWOD) can be used to induce the detachment of micro-water droplet from hydrophobic surface. The level set method has been used to track the interface of water and air. The capillary wave on the droplet interface could be seen during the electrowetting effect. The sudden variation of the droplet base creates a disturbance that propagates along the surface in the form of a capillary wave. As the wetted area is reduced during this transformation, the excess surface energy is converted into kinetic energy which stretches the droplet vertically and eventually leads to the detachment from the substrate; the results have been validated with available experimental data. The physics of stretching, recoiling and detachment of the droplet have been investigated.

Inspired by the potential demonstrated by electrowetting-controlled droplets, this work also investigates the potential advantages of electrowetting to disrupt bubble dynamics to improve phase change heat transfer. Electrowetting-on-dielectric is used to modulate the contact point movement at the water-air interface in a thin liquid film. Rapid oscillation of the contact line is achieved by a swift change of voltage under an AC signal. When disturbed with such contact angle changes, the interfacial wave between two immiscible fluids disrupts bubble dynamics. Numerical modeling reveals that an air bubble on a hydrophobic surface can be detached by the trough of such a wave. The frequency of interfacial wave is twice the voltage frequency. A higher voltage frequency leads to a smaller amplitude and higher celerity of the wave, while a lower voltage frequency leads to a larger wave amplitude and lower celerity. The bubble can easily detach when the voltage frequency from 2Hz-10Hz. However, the bubble fails to detach when the voltage frequency is 100Hz. This approach can be useful to improve two-phase cooling performance.