Wetting and Dewetting on Electrically Switchable Surfaces

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ABSTRACT

Wetting of surfaces can be modified using non-uniform electric fields to store energy in a dielectric liquid at the solid-liquid interface and alter the overall energy balance based on surface energies. Here we outline how this interface-localized dielectrophoresis (dielectrowetting) effect can be used to control the equilibrium contact angle of droplets and bubbles in air and liquid, to spread droplets into liquid films and to detach bubbles from surfaces [1,2]. We show that the dynamics of liquid spreading can be modified [3] and that it is possible to induce a liquid film of a user-designed shape on an otherwise liquid-repellent surface and initiate de-wetting in a controlled manner [4]. We present data on dewetting showing two regimes (rim-and-dimple and spherical cap), and the interplay between substrate hydrophobicity/hydrophilicity and the inner/outer fluid viscosities for a liquid film immersed in a second fluid. We demonstrate that control of the viscosity ratio can be used to induce a counter-intuitive slower dewetting on a more phobic surface [5]. Finally, we show how dielectrowetting can be used to control instabilities in the break-up of user-defined liquid shapes, such as rings of liquid.

Acknowledgements. The financial support of the UK Engineering & Physical Sciences Research Council (EPSRC) is gratefully acknowledged (EP/R036837/1 and EP/R042276/1).

[1] McHale G., *et al.* Dielectrowetting driven spreading of droplets. *Physical Review Letters* **107** (2011), 186101
[2] Brown C.V., *et al.* Controlling bubbles - Electric field induced detachment, levitation, and reattachment. Submitted (2020).
[3] McHale G., *et al.* Voltage-induced spreading and superspreading of liquids. *Nature Communications* **4** (2013), 1605.
[4] Edwards A.M.J., *et al.* Not spreading in reverse: The dewetting of a liquid film into a single droplet. *Science Advances* **2** (2016), e1600183.
[5] Edwards A.M.J., *et al.* A viscous switch for liquid-liquid dewetting. *Communications Physics* **3** (2020), 21.