PARTICLE-STABILIZED WATER DROPLETS THAT SPROUT MILLIMETER-SCALE TUBES

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A layer of colloidal particles will become irreversibly trapped at a fluid–fluid interface if they exhibit partial wettability with both fluid phases. This effect has been exploited to create Pickering emulsions, armored bubbles, and new materials of various kinds. When the interfaces are densely coated with particles, they behave like rigid elastic sheets with moduli that are proportional to the underlying interfacial tension. The interfaces are permeable, a characteristic that can, for example, lead to compositional ripening of Pickering emulsions

Here we show that when particle-stabilized water droplets are created in a bath of toluene with ethanol, millimeter-scale tubes are observed to sprout from the top of the droplets. Growth is driven by the ethanol partitioning from the toluene into the water which leads to an internal overpressure. Vertical growth occurs over many minutes; finally the tube buckles when it can no longer support its own weight (Figure 1). There are several different growth modes controlled by the concentration of ethanol and of silica particles.[1] An alternative way to manipulate the system is by using a different alcohol, leading to insight on the role of the underlying three-fluid phase diagram. Our work paves the way for future studies of droplet growth because the liquid droplets and the interfacial properties can be independently studied.

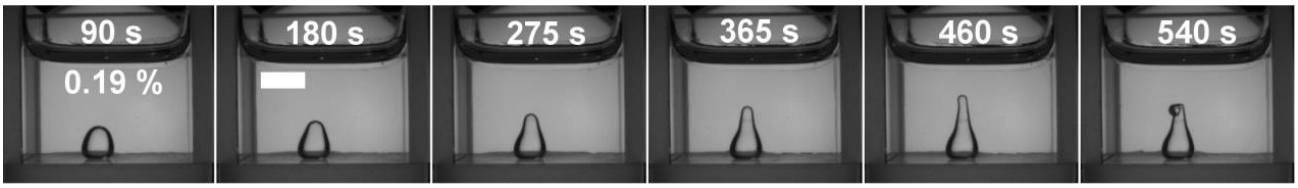

FIGURE 1. SHOWING AN EXAMPLE GROWING WATER DROPLET STABILIZED BY INTERFACIAL PARTICLES. HERE A 50µL DROPLET OF WATER HAS BEEN INJECTED INTO A BATH OF TOLUENE CONTAINING 15 VOL.% ETHANOL AND 0.19 VOL.% SILICA NANOPARTICLES. THE DROPLET IS OBSERVED TO SPROUT A VERTICAL TUBE WHICH GROWS WITH TIME UNTIL BUCKLING OCCURS (FINAL FRAME). THE SCALE BAR IS 5 MM.

[1] M. Graužinytė, J. Forth, K. A. Rumble, P. S. Clegg, Angew. Chem. Int. Ed. 54, 1456 (2015).