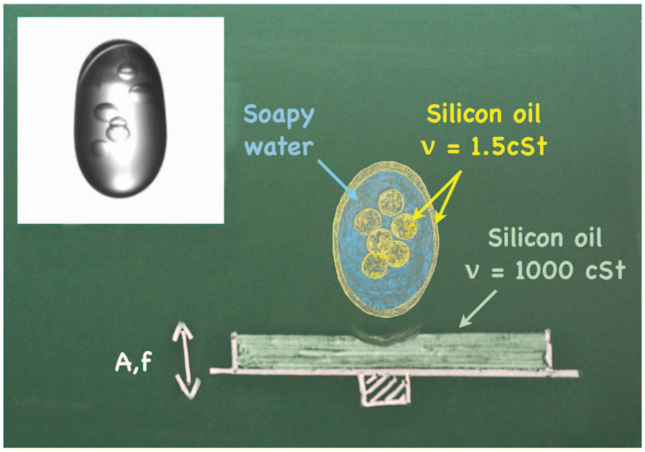


FIG. 1. (Color) Experimental setup. A millimetric compound droplet bounces on a high viscosity oil bath which is vibrated vertically (sinusoid of amplitude $A$ and frequency $f$). When the amplitude is sufficiently high, the oil layer penetrates into the water droplet, thus forming a double emulsion (enhanced online). [URL: http://dx.doi.org/10.1063/1.3202626.1]

## The mayonnaise droplet

D. Terwagne, N. Mack, S. Dorbolo, T. Gilet, J.-Y. Raty, and N. Vandewalle
*University of Liege, B-4000 Liege, Belgium*
(Received 15 July 2009; published online 27 October 2009)
[doi:10.1063/1.3202626]

Droplets are observed to bounce several times onto the surface of a high viscosity oil bath before they merge with the underlying liquid. Bouncing is achievable because a thin air layer is trapped in between the droplet and the bath. This film has first to drain out. The coalescence may be avoided and droplets may be kept bouncing indefinitely by vibrating the container vertically, so the air layer is constantly refreshed.[1,2]

In the present experiment (Fig. 1), we consider the permanent bouncing of a compound droplet, namely a soapy water droplet (sodium dodecyl sulfate) surrounded by a 1.5 cSt oil layer (Dow Corning 200). This liquid object is formed by releasing both water and oil droplets on a suspended fiber. These millimetric droplets merge together and the resulting compound droplet is sufficiently heavy to unhook from the fiber and fall onto the bath. The bouncing of this water-in-oil compound droplet is ensured through a sinusoidal vibration of the system, with amplitude $A=0.5$ mm and frequency $f=25$ Hz.

Large amplitudes lead to equivalently large deformations; the droplet trajectory may consequently become chaotic.[3] During such vigorous impacts, the oil layer can be locally pushed inside the water droplet and, thanks to a process similar to partial coalescence,[4] a small oil droplet (radius about 20% of the water droplet) may be left within the water droplet. Progressively, impact after impact, a double microemulsion of oil-in-water-in-oil is created (Fig. 2). Obviously, due to obstruction, there is a maximal number of microdroplets that may be formed within the water.

When this limit is reached, the forcing amplitude is reduced in order to prevent the coalescence between the emulsion and the underlying viscous bath. Indeed, the air layer separating them is more likely to break up for high impact velocity. With a lower forcing amplitude, the emulsion may be kept bouncing for a very long time.[5] Evaporation is prevented thanks to the remaining oil layer that wraps the water.

S.D. and T.G. thank FNRS/FRIA for financial support. This project was a part of IAP-P6/17 (Belgian Science Policy) and COST-P21 actions.

[1]J. Walker, Sci. Am. **238**, 123 (1978).
[2]T. Gilet, D. Terwagne, N. Vandewalle, and S. Dorbolo, Phys. Rev. Lett. **100**, 167802 (2008).
[3]D. Terwagne, T. Gilet, N. Vandewalle, and S. Dorbolo, Chaos **18**, 041104 (2008).
[4]T. Gilet, K. Mulleners, J. P. Lecomte, N. Vandewalle, and S. Dorbolo, Phys. Rev. E **75**, 036303 (2007).
[5]D. Terwagne, T. Gilet, N. Vandewalle, and S. Dorbolo, Phys. Fluids **21**, 054103 (2009).

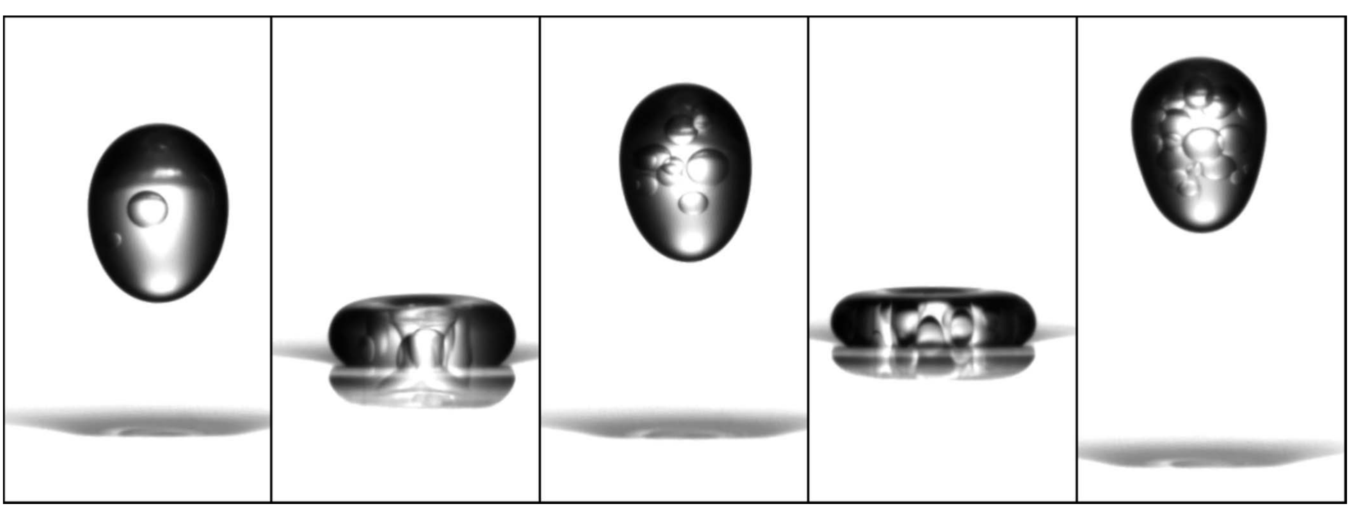

FIG. 2. Bounce after bounce, small oil droplets are created within the water droplet, thus progressively forming a microemulsion of oil-in-water-in-oil.

 