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BREAKING OF LIQUID BRIDGE BETWEEN TWO GRAINS DUE TO ITS EVAPORATION OR EXTENSION

B. Mielniczuk^{1,2}, M. S. El Youssoufi^{1,2}, T. Hueckel³, L. Sabatier^{1,2}

¹MIST Laboratory, IRSN, CNRS UMR 5508, Montpellier, France

²LMGC UMR UM2-CNRS 5508, Université Montpellier 2, 34095 Montpellier Cedex 5, France
boleslaw.mielniczuk@univ-montp2.fr, Moulay-Said El-Youssoufi@univ-montp2.fr,

laurent.sabatier@univ-montp2.fr

³Duke University, Durham, NC 27708, USA, hueckel@duke.edu

The main aim of these studies is to examine the process of rupture of water bridge between two glass spheres during its convective evaporation or mechanical extension. Evolution of bridge profile was recorded with use of high-speed camera, with frame rate up to 54000 frames per second, and subsequently digitalized. Digital image processing allows to determine several geometrical parameters: curvature of the surface of the water body (gorge radius, external shape radius), water wire dimensions, satellite drop radius. Basing on these parameters time evolution of following parameters was calculated: capillary force (gorge method) and suction and surface tension force components, frequency of oscillation of satellite droplet and remaining water caps, capillary force jump.

Processes of evaporation or extension induce thinning of liquid, with significant acceleration just before the rupture (Fig. 1a,b). Then neck transforms into thin cylindrical water wire which subsequently breaks (Fig. 1c). At this moment the mass of water is separated, forming two hemi-drops, attached to the spheres, and suspended water-wire, which next transforms into satellite droplet (Fig.1d). The unbalanced surface tension rapidly accelerates liquid in these three water bodies and acts almost like an impact. As a result of release and dissipate of energy fast oscillations of satellite droplet (small water mass) and much slower oscillations of two spherical caps (larger water mass) are observed (Fig. 1e-g).

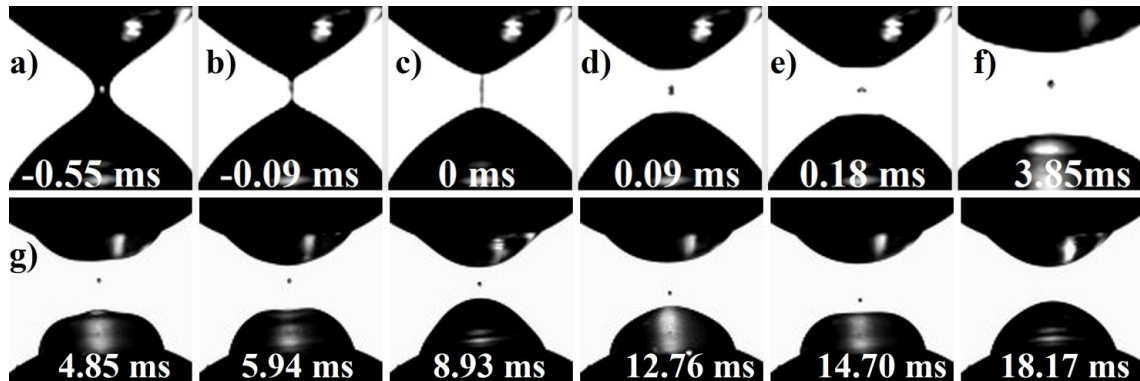


Fig. 1. Evolution of liquid capillary bridge between two spheres: a) necking stage, b) creation of water wire, c) bifurcation, d)-f)- droplet oscillations, g) droplet fall, drops oscillations

For both examined processes the diameter of the neck decreases, with sudden acceleration about 1-2 ms before the rupture. Just before the rupture positive (repulsive), increasing Laplace pressure, and negative (attractive) decreasing surface tension force were determined. Surface tension force component is several times higher than suction force, so resulting capillary force follows the trend of surface tension force, decreasing significantly just before the rupture, when water-wire appears. Dimensions of created water-wire are: diameter of about 90-120 μm and length up to 250 μm , and it exist for about 100 μs , than cracks. Oscillation frequency of remaining water hemi-spheres is from 60 to 1300 Hz, depending on released energy (remaining water mass). Duration of whole rupture process and water stabilization is from 10 to 60 ms.

Three main ways of rupture are observed, depending on the bridge dimensions: thinning and vanishing bridge neck for the smallest bridges, creation of water-wire and its rupture simultaneously at two points (for larger bridges) or at lower part first (for the largest bridges).