—Supporting Information—

Effect of particle shape on capillary forces acting on particles at an air-water interface

Nirmalya Chatterjee* and Markus Flury

[1]*Department of Crop and Soil Sciences, Washington State University, Puyallup, WA 98371, USA.* **Corresponding author, Phone: +1-509-432-9533, c_nirmalya@wsu.edu*

Supporting information (5 pages) contains:

1. Details on the capture of the high-speed videos of particles being immersed into an air-water interface. Videos are available in MP4 format.

2. Figure showing comparison of experimental and scaled theoretical force-position curves during immersion for spherical and ellipsoidal particles.

This information is available free of charge via the Internet at http://pubs.acs.org.

S1 Method for High-speed Videography

High-speed videos were taken with a MotionBlitz Cube 3 high-speed camera (Mikrotron GmbH, Unterschleissheim, Germany) and a Nikon 50 mm lens. Lighting was provided by a standard 1 kW floodlamp placed 15 cm away from the platform and water bath in which the particle was being immersed. The camera was attached to a laptop running Windows 7 equipped with a Gigabit ethernet port using a standard Cat5 LAN cable. The camera management and frame-capture software supplied by Mikrotron (MotionBlitz Director 2) was used to capture and store the videos.

The original videos were taken at 1000 frames/second at a frame size of 320×160 pixels. The MotionBlitz software saved the raw video footage as XVid encoded AVI (audio video interleave) files. The videos were later edited (time and frame cropping) using HandBrake version 0.98 and saved as 100 frames/second, x264 encoded MP4 files. The videos available online for viewing were set up to play at a speed one-tenth of the speed at which they were taken. This enables us to view the air-water interface interacting with the particle in slow-motion. The frames were cropped to 214×160 pixels.

S2 Discussion

The videos allow us to view a number of key events about the interaction of the air-water interface with the particles.

Particles with rounded cross-section. The videos show the abrupt force change during the snap-in of the air-water interface. This abrupt movement of the interface manifests itself as large spike in the force-position curve, and is visually seen as being followed by large-amplitude undulations on the air-water interface. Another key feature for particles of rounded cross-section is the change in direction of the direction of curvature of the interface. For the spherical particle this occurs at a position of the interface below the equatorial plane. For the flatter ellipsoidal particle this change in direction of curvature of the interface is past the position of the equatorial plane.

Particles with fixed cross-section. Similar to the videos of the round particles, the snap-in of the air-water interface with the bottom of the particles is observable for particles with fixed cross-section. After the snap-in, we observe a continuously larger diameter depression of the air-water interface being created as the particles move down with the air-water interface remaining pinned at the bottom edge. When the particles are less than half immersed in the water the interface depression becomes smaller and thereafter remains at a fixed size indicating sliding of the air-water interface line along the vertical walls of the particles. The depression size starts increasing again when the particles are completely underneath the surface of the undisturbed air-water interface. Near the end of the video, we observe a rapid reduction in the size of depression formed in the air-water interface as the contact-line creeps across the top of the particle, before eventually snapping off of from the top face of the particles. The snap-off is also followed by large amplitude waves on the rapidly equilibrating air-water interface.

Particles with tapered cross-section. The particles with a tapered shape also interface snap-in at the bottom edge of the particles, and the subsequent pinning at the bottom edge. However, after the air-water interface snaps-off from the bottom edge of the tapered particles, the size of the depression formed decreases continuously. There is almost no observable pinning at the top, as is expected for such particles. The trigonal prism (tent-shape), however, does shows some pinning at its top edge.

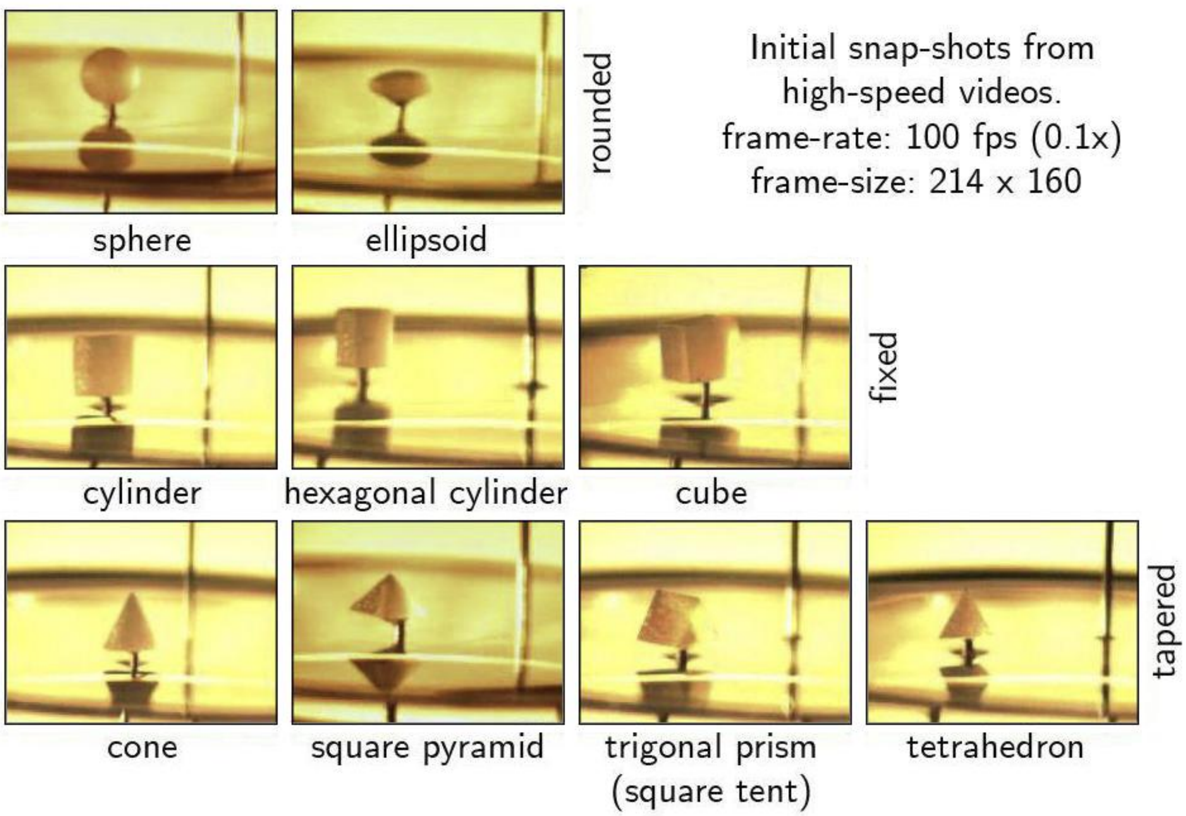

Figure S1. Snap-shots of particles of different cross-sections prior to snap-in of the air-water interface.

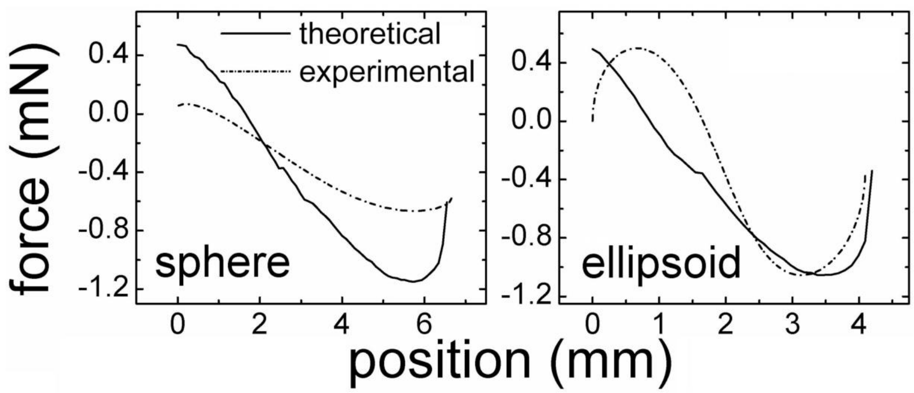

Figure S2. Comparison of experimental and scaled theoretical force-position curves during immersion for spherical and ellipsoidal particles. The advancing contact angle for the particles is $\theta = 151^\circ \pm 2^\circ$.