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Capillary origami in nature

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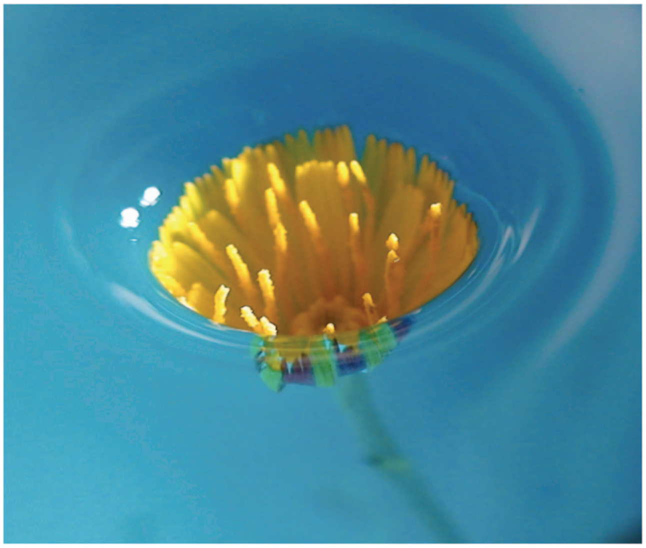

FIG. 1. (Color)

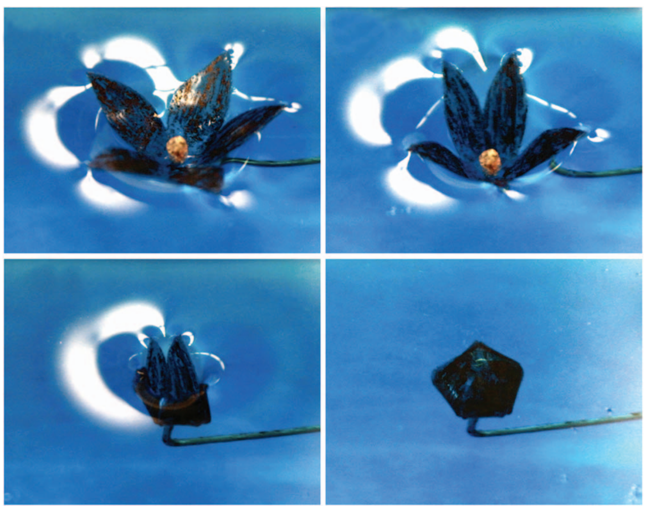

FIG. 2. (Color)

Capillary origami in nature

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Capillary forces dominate gravity on a small scale and may deform flexible bodies in both natural and laboratory settings.[1] Two examples are considered here: floating flowers and spider webs.

Some flowers float on the water surface with their weight supported and shape determined by the combined influence of elastic, capillary, and hydrostatic forces (Fig. 1). Analogous artificial flowers cut out of a flexible polymer sheet similarly deform when submerged (Fig. 2). In the extreme case of complete submergence, the flower may close completely, staying dry inside by trapping an enclosed air bubble. When the experiment is inverted, and the artificial flower is withdrawn from the water surface, it instead traps a water droplet of fixed volume, and so serves as an elastocapillary pipette (Fig. 3).

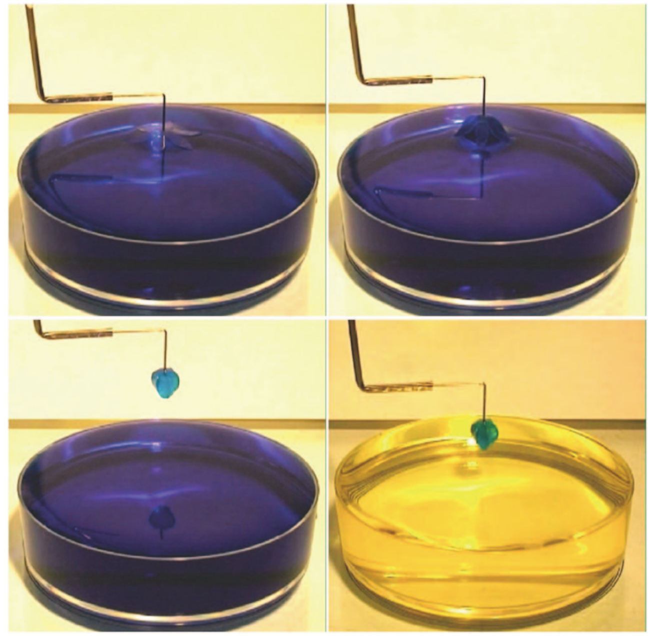

FIG. 3. (Color)

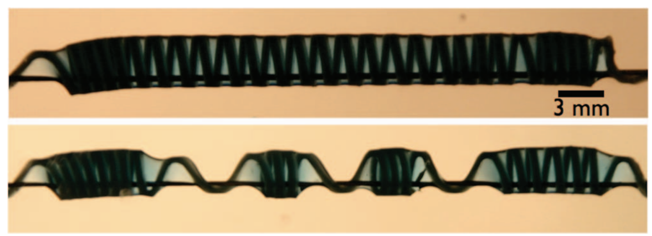

FIG. 4. (Color)

The spider capture threads that run circumferentially around spider webs are typically coated with a viscous fluid. Capillary instability of this film prompts its evolution into a series of fluid droplets, inside of which the slack elastic thread wraps into a series of coils. The result is a characteristic windlass mechanism:[2] When the prey strikes the web, the coil unravels within the drop, and the associated viscous damping prevents the prey from being ejected.[3] Analogous laboratory experiments mimic the instability of the spider web (Fig. 4). The elastocapillary instability of a helical elastic thread immersed in silicone oil results in a wavelength prescribed by the interfacial tension and the spring's initial loading.

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