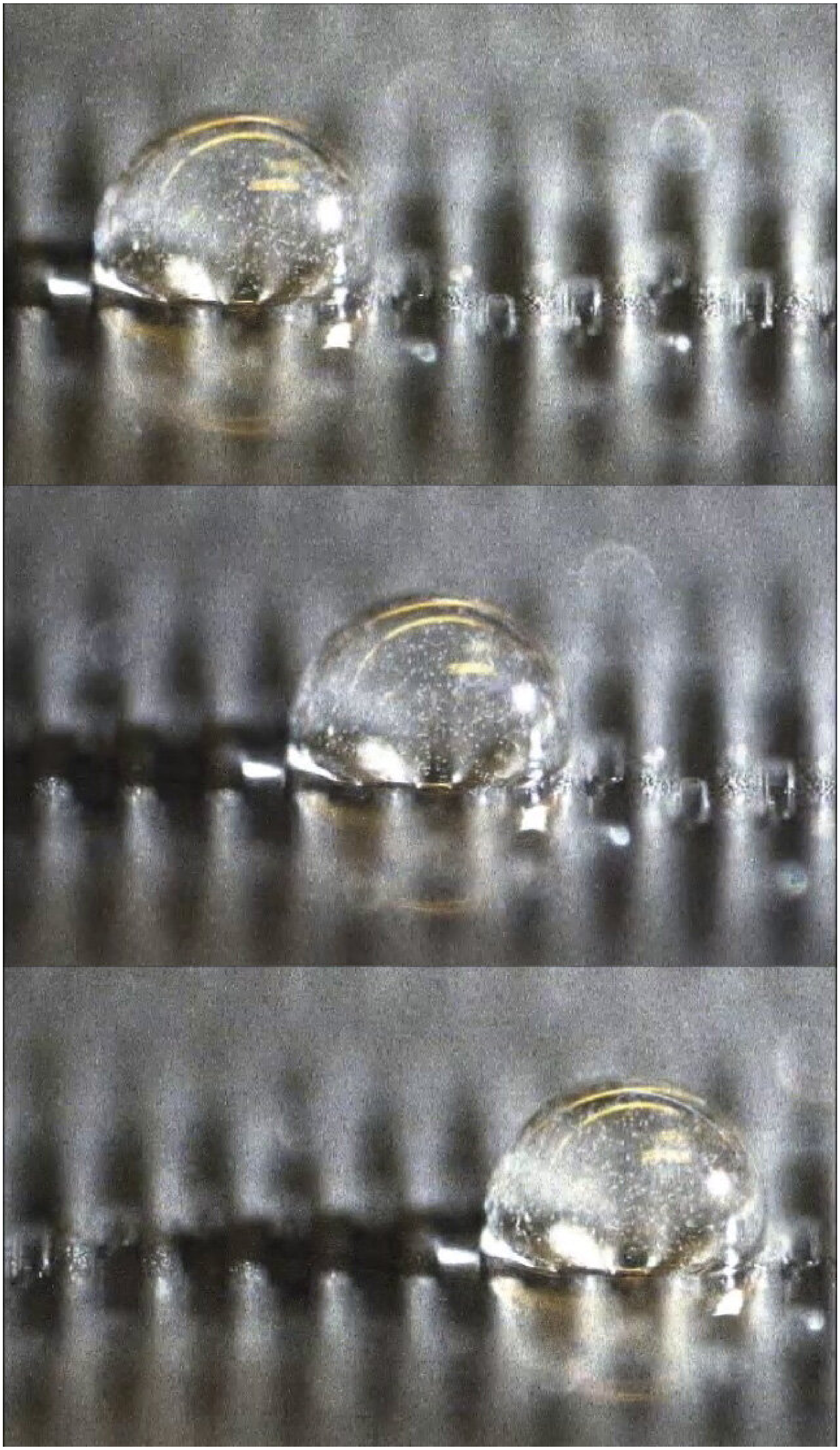
Using waves to move droplets

June 17 2019



A glycerol droplet travels along with the wave. Small particles in the droplet visualize the internal fluid flow. Credit: De Jong et al., *Sci. Adv.* 2019;5: eaaw0914

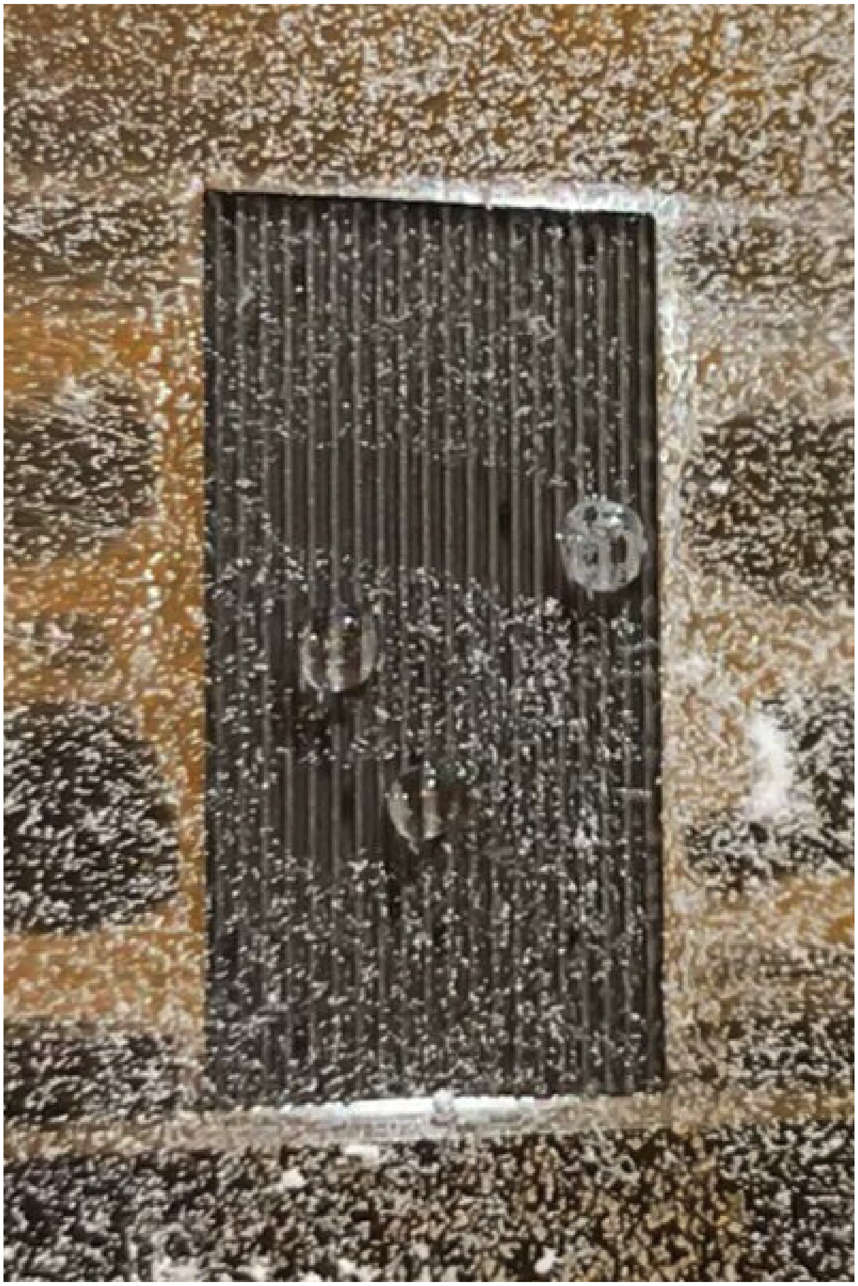
Controlling individual droplets leads to more efficient self-cleaning surfaces and lab-on-a-chip implementations. University of Groningen professor Patrick Onck and colleagues from Eindhoven University of Technology have shown that this is possible by using a technique named mechanowetting. The researchers report a way of transporting droplets by using transverse surface waves, which even works on inclined or vertical surfaces. The research was published in *Science Advances* on 14 June.

The idea of mechanowetting is simple: A droplet on a transverse surface wave will move with the wave. "One of the properties of water droplets is that they always try to stay on top of a wave. If that top runs ahead, the droplet will run with it," Onck explains. It is possible to move the droplets by using mechanical deformation to create surface waves. "The remarkable thing about this is that it also works on inclined or vertical surfaces—drops can even move upward against gravity."

Edwin de Jong, Ph.D. candidate in Onck's group and first author of the paper, tested the concept of mechanowetting by means of a computer model. "When it seemed to work in theory, our colleagues from Eindhoven University of Technology devised an experiment to test it. Our model turned out to be right. In practice, the drops moved exactly as we had imagined."

Lab-on-a-chip

One of the applications of mechanowetting is in lab-on-a-chip systems, complete laboratories the size of a credit card, that are used to analyze biological fluids such as blood or saliva. This allows testing of samples outside the lab, e.g., directly at the bedside, with a much faster response rate. "If we are able to direct each drop separately, it is possible to perform a lot of different tests at high speed with a very small volume of fluid," says Onck. Transporting droplets separately was already possible by means of electrowetting. "Electrowetting is transporting droplets by applying electric fields. However, these fields can change the biochemical properties of the sample, and that is something you don't want when doing blood tests."



Demonstration of an active, self-cleaning surface. The droplets pick up the dirt particles as they travel along with the surface wave. Credit: De Jong et al., *Sci. Adv.* 2019;5: eaaw0914

In the meantime, Onck's group is exploring new possibilities. "We have performed computer simulations that show that mechanowetting also works by using light-responsive materials to create waves. Light is especially interesting because of its precision and its ability to control the movement of drops remotely." In addition to lab-on-a-chip systems, mechanowetting has several other interesting applications, such as self-cleaning surfaces, where water droplets actively absorb and remove dirt. It also offers opportunities for harvesting moisture from the air, by collecting dew drops for use as drinking water.

More information: Edwin De Jong et al. Climbing droplets driven by mechanowetting on transverse waves, *Science Advances* (2019). DOI: 10.1126/sciadv.aaw0914

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