Researchers make breakthrough in dewetting surfaces

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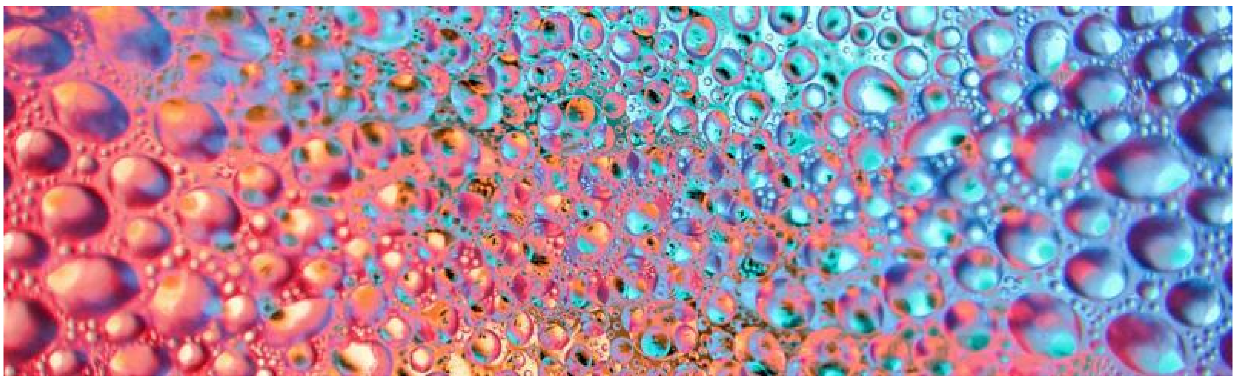


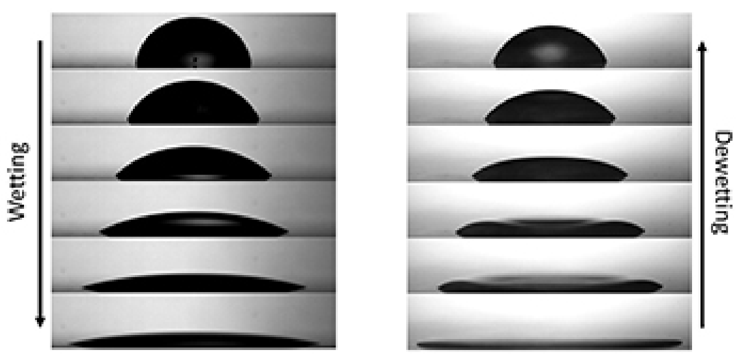
Credit: Northumbria University

How would you like a kitchen surface that cleans itself? Technological advances such as this could be one step closer after a breakthrough by Northumbria University and Nottingham Trent University.

Using experimental techniques, researchers have made the first ever direct observation of the elusive dewetting process, which takes place when a liquid film retracts to form a bead-shaped drop. The achievement could now spark a new line of research and lead to breakthroughs involving the use of liquids, such as better coatings and more effective self-cleaning surfaces.

Dewetting is the opposite of 'spreading', a familiar process which can be observed day to day, such as when a drop of oil is placed on the surface of a pan. The liquid initially has a bead-like shape, and it slowly spreads to form a thin film. The opposite process, called dewetting, occurs when a liquid film retracts from a solid to form a bead-shaped drop, which can be observed when a wet window is left to dry up.

The details of dewetting are extremely important to any situation involving the removal or drying of a liquid. Despite its apparent simplicity, the direct observation of the full dewetting of a droplet into a single drop had remained elusive and difficult to achieve until Northumbria and Nottingham Trent's recent experiment.



Credit: Northumbria University

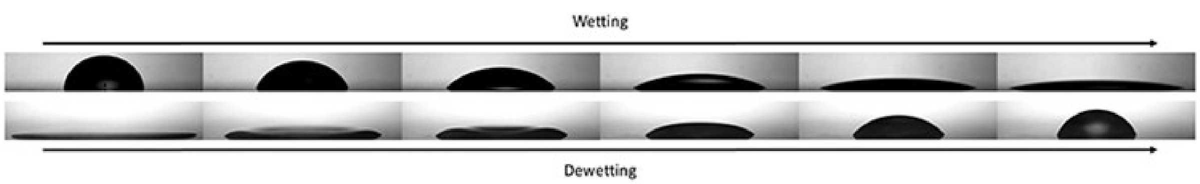
In a recent paper in the journal *Science Advances*, the research team came up with an ingenious solution to this problem. Using a novel method known as dielectrowetting, they exploited the electric properties of liquids to force a liquid to coat a solid surface using an applied voltage.

Professor Glen McHale, Pro-Vice Chancellor (Engineering and Environment) at Northumbria University and Professor of Applied and

Material Physics, said: "Our experimental setup opens-up the possibility of preparing liquid shapes in a very controlled manner, which then dewet. This can lead to new methods for liquid manipulation in technologies such as coating and self-cleaning surfaces."

By embedding very thin patterned electrodes in the solid and carefully arranging them into a circular pattern, the team achieved the formation of a thin circular liquid film. By switching off the voltage, they revealed, for the first time, the full dewetting process of the liquid film back to a bead-like drop shape.

"At first sight, one might have expected that dewetting is just the time-reversal of spreading. Surprisingly, we found that dewetting not spreading in reverse" said Prof Carl Brown from Nottingham Trent University's School of Science and Technology. "Instead of a smooth sequence of drop-like shapes, the dewetting film forms a rim at its own edge which retracts at constant speed for most of the dewetting process."



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To understand this behaviour, the team used a combination of theory and numerical simulations to rationalise the experiments. Dr Rodrigo

Ledesma-Aguilar, from Northumbria, said: "Both the simulations and the theory support that the liquid tends to adopt the closest local equilibrium shape it can during dewetting. This explains the smooth rim shape which survives for most of the process."

Nottingham Trent University's Andrew Edwards, first author of the paper, said: "Unveiling the dynamics of a dewetting film in all its detail has been a mind-blowing experience. This is my first original contribution as a PhD student and has allowed me to apply a range of knowledge gained in my first degree as a physicist. It is extremely pleasing to see how the experiments are so well described by the theory and the simulations."

Dr Michael Newton, from Nottingham Trent University, added: "Our method can be used to learn more about the underlying physics behind other dewetting phenomena such as condensation, evaporation and droplet rebound. These processes are critical for applications such as fog-collection, coating and lubrication. The technique developed can also be used for characterising liquid properties when only small volumes are available."

More information: A. M. J. Edwards et al. Not spreading in reverse: The dewetting of a liquid film into a single drop, *Science Advances* (2016). DOI: 10.1126/sciadv.1600183

Provided by Northumbria University