Supplementary Information

Sophisticated oil film geometries through incomplete electrical dewetting by feedback control and Fourier construction

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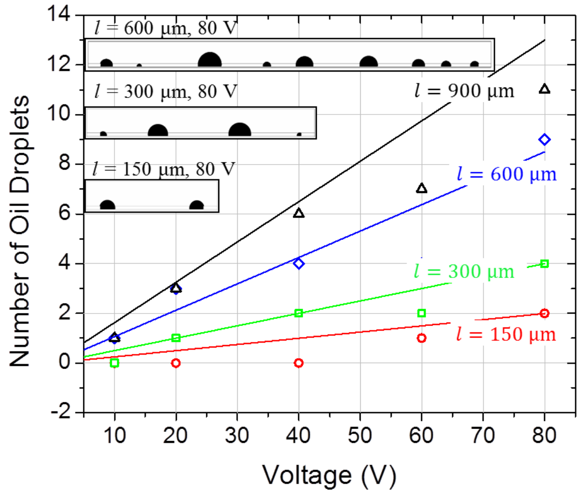
Supplementary Note 1: oil dewetting patterns in an electrowetting pixel.

As demonstrations in this paper are created by modeling, a comparison to complex experimental dewetting behavoir in electrowetting pixels[1,2,3] is presented to increase confidence in the predictions that will provided by the model. Here the finite element method (FEM) is utilized to solve all of the governing equations including the Cahn−Hilliard equation for detecting the dynamic moving interface between oil and water phase, the Laplace equation for calculating the electric field distribution, and the Navier−Stokes equation for solving the velocity field distribution. The details of the proposed model are reserved for the Appendix section of this paper.

The hydrophobic dielectric used in the simulation consists of a stack of 1.5 μm dielectric layer and 0.2 μm hydrophobic layer with the permittivity $3\varepsilon_0$ and $2\varepsilon_0$, respectively. Here, a dielectric oil film thickness of 4.7 μm with $3\varepsilon_0$ is adopted. In addition, the contact angle of the hydrophilic grid is set to 90°, which ensures that the oil film is initially flat in the pixel in the absence of voltage[1]. In the experiments, and as predicted by theory, the dominant dewetting wavelength for the oil film will exhibit a dependence on the abruptly applied voltage (increased voltage magnitude, shorter dominant dewetting wavelength, increased number of smaller volume oil droplets). As shown in Supplementary Figure 1, the number of oil droplets versus applied voltage for various pixel sizes (l) is plotted vs. increasing voltage. The symbols represent the results using the modeling methods used in this paper, and are in agreement with the theoretical behavior (solid lines)[1], which have been further shown to agree with experimental results[1] as the droplet counts plotted in Supplementary Figure 1 increase linearly with increasing voltage. The insets photographs are the model results showing the periodically dewetted oil droplets subjected to 80 V in the pixel sizes l = 150, 300, and 600 μm.



Supplementary Figure 1 | Oil dewetting patterns in an electrowetting pixel. Plot of the number of oil droplets versus applied voltage for various pixel sizes (l) with the oil thickness d_{oil} = 4.7 μm. The symbols represent the simulation results and the solid lines denote the theoretically predicted result.

Supplementary References

1. B. Sun and J. Heikenfeld, *J. Micromech. Microeng.*, 2008, **18**, 025027.

2. S. Herminghaus, *Phys. Rev. Lett.*, 1999, **83**, 2359.

3. A. Staicu and F. Mugele, *Phys. Rev. Lett.*, 2006, **97**, 167801.