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Electrowetting-induced oil film entrapment and instability
ADRIAN STAICU, FRIEDER MUGELE, Physics of Complex Fluids, University of Twente — Electrowetting is a classic example of interaction between fluids and electric fields: by applying a voltage between a drop of conductive liquid and an insulator-covered hydrophobic electrode, the contact angle θ of the drop can be reduced by several tens of degrees compared to Young's angle (F. Mugele and J.-C. Baret, J. Phys.: Condens. Matter 17, R705, 2005). We investigate the spreading at variable rate of a water drop on a smooth hydrophobic substrate in an ambient oil bath driven by electrowetting. We find that a thin film of oil is entrapped under the drop. Its thickness is described by an extension of the Landau-Levich law of dip coating that includes the electrostatic pressure contribution. Once trapped, the thin film becomes unstable under the competing effects of the electrostatic pressure and surface tension and dewets into microscopic droplets, in agreement with a linear stability analysis. By varying the thickness of the dielectric layer, we expect to be able to tune the relative importance of the electrostatic contribution in future experiments. Our results recommend electrowetting as an efficient experimental approach to the problem of dynamic wetting in the presence of a tunable substrate-liquid interaction.

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