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Drying water droplets: Suppression of the coffee-stain effect by letting them dry on a thin oil film YAXING LI, Physics of Fluids group, University of Twente, CHRISTIAN DIDDENS, TIM SEGERS, Physics of Fluids group, University of Twente; Eindhoven University of Technology, HERMAN WIJSHOFF, Oce Technologies, B. V.; Eindhoven University of Technology, MICHEL VERSLUIS, Physics of Fluids group, University of Twente, DETLEF LOHSE, Physics of Fluids group, University of Twente; Max Planck Institute for Dynamics and Self-Organization — We systematically study the evaporation of a water microdroplet put on a thin oil film, both experimentally and theoretically. First, the absence of an intercalated film between droplets and substrates is demonstrated by interferometry. The interfacial energies between the droplet, the oil film and the solid surface are the key parameters to determine the wetting characteristics. During evaporation, we measure the flow field with μPIV, which shows that it is controlled by the contact line behavior and the wetting state of the film with the droplet. Once the microdroplet contains particles, they accumulate during the evaporation process. We experimentally find that the final deposit of the particles is determined by the flow and by the movement of the contact line. We derive an analytical expression for the radial velocity profile in the flow field near the substrate, which proves that the hindering of evaporation at the rim of the droplet by the non-volatile oil meniscus prevents the flow towards the edge, and therefore suppresses the "coffee-stain effect. We finally demonstrate that the final particle deposition can be manipulated by tuning the surface energy of the droplet by adding a specific amount of a surfactant.

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