EUROMECH COLLOQUIUM 651
International Colloquium on Films, bubbles, droplets and phase change

August 25th-29th 2025, Metz, France
https://euromech.org/colloquia/colloquia-2025/651

Receding contact line dynamics on superhydrophobic surfaces

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Because of their practical importance in applications like self-cleaning and drag reduction, superhydrophobic surfaces have been widely studied. However, the link between microscopic surface properties and macroscopic dynamic contact angles remains an open question. This study systematically examines dynamic contact angles on superhydrophobic micropillar surfaces across a wide range of velocities, analyzing their dependence on solid surface fraction. Using two complementary geometries (a millimetric sessile drop and a centimetric capillary bridge), we have measured the dynamic receding contact angle of water on surfaces composed of micropillar arrays for velocities spanning over five decades. We show that introducing surface textures in the form of micropillar arrays significantly decreases the dependency of the contact angle on the contact line speed compared to a smooth surface, and this velocity dependency also decreases with decreasing surface fraction of micropillars. Interestingly, we show that the exact texturation of the surface does not play a fundamental role in the angle-velocity relationships as long as microtextures present the same type of periodic pattern (pillar arrays or microgrids). We compare existing models to identify dissipation sources and propose a new mechanism based on droplet detachment from pillars.

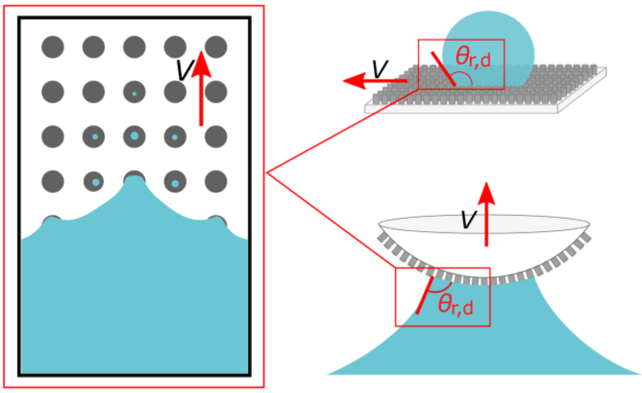

Figure 1. Schematics representing the top view of contact line deformations and droplet pinched off on micropillars while the contact line recedes on a superhydrophobic surfaces composed of micropillars array. The receding is imposed at a chosen velocity by moving horizontally the substrate supporting a sessile drop either by moving vertically a curved substrate forming a centimetric capillary bridge with an infinite liquid bath

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