Wetting of textured surfaces and the capillary bridge technique

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Superhydrophobic surfaces feature remarkable water repellency which are widely known to be governed by a combination of roughness at the micro/nano scale and low surface energy. Because of their considerable practical importance, they have been the center of extensive research for the last decades, both in terms of manufacturing and microfabrication and in terms of fundamental studies of these "super-surfaces" which exhibit noteworthy behaviors such as rebound, drag reduction, anti-icing...

The aim of this work [1] is to study the wetting properties (advancing and receding contact angles) of textured surfaces with an unconventional method: the capillary bridge technique [2]. Indeed, to our knowledge, apparent contact angles on superhydrophobic surfaces were measured so far using drop shape analysis by side view imaging. Recent experiments of Schellenberger et al. [3] show that this method can significantly underestimate apparent advancing contact angle.

In order to use the capillary bridge setup (a stable, centimetric capillary bridge is formed with a curved surface facing down toward a liquid bath), we developed a fabrication method to obtain new complex superhydrophobic surfaces: transparent, curved and textured. We proposed an improved numerical analysis which allows one to measure the value of the contact angle for each height reached by the surface. We show that both receding and advancing contact angle increase with decreasing pillar density. Receding contact angle measurements made on our surfaces are in very good agreement with the contact line elasticity theory recently proposed by Dubov et al. [4]. However, we show that the advancing angle increases with the distance between pillars and is not constant, contrary to measurements obtained with the sessile drop method that are constant. This point is an important basis to build a refined model describing the advancing behavior. In addition, we also show how the relation between the contact angle and the contact line speed can be measured the capillary bridge experiment. Finally, it allows to explore wetting contact area much larger than contact area generally explored with a simple millimetric droplet, this situation is much closer to practical applications. This allows us to observe new impalement transition behaviors as function of the experimental conditions.

[1] Cohen C., Bouret Y., Izmaylov Y., Sauder G., Forestier E. and Noblin X. Soft Matter 15, 2990-2998 (2019).
[2] Restagno F., Poulard C., Cohen C., Vagharchakian L., Léger L., Contact angle and contact angle hysteresis measurements using the capillary bridge technique, Langmuir, 25(18), 11188-11196, (2009).
[3] Schellenberger F., Encinas N., Vollmer D., Butt H. J., Physical review letters, 116(9), 096101, (2016).

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