Abstract Title

Wetting – non wetting states of wavy surfaces

Symposium Track

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Abstract body

Roughness-induced hydrophobicity is a well known effect, often observed in many plant leaves, e.g. Sacred Lotus leaves (Barthlott 1997). The very high water-repellency of such natural surfaces is the origin of the so-called "self-cleaning effect", also referred to as "Lotus effect": rain drops are able to remove almost completely any external impurity from the leaf surface. Many artificial surfaces that mimic the super-hydrophobic properties of the Lotus leaves (Lau et al. 2003, Feng et al. 2002, Onda et al. 1996) have been produced. Such man-made super-hydrophobic surfaces can show CAs up to 174° (Feng et al. 2002, Onda et al. 1996, Shibuichi et al. 1996). Roughness-induced non-wettability has attracted much interest from both fundamental research, because of its potential applications to the high-tech field of nano- and micro- fluidics, and industry for the "self-cleaning" ability of such surfaces. Moreover, new researches are being carried on with the aim of producing super-hydrophobic optically transparent self-cleaning surfaces (Nakajima et al. 2000, Duparrè 2001). Such surfaces may be used as coatings in the automotive field, e.g. car-windshields and biker helmets. In this case the super-hydrophobic surfaces should be able to suspend rain drops despite the very large impact forces. Some studies have shown, indeed, that falling drops may fully rebound on such water-repellent surfaces with very high restitution coefficients ~ 0.9 (Lau, et al. 2003, Richard and Quéré 2000, Quéré 2002), but some experiments have also shown that increasing the pressure at the interface between the liquid and the super-hydrophobic surface may result in an irreversible transition between two different states: the Cassie and the Wenzel states respectively (Lafuma and Quéré 2003, Quéré et al 2003). In a Cassie state (Cassie and Baxter, 1944) air is trapped between the liquid and the substrate, and a composite interfaces is created, which leads to a super-hydrophobic behavior with a very small CA hysteresis. In a Wenzel state (Wenzel 1936) full contact occurs between the liquid and the substrate. In this case the roughness of the surface increases the area of real contact and the effective interfacial energy, resulting in an enhanced hydrophobicity, but also in a very pronounced CA hysteresis (Lafuma and Quéré 2003, Quéré et al 2003). Thus a drop in a Wenzel state adheres much strongly to the substrate than in a Cassie state. A possible way to avoid CA hysteresis is that of preventing the Wenzel state to be formed. Thus, in this case, a robust super-hydrophobic surface should be designed in such a way to make stable the Cassie state and increase the critical pressure p_W at which the transition to the Wenzel state occurs. In this paper the problem of impacting drops is taken under consideration, the maximum interface pressure is estimated as a function of the impacting velocity, and the influence on super-hydrophobic properties of the substrate are investigated. Also some suggestion are derived to design a robust super-hydrophobic surface.

Keywords

Wettability, hydrophobicity, adhesion, roughness, tribology

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