Wetting of regularly structured substrates

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Despite the enormous amount of literature published on superhydrophobicity, the wetting of non-flat, moderately hydrophilic surfaces is still barely addressed [1]. A theoretical approach to establish a link between contact angle hysteresis or droplet eccentricity on anisotropic patterns, and the geometry of the surface features is still missing. In order to elucidate the fundamental relation between advancing contact angles and substrate geometry, a highly idealized system consisting of a plane surface decorated with a regular array of posts with circular cross section is investigated using numerical minimizations of the interfacial energy. Employing the static apparent angle as a control parameter, a number of interfacial instabilities are detected, which lead to topological transitions of the interface and contact line. Such instabilities can be depinning from sharp edges, coalescence of the liquid menisci ahead of the posts, or the appearance of soft deformation modes of the interface. By extensively varying the line fraction and aspect ratio of the posts as well as the material contact angle of the substrate, a complete numerical characterization of the system is constructed [1]. The second part of the talk will be devoted to a study of global equilibrium shapes of droplets in contact to a regular pattern of linear grooves with triangular cross section. Depending on the opening angle of the grooves and the material contact angle, the liquid either spreads only into the directions of the grooves, or grows into all three dimensions. In the latter case, the droplet approaches a scale invariant shape as the number of covered grooves increases. A mapping of the shape to a partially wetting droplet on a plane linear stripe can be employed to predict the droplet eccentricity in this asymptotic limit. As this model is not restricted to a specific class of patterns, it can be applied through suitable mapping to any type of chemical or topographic pattern. On all of these linear surface patterns, shrinking droplets exhibit an almost circular shape.

References

[1] P. Fosberg, C. Priest, et al., "Contact line pinning on microstructured surfaces for liquids in the Wenzel state", Langmuir **26**, 860 (2010).
[2] C. Semprebon, S. Herminghaus, M. Brinkmann, "Advancing modes on regular patterned substrates", Soft Matter **8**, 6301 (2012).