Multifacted Design Optimisation for Superoloephobic Surfaces

From water purification to anti-fingerprint displays, a vast range of potential applications exists for physically textured, superoleophobic surfaces. The complex structures necessary however preclude comprehensive experimental and computational studies of the wetting properties. Here, we develop three simulation strategies to take a systematic and multifaceted approach to optimal reentrant and doubly reentrant design. In the contact angle hysteresis study, we analyse prevailing theories of receding mechanisms, and discover two new mechanisms which are quantitatively modelled via capillary bridge rupture. In the critical pressure study, we show that current models are inaccurate. However, by employing a capillary bridge description, these can be modified to allow accurate predictions for both the critical pressures and their corresponding liquid-vapour interface morphologies. Finally, we study the minimum energy failure mechanisms by developing a rapid and precise energy barrier search process. Overall, efficient simultaneous optimisation is demonstrated using a genetic algorithm to perfect two example textures for membrane distillation and digital microfluidics.