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Metastable wetting state of submersed hydrophobic surfaces

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Superhydrophobic surfaces have a promising application in drag reduction of micro-fluidic devices and submersed moving bodies. The stability of the air trapped in the surface structure by water above it is essential for significant drag reduction. In this work, we investigate the wetting states on submersed hydrophobic surfaces with one-level structure under hydrostatic pressure. We theoretically predict that there is a new metastable wetting state, which happens after depinning of the three-phase contact line (TCL). To verify the existence of the metastable state, we image the wetting states of hydrophobic surfaces under different hydrostatic pressures by confocal microscopy. We clearly observe that the menisci hang on the side wall of the structure, leading to the metastable state. Then we show that a strategy of using hierarchical structures can strengthen the TCL pinning in the metastable state, and thus is important to improve the stability of superhydrophobicity under high liquid pressure.

Keywords: Metastable state, Hydrostatic pressure, Pinning, Confocal microscopy, Hierarchical structures