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Wetting transition on submerged micro-structured surfaces

Pengyu Lv, Yahui Xue and Huiling Duan*

Department of Mechanics and Engineering Science, College of Engineering, Peking University, Beijing, 100871, China

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Submerged superhydrophobic surfaces exhibit great potential for reducing flow resistance in microchannels and drag of submerged bodies. However, the low stability of liquid−air interfaces on those surfaces limits the scope of their application, especially under high liquid pressure. The current work examines *in situ* liquid-air interfaces on a submerged surface patterned with cylindrical micropores using confocal microscopy. Both the pinned Cassie-Baxter and depinned metastable states are directly observed and measured. The metastable state dynamically evolves, leading to a transition to the Wenzel state. This process is extensively quantified under different ambient pressure conditions, and the data are in good agreement with a diffusion-based model prediction. A similarity law along with a characteristic time scale is derived which governs the lifetime of the air pockets and which can be used to predict the longevity of underwater superhydrophobicity. Finally, we show that a strategy of using hierarchical structures can strengthen the three-phase contact line pinning of the liquid−air interface in the metastable state. Therefore, the hierarchical structure on submerged surfaces is important to further improve the stability of superhydrophobicity under high liquid pressure. The current work, by combining quantitative measurements with theoretical analyses, provides a better prediction of the multiphase phenomenon pertinent to structure-enabled underwater superhydrophobicity.

Keywords: