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PROCEEDINGS

Self-Driven Droplet on the Bilayer Two-Dimensional Materials and Nanoscale Channel with Controllable Gradient Wettability

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ABSTRACT

The wetting behavior is ubiquitous in natural phenomenon as well as engineering application. As an intrinsic property of solid surface, the wettability with a controllable gradient has been an attractive issue with a wide application in various fields, including microfluidic devices, self-driven transport, biotechnologies, etc. Generally, it often requires elaborate design of microstructure or its response under the electrical, thermal, optical, pH stimuli, etc. However, the relevant complex underlying mechanism makes it difficult to construct quantitative relations between the wettability and the external field for the fine design. In this work, based on the bilayer two-dimensional materials, a simple controlling method of the wettability gradient is established. Molecular dynamics simulation is utilized to examine the controlling strategy and its performance for self-driven motion of water droplet. The results show that the coupling wettability of the bilayer materials always develops towards the hydrophilicity relative to the wettability of the upper layer. But the variation extent becomes small with increasing the interlayer distance, and the coupling wettability approaches the wettability of the upper layer material gradually. For this simple controlling strategy, a theoretical model of governing relationship is established based on the work of adhesion, which correlates the overall surface wettability with the interlayer distance and the wettabilities of individual materials. Based on the varying interlayer distance, the uniform gradient wettability can be achieved through inclining the bottom material. Thus, a surface with the bilayer two-dimensional materials and a channel composed of two gradient surfaces are constructed for droplet transport, respectively. The results indicate the spontaneous and steady motion of droplet under the corresponding gradient wettability. A theoretical model is proposed to describe the acceleration behavior of the droplet, which reveals the crucial role of the bottom layer. The present work provides essential guidelines for manipulating two-dimensional materials to design unconventional wettability surfaces, paving new routes to many applications such as micro-fluidic chip, virus diagnosis, intelligent sensor, etc.

KEYWORDS

Wettability Gradient; droplet; self-driven motion; nanochannel; molecular dynamics simulations

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