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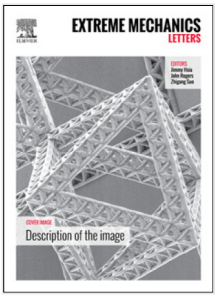

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A Unified Mechanics Model of Wettability Gradient-Driven Motion of Water Droplet on Solid Surfaces

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Abstract: Wettability gradient-driven motion of a liquid droplet on solid surfaces is a ubiquitous phenomenon, and understanding the unidirectional movement is of fundamental importance in surface engineering. By probing the wettability gradient-induced driving force and the friction force at the solid-liquid interface, we present a unified mechanics model in theory that integrates the static configuration of droplets at equilibrium and the dynamic configuration of droplets at movement. Molecular dynamics (MD) simulations show the configuration of water droplets on the surface of solids will relax during movement, and a dimensionless parameter is proposed to describe their dynamic contact area. Moreover, our analysis reveals that the friction coefficient of a water droplet on solid surfaces is significantly different from that of water film, and a geometry factor associated with surface wettability of solids is formulated to calibrate the movement friction force of water droplet. The full velocity trajectory of the droplet movement is extracted and the predictions show excellent agreement with extensive MD simulations in a full range of surface wettability gradients across from superhydrophobicity to superhydrophilicity.

Keywords: Wettability Gradient; Water droplet; Movement; Configuration; Friction coefficient

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