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Microscopic wetting behavior of droplets on swollen polymer brushes

Polymer brushes with lubricants show significant potential in reducing contact angle hysteresis, yet the microscopic wetting phenomena and underlying mechanisms remain poorly understood. Our study focuses on observing and analyzing the formation and deformation processes of microscopic wetting ridges to elucidate the macroscopic reduction of contact angle hysteresis and the dynamic wetting behavior of various liquid drops on Poly Lauryl Methacrylate (PLMA) brushes. Using the hot hexadecane vapor infusion method, we achieved controllable swelling of brush, e.g., from 160 nm to 640 nm within ten minutes. We developed a thin-film interference-based color-matching algorithm to measure the real-time brush thickness. Through this method we observed the oil extraction from brush layer, resulting in a local brush collapsing for tens of nanometers and the region of collapsing extend to around two hundreds of micrometers. However, visualizing the microscopic wetting ridge to establish local Neumann's triangle equilibrium remains challenging. Furthermore, recording and analyzing the dynamic wetting behavior is elusive. In our future studies, we aim to visualize static and dynamic microscopic wetting ridges using a high-resolution confocal microscope. This approach may help us unravel the competition between surface tension-driving solvent extraction and disjoin pressure-induced solvent retention.

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