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Macroscopic Evidence of the Liquidlike Nature of Nanoscale Polydimethylsiloxane Brushes

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Abstract : We report macroscopic evidence of the liquidlike nature of surface-tethered poly(dimethylsiloxane) (PDMS) brushes by studying their adhesion to ice. Whereas ice permanently detaches from solid surfaces when subjected to sufficient shear, commonly referred to as the material's ice adhesion strength, adhered ice instead slides over PDMS brushes indefinitely. When additionally methylated, we observe a Couette-like flow of the PDMS brushes between the ice and silicon surface. PDMS brush ice adhesion displays shear-rate-dependent shear stress and rheological behavior reminiscent of liquids and is affected by ice velocity, temperature, and brush thickness, following scaling laws akin to liquid PDMS films. This liquidlike nature allows it to detach solely by self-weight, yielding an ice adhesion strength of 0.3 kPa, 1000 times less than low surface energy, perfluorinated monolayer. The methylated PDMS brushes also display omniphobicity, repelling all liquids essentially with vanishingly small contact angle hysteresis. Methylation results in significantly higher contact angles than previously reported, nonmethylated brushes, especially for polar liquids of both high and low surface tension.

Keywords : omniphobic, surface science, polymer brush, icephobic surface
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