

Nanoscale, liquidlike polymer brushes: wettability, tribology, and adhesion

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When a single polymer chain above its glass transition temperature is bonded to a solid substrate, it can retain many of its liquidlike character. Densely packed chains can form a brush morphology where they linearly extend normal to the substrate. Polydimethylsiloxane (PDMS) brushes are one example of such a system, and exhibit exciting surface properties due to this unique combination of structure and phase. In terms of wettability, such surfaces are being developed as replacements for perfluoroalkylated substances (PFAS), the toxic components used ubiquitously in industry today. Combining two liquidlike polymer brushes of varying wettability also enables lossless liquid transport on surfaces, with applications in microfluidics and water harvesting. In terms of tribology, liquidlike polymer brushes can imbue a very low coefficient of friction to a covered substrate, which has applications in external lubrication and the prevention of microplastics released from textiles. And in terms of adhesion, solids do not bond strongly to PDMS brushes, owing to their liquidlike nature, which has found use in de-icing, anti-fouling, and dust repellency.

Relevant Papers

1. S. K. Lahiri, Z. Azimi Dijvejin, K. Golovin, "Polydimethylsiloxane-coated textiles with minimized microplastic pollution," **Nature Sustainability**. (2023). DOI: 10.1038/s41893-022-01059-4.
2. M. Soltani, K. Golovin, "Lossless, passive transportation of low surface tension liquids induced by patterned omniphobic liquidlike polymer brushes," **Advanced Functional Materials**. 2107465, 1–10 (2021).
3. X. Zhao, B. Khatir, K. Mirshahidi, Y. Kai, J. Kizhakkedathu, K. Golovin, "Macroscopic Evidence of the Liquidlike Nature of Nanoscale Polydimethylsiloxane Brushes," **ACS Nano**. 15, 8, 13559–13567 (2021).
4. S. Shabanian, B. Khatir, A. Nisar, K. Golovin, "Rational design of perfluorocarbon-free, oleophobic textiles," **Nature Sustainability**. 3, 1059–1066 (2020).