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Microstructured PDMS surfaces for bacterial adhesion control

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Replicating the intricate natural microenvironments is vital for developing advanced biomedical applications, yet conventional flat surfaces inadequately mimic these conditions, limiting progress in fields such as anti-biofouling and biomedical device design. To address this challenge, we engineered bioinspired microstructured surfaces on polydimethylsiloxane (PDMS) substrates, aiming to modulate bacterial adhesion behavior. Using maskless photolithography to create master molds and soft lithography for negative replication, we fabricated arrays of circular and rectangular microstructures in various sizes (down to 5 μm). Process parameters including exposure dose and baking times were optimized for structural precision. Topographical features were characterized using scanning electron microscopy and optical profilometry. The influence of surface topography on bacterial adhesion was then assessed using *Escherichia coli*, with adhesion levels quantified after incubation. Compared to flat PDMS controls, structured surfaces exhibited variations in bacterial adherence, depending on geometry and scale. Our findings underscore the potential of precisely engineered microstructured surfaces in controlling bacterial-surface interactions, opening avenues for applications in healthcare, bioengineering, and surface science.