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Wetting Dynamics of Droplets on Soft Biological Surfaces

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ABSTRACT

Biological surfaces exhibit sophisticated multiscale hierarchical structures, exceptional physicochemical properties, and highly efficient biological functions. Investigating the intrinsic relationships among chemical composition, geometric structure, mechanical properties, and biological functions on these surfaces remains a central challenge in biomechanics and biomimetics. The wetting dynamics of solid–liquid interactions—such as contact, adhesion, and impact—on biological and bioinspired materials are widespread in nature and critical to various engineering applications. These studies not only inform the design and fabrication of functional materials (e.g., self-cleaning and anti-icing surfaces) but also have promising applications in pathogen control, high-precision inkjet printing, and brain-computer interface. This study focuses on the dynamic wetting behaviors of droplets on biological and bioinspired surfaces by establishing theoretical and experimental frameworks for solid–liquid interactions. We examine interfacial interactions and strongly coupled deformation behaviors, elucidate the dynamics and regulatory mechanisms of droplets on the surfaces of flexible leaves and biological soft tissues, and explore their key applications in energy transport, soft robotics and bioelectronic interfaces.

KEYWORDS

Wetting; droplet; elastocapillarity; biological surfaces; solid–liquid interaction

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