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Curvature-controlled Wrinkling Surfaces for Friction

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Abstract

Topographical patterns endow the material surfaces with unique and intriguing physical and chemical properties. For the flat hard film/soft substrate system, spontaneously formed wrinkling has been harnessed to generate the surface topography for various functionalities. Despite promising applications in biomedical devices and robot engineering, the friction behavior of wrinkling on curved surfaces remains unclear. Herein, wrinkled surfaces were induced by sputtering metals on PDMS microspheres and three wrinkling patterns are prepared(dimple, labyrinth, herringbone). The wrinkle morphologies and length scales can be controlled precisely by tailoring the microsphere radius (substrate curvature) and film thickness. The wrinkled surfaces exhibit tunable friction property, depending on the wrinkling patterns and length scales. An increase in friction force with increasing surface roughness is generally found for dimple patterns and labyrinth patterns. The dimple patterns show the lowest friction due to strong curvature constraint. The herringbone patterns exhibit apparent friction anisotropy with respect to topographic orientation. The present results will guide future design of wrinkled surfaces for friction by harnessing substrate curvature.

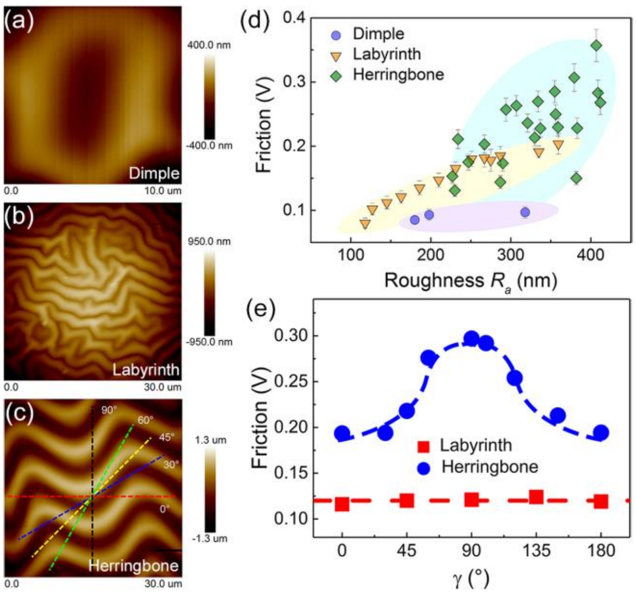

Figure 1: (a-c) AFM height images of different wrinkling patterns and the colorful lines in (c) representing diffrent scan direction respectively. (d) Summary of friction force of wrinkled Cr films with the roughness for three wrinkling patterns. (e) Dependence of friction force on the orientation angle for labyrinth patterns and herringbone patterns.