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The Use of Microscale Geometry to Tailor Stimulus-Responsive Surface Friction LIN HAN, JIE YIN, LIFENG WANG, KHEK-KHIANG CHIA, ROBERT COHEN, MICHAEL RUBNER, MARY BOYCE, CHRISTINE ORTIZ, Massachusetts Institute of Technology — The capability to tailor stimulus-responsive surface friction, including sensitivity profile, range, temporal response and deformation mechanisms, holds great potential for an array of engineering and biomedical applications. In this study, the pH-dependent friction of layer-by-layer assemblies of poly(allylamine hydrochloride) and poly(acrylic acid) (PAH/PAA) were quantified for structures of a continuous planar film and anisotropic microtube forests via lateral force microscopy. By comparing experiments to microstructure-specific finite element modeling, a mechanistic change from surface adhesion-dominated friction (μ=0.11) to viscoelasticity-governed shear (=0.017) was predicted upon ionic crosslink density reduction of PAH/PAA from pH 5.5 to 2.0 for the film (6.5$\times$ decrease). The responsiveness of μ was further tuned by the tube forest geometry to be 3.5$\times$. At pH 5.5, μ (=0.094) was lower than the film due to discrete tube bending/buckling and smaller tip-sample interface stress. At pH 2.0, μ (=0.027) was higher because of inter-tube contact and weaker substrate effect. This study provides an excellent platform to quantitatively access and design dynamic substrates with tailorable stimulus-responsive surface friction.

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