The Use of Microscale Geometry to Tailor Stimulus-Responsive
Surface Friction LIN HAN, JIE YIN, LIFENG WANG, KHEK-KHIANG CHIA,
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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 ($\mu=0.11$) to viscoelasticity-governed shear ($=0.017$) was pre-
dicted upon ionic crosslink density reduction of PAH/PAA from pH 5.5 to 2.0 for
the film (6.5× decrease). The responsiveness of $\mu$ was further tuned by the tube
forest geometry to be 3.5×. At pH 5.5, $\mu$ (=0.094) was lower than the film due to
discrete tube bending/buckling and smaller tip-sample interface stress. At pH 2.0, $\mu$
(=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.