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Lubricated tribology of soft patterned substrates LILIAN HSIAO, North Carolina State University — The prediction of sliding friction for wet, patterned surfaces from first principles has proven challenging. While emerging applications such as synthetic cartilage, finger-touchscreen contacts, and soft robotics have sought design principles from biology, a general framework is lacking because these soft interfaces experience a complex multiphysics coupling between solid deformation and fluid dissipation. We investigate the elastohydrodynamic sliding of more than fifty patterned 2D sliding pairs comprising elastomers, thermoplastics, and hydrogels, and discover that texturing universally induces a jump in the lubrication film thickness that leads to a critical transition in the macroscopic friction coefficient. A simple scaling framework that combines lubrication theory and elastic deformation is able to capture this localized transition in the friction coefficient. This model separates the flow curve into two limiting length scales and accounts for the contributions of shear and normal forces applied by the fluid on the patterned substrates. Our predictions provide physical insights for which the critical elastohydrodynamic friction in a broad class of soft materials can be engineered using pattern geometry, material elasticity, and fluid properties.

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