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Shape influence during lubricated contact formation

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Abstract

The formation of contact between a soft solid and a rigid interface in a fluid-mediated environment is a fundamental problem with applications ranging from biology to soft lubrication. Prior studies have shown that when a soft elastic indenter with a locally spherical leading edge approaches a surface, elastic deformation can cause contact to initiate in an annular region rather than at the tip center. The resulting fluid entrapment between the solid and the interface reduces the effective contact area, leading to undesirable outcomes such as diminished grip in soft robotic systems or porosity in inkjet bioprinting. In this talk, I will examine how indenter geometry influences air entrainment during contact formation. In particular, I will show that shapes with lower local curvature, such as conical leading edges, significantly reduce air entrapment and foster larger contact areas. These findings are supported by numerical elastohydrodynamic simulations that couple quasi-static elastic deformation of the solid with thin-film viscous flow modeled by the Reynolds equation. In addition to practical design implications, I will discuss the numerical methodology and the limitations of the current modeling framework.

Keywords:

contact soft solid impact viscosity solid-fluid interaction shape