Molecular mechanisms of self-mated hydrogel friction

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The friction coefficient of self-mated hydrogel systems is velocity independent at slow sliding speeds and transitions to a velocity dependent regime at a mesh size dependent velocity. Whilst the speed independent regime has been attributed to the thermal fluctuations, above the transition the increase of the friction coefficient has been attributed to either hydrodynamic lubrication or non-equilibrium polymer dynamics. We have developed a mesoscopic model based on bead-spring polymer networks, which is able to reproduce the speed-dependent frictional behavior. Our model qualitatively reproduces the experimentally observed collapse of friction curves achieved by rescaling the sliding speed. By using implicit solvent, we are able disentangle the role played by hydrodynamic interactions and polymer interactions in the frictional behavior of self-mated hydrogels. We further present experimental data confirming our findings from simulations that the coefficient of friction increases with mesh size for hydrogels with highly crosslinked interfaces.

Keywords: Biotribology, hydrogels, molecular dynamics.

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