TIME-DEPENDENT FRICTION AND DYNAMICS IN HYDROGEL SURFACE CONTACTS

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Key Words: Hydrogel, Tribology, Friction, Lubrication, Porous Material

Hydrogels are composed of a sparse, cross-linked polymer matrix infused with water. They can be found in a multitude of biological settings, from cell nuclei to cartilage, and are used in many industrial applications. However, their material properties are not well-understood due to their heterogeneous nature. Here we investigate the interfacial rheology of both polyacrylamide and agarose hydrogels using a custom, low-force pin-on-disc tribometer under a variety of environmental conditions. Under a constant normal load, these hydrogels exhibit a dynamic frictional transition characterized by a precipitous drop in the friction coefficient at a critical velocity. Within a range of speeds near this dynamic frictional transition, transient behavior can be observed. Upon increasing the speed, the coefficient of friction decreases exponentially, with a characteristic decay time of order 5-10 minutes. Surprisingly, a cessation of sliding results in a much more rapid recovery of the friction coefficient, suggesting that nonlinear processes control these timescales. We will show how this transition can be tuned by varying the liquid salt concentration, liquid viscosity, and sliding geometry.

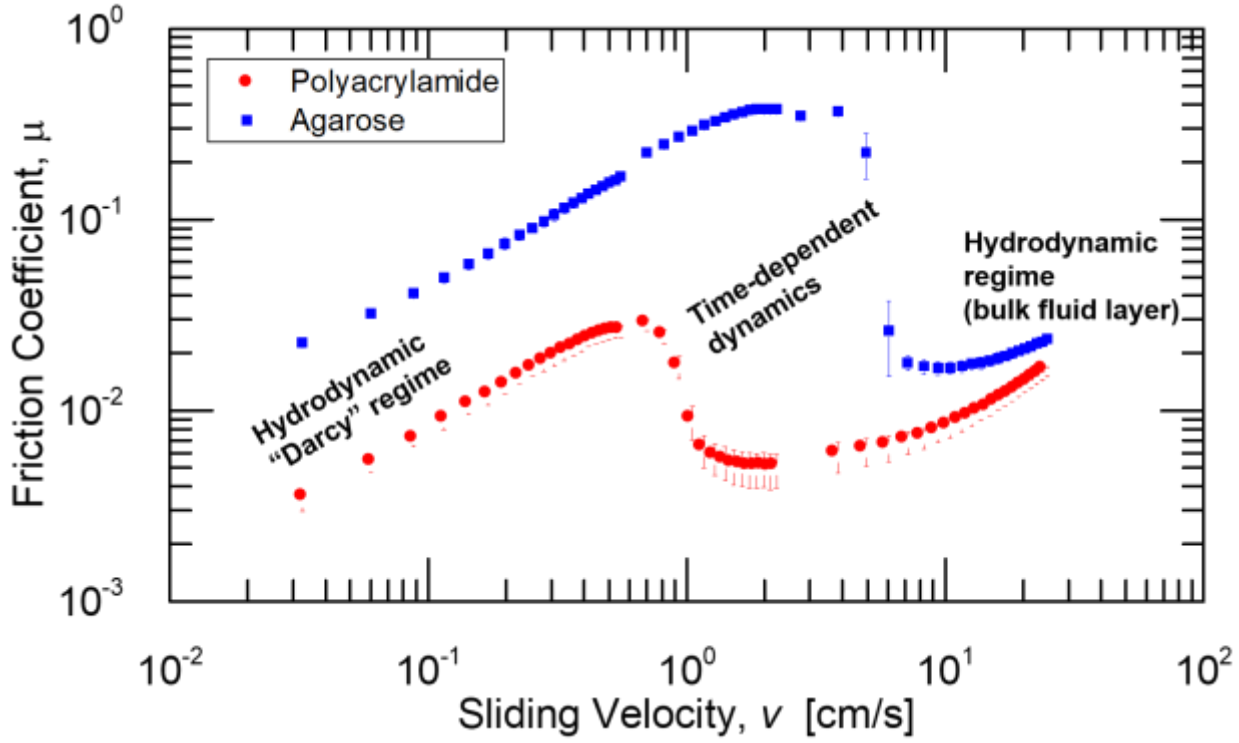

Figure 1 – Coefficient of friction versus sliding velocity for two different hydrogel spheres sliding on a PMMA surface. At low velocities, the frictional force increases almost linearly with velocity (Darcy regime). A transitionary regime is characterized by time-dependent dynamics, and finally a bulk, hydrodynamic regime sets in at high velocities.