1. PRF# 58606-ND5
2. Friction in saturated porous media
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Objective of the project. The objective of this project is to understand the role of pore-scale flow on the friction forces between fluid-filled porous media. Similar to squeezing fluid out of a wet sponge, the forces necessary for sliding can cause local elastic deformation of the porous solid, which in turn can lead to expulsion of the fluid and help lubricate contact and favor slip. An important challenge in trying to understand the friction properties of fluid saturated poroelastic solids is the coupling between the complex (and local) nature of the fluid flow with the elastic deformation of the matrix to give rise to static and sliding friction forces.

Accomplishment during the reporting period. Effort during this period were aimed at developing a robust material system and incorporating interferometry (in reflection) to our measurement system to characterize surface deformation (see Figure 1). We characterized adhesion and sliding on saturated porous soft solids. We find regimes where elastic deformation leads to significant enhancement of adhesion and friction due to fluid transport within the porous material (Figure 2).

Impact on career and students. The project fostered the collaboration between a postdoctoral researcher and a PhD student in the group. Together they were able to significantly enhance both our experimental capabilities and also develop a material system that leads to reproducible results in terms of dynamic and static interfacial properties as well as mechanical properties. We can systematically vary the solid fraction and study the coupling between fluid transport and elastic deformation.

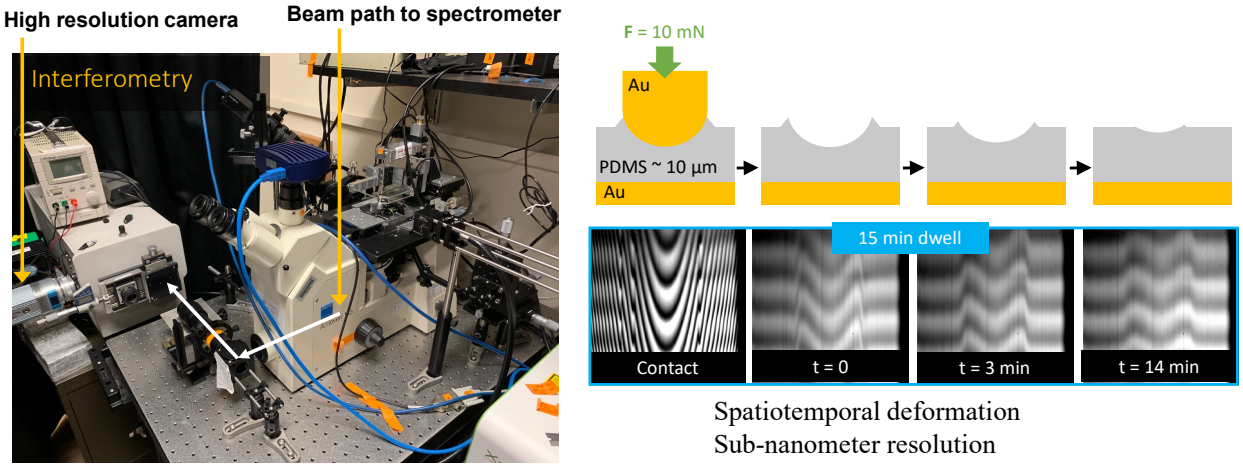

Figure 1. (Left) Picture of the multimode force microscope with added interferometry measurement. (Right) Direct imaging of out-of-contact relaxation of a swollen elastomer after indentation.

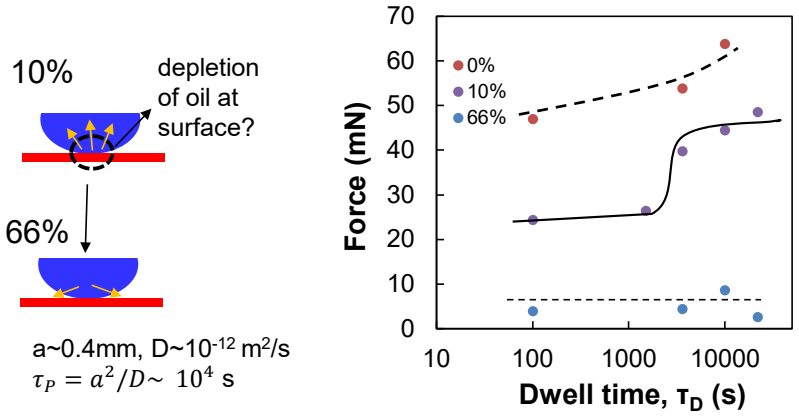

Figure 2. (Left) Schematic of fluid transport for materials loaded with different volume fraction of fluid along with characteristic time- and lengthscales. (Right) For undersaturated soft porous gels an increase in contact time can lead to an increase in adhesion. For saturated material the adhesion is independent of contact time and is dominated by capillarity.