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Tribological and Rheological Properties of a Synovial Fluid Model

REBECCA KLOSSNER, JING LIANG, WENDY KRAUSE, North Carolina State University — Hyaluronic acid (HA) and the plasma proteins, albumin and globulins, are the most abundant macromolecules in synovial fluid, the fluid that lubricates freely moving joints. In previous studies, bovine synovial fluid, a synovial fluid model (SFM) and albumin in phosphate buffered saline (PBS) were observed to be rheopectic—viscosity increases over time under constant shear. Additionally, steady shear experiments have a strong shear history dependence in protein-containing solutions, whereas samples of HA in PBS behaved as a "typical" polyelectrolyte. The observed rheopexy and shear history dependence are indicative of structure building in solution, which is most likely caused by protein aggregation. The tribology of the SFM was also investigated using nanoindenter-based scratch tests. The coefficient of frictions (μ) between the diamond nanoindenter tip and a polyethylene surface was measured in the presence of the SFM and solutions with varied protein and HA concentrations. The lowest μ is observed in the SFM, which most closely mimics a healthy joint. Finally, an anti-inflammatory drug, hydroxychloroquine, was shown to inhibit protein interactions in the SFM in rheological studies, and thus the tribological response was examined. We hypothesize that the rheopectic behavior is important in lubrication regimes and therefore, the rheological and tribological properties of these solutions will be correlated.

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