Lubricating Behaviour of Albumin at the Sliding Contacts of Chemically Modified Elastomers

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INTRODUCTION: At present, the most widely employed material pairings for artificial articular joint implants are ceramic/UHMWPE or metal/UHMWPE, both of which display "rigid-on-rigid" mechanical contacts.[1] Although these pairings have shown many favourable properties and successful performance as articular joint prostheses, their tribological properties demand further improvement, e.g. reduction/control of polymer wear particles, which is known to be responsible for the limitation of lifetime. This study was thus inspired by the potential application of elastomeric materials as artificial articular joint implants.[2,3] Of particular interest is to control the surface chemical properties to probe the lubrication properties of albumin, the most abundant protein in natural cartilage, at an elastomeric interface.

METHODS: Aqueous lubricating properties of human serum albumin (HAS, 1mg/ml, pH 7) at the sliding contact of a self-mated elastomer, PDMS, have been investigated as a function of surface chemical functionality of PDMS: (a) no treatment (-CH_3), (b) air plasma treatment (-OH), (c) PEG-ylation on hydrophobic PDMS surface (PEO-PPO-PEO) (d) PEG-ylation on plasma-treated, hydrophilic PDMS surface (PLL-*g*-PEG). A schematic for these surfaces are shown in Figure 1. The adsorption behaviour of HSA onto the PDMS surfaces, either untreated or chemically functionalized, was characterized by means of OWLS.

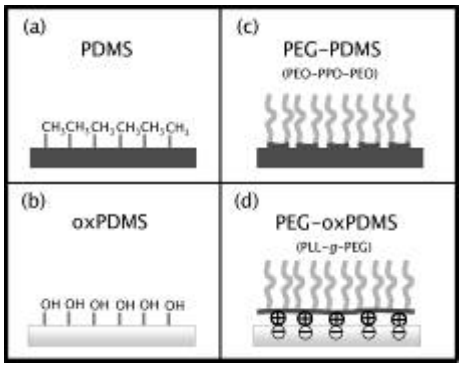

Fig. 1: The PDMS tribopair with varying surface chemical functional groups in this work.

RESULTS:

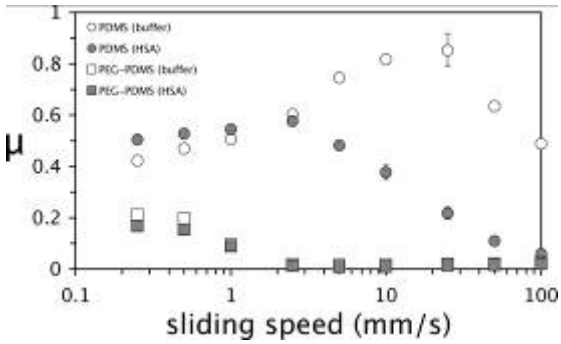

Figure 2. The μ vs. sling speed plots for the PDMS pair and PEG-PDMS pairs with or without HAS.

While an apparent lubricating effect of HSA was observed for the untreated PDMS tribopair, which is attributed to an effective suppression of adhesive hydrophobic interactions between two PDMS surfaces in aqueous environment,[4] the contribution of HSA to the lubrication of the chemically functionalized PDMS tribopairs was generally negligible (shown in Figure 2 for the PDMS and PEG-PDMS cases only).

DISCUSSION & CONCLUSIONS: It should be noted that the mechanical properties (elasticity modulus) of PDMS employed in this work are similar to those for the natural cartilage system. The results in this study suggest that as long as the surface properties of an elastomeric tribopair can be controlled to remain hydrophilic, an effective aqueous lubricating performance, which is essential for artificial articular joint implants, can be readily achieved without involving HSA.

REFERENCES:

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