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Synergy between molecular brushes and linear polymers for wear protection at interfaces

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Lubricating and protecting surfaces against wear using liquid lubricants is a great technological challenge. Until now, wear protection was usually imparted by surface coatings involving complex chemical modifications of the surface while lubrication was provided by a lubricating fluid. Hence, we here research for a simple, effective and applicable solution to the above problem using surface force apparatus (SFA). SFA is a powerful technique with sub-angstrom resolution in distance and 10 nN/m resolution in interaction force while performing friction experiment. Thus, SFA is used to have the direct insight into interaction force, material and friction at interface. We found that by precisely controlling the molecular interactions between anti-wear macromolecules and lubricating molecules, we obtained a fluid with excellent lubricating and wear protection capabilities. The reason for this synergistic behavior relies on the subtle interaction forces between the fluid components which allow the confined macromolecules to sustain high loads under shear without rupture. The lowest friction coefficient and the maximum pressure that it can sustain in our system is 5*10-3 and >14 MPa which is well above the physiological pressure. Our results provide rational guides to design such fluids for virtually any type of surfaces. Most importantly this process is simple, effective and applicable method of lubrication and protection as until now wear protection was usually imparted by surface coatings involving complex chemical modifications of the surface. We further studied the stability and its lubricity of the polymer for two months at the temperatures ranging from 4 to 37 °C and found that the polymer was able to perform adequately. Further we would like to confirm the lubricating and anti-wear protection remains the same by performing the friction experiments in synthetic cartilages.

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