Investigate the behavior of zwitterionic polymer brushes under different environmental conditions.

Sufia Fatima, Anne Neville and Michael Bryant
Institute of Functional Surfaces, University of Leeds, Leeds, LS2 9JT
**Corresponding author: ll08s5f@leeds.ac.uk*

1. Introduction

There has been a great deal of focus in understating the polymerization techniques and behavior of neutral brushes for biomedical applications However, there is limited research with regards to understanding the tribological behavior of zwitterionic brushes.The responsive behaviour of polymer brushes is largely due to the confirmation occurring in different environments. Zwitterionic brushes have shown effective reduction in friction under hydrated conditions (water) as a result of swelling of the brushes. The swelling occurs when the water molecules bind to the polymer via intermolecular electrostatic induced hydration.[1]

Other factors which affect the friction response include pH, solvent, ions and temperature.[2] The effect of differential ions has been reported to be the result of ionic pairing of opposite changes between zwitterionic groups which can cause the brushes to stretch.[3]

Conformational behaviour of brushes on metal substrates in different environmental conditions has not been explored. Therefore the aim of this project is to investigate the frictional behavior of zwitterionic brushes in relation to different salt concentrations to further understand the mechanism of hydration lubrication.

2. Methodology

Stainless Steel (SS316L) substrates were modified with charged zwitterionic polymer 2-Methacryloyloxethyl Phosphorylcholine Polymer MPC) brush through surface initiated photo-induced polymerisation. To investigate the wettability of the brushes in the different environments contact angle measurements were conducted. The Anton Parr Nano Tribometer was used to understand the frictional behavior of surfaces mediated with brush layers and understand the effect of different ions (sodium chloride) on these surfaces.

3. Results and Discussion

The coefficient of friction had a spike in friction for 35 seconds it then remained steady under 0.9 wt % sodium chloride, with coefficient of friction similar to samples tested in deionised water (Figure 1). Therefore, a lower concentration of salts has little effect on the behavior. However, as the wt % of sodium chloride increased the coefficient of friction decreased (Figure 2). This decrease is a result of the ions in the solution screening and reducing the strength of the electrostatic attraction between the chains.[3] The free floating ions thus cause the brushes to maintain a brush like structure reducing entanglement. Consequently, the brushes maintains a low coefficient of friction over time.

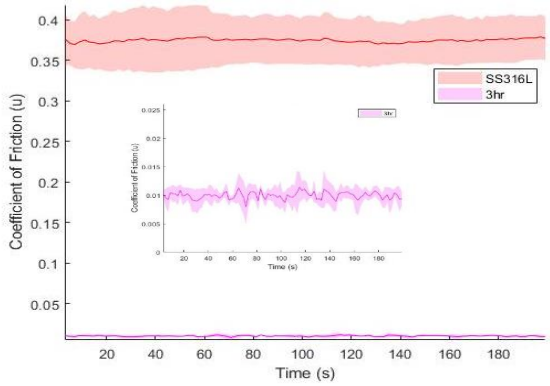

Figure 1 *Coefficient of friction of ungrafted stainless steel and stainless Steel grafted MPC polymer against PDMS probe, under 10mN load in di-water.*

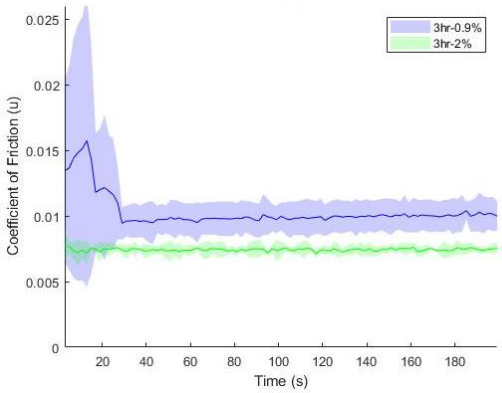

Figure 2 *Coefficient of friction of Stainless Steel grafted MPC polymer against PDMS probe, under 10mN load in 0.9% NaCl and 2% NaCl.*

4. References

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2. Yang J, Chen H, Xiao S, et al. Salt-Responsive Zwitterionic Polymer Brushes with Tunable Friction and Antifouling Properties. doi:10.1021/acs.langmuir.5b02119.
3. Xiao S, Ren B, Huang L, et al. Salt-responsive zwitterionic polymer brushes with anti-polyelectrolyte property. *Curr Opin Chem Eng*. 2018;19:86-93. doi:10.1016/j.coche.2017.12.008.