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The role of confined water within plasma polymerized vertical gradient films in protein adsorption

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The protein-surface interaction at the solid-liquid interface is of paramount interest in surface sciences such as bio-compatibility, non-fouling and bio-sensing. The suppression of non-specific protein adsorption is sought for the prevention of the initiation of undesired biological reactions. In view of changing surface chemistry to diminish protein adsorption, the water molecules in the vicinity would play an unanticipated role. Plasma polymerization offers a possibility to design subsurface gradient architectures comprising a hydrophilic to hydrophobic gradient for adsorption studies. The addition of a precise amount of oxygen to hexadimethylsiloxane in the plasma leads to the deposition of a hydrophilic SiO_x base layer, while the oxygen is removed from the nm-thick hydrophobic termination yet still allowing water penetration. Moreover, the sub-surface water uptake properties are modified to enhance the gradient by changing film composition (e.g. increasing oxygen/carbon ratio of the base layer). The response of the gradient matrix to aqueous environments was investigated by neutron reflectometry. Regardless of the hydrophobicity of the terminating layer, penetration of water molecules through gradient is energetically favorable which results in enrichment of water molecules underneath the surface. The impact of this water mediated gradient on protein adsorption was observed via a unique instrument, Transmission Interferometric Adsorption Sensor. It was notably perceived that the protein adsorption is substantially reduced on the hydrated gradient compared to reference surfaces. It is even much more suppressed in the presence of an enhanced hydrated gradient. This remarkable result is attributed to the directional orientation of penetrating water molecules in the designed gradient that yields to the separation of molecules in a distance of 5-6 Å. Hence, the dipole moment of ferro-electric water molecules creates long range interaction forces in the crosslinked sub-region. To go beyond this hypothesis, the force-distance characteristics of both non-hydrated and hydrated state of films have recently been characterized by Kelvin probe force microscopy. Furthermore, the hydration time effect on protein adsorption kinetics will be examined.

Keywords

vertical chemical gradient film
BSA adsorption