

Swollen Structure of Polyelectrolyte Brushes in NaCl Aqueous Solutions Characterized by Neutron Reflectometry

Motoyasu Kobayashi,¹ Masami Terada,¹ Kohji Mitamura,¹ Norifumi L Yamada,² Atsushi Takahara^{1,3}

¹JST, ERATO, ² High Energy Accelerator Research Organization (KEK),

³Institute for Materials Chemistry and Engineering, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, 819-0395, Japan

Surface tethered polyelectrolyte chains on the substrate in an aqueous solution are in an extended or collapsed state depending on the ionic strength of the environment. In this study, neutron reflectivity (NR) was used to characterize swollen states of polyelectrolyte brushes in a salt aqueous solution. Zwitterionic and cationic polyelectrolyte brushes on quartz substrate as shown in Figure 1 were prepared by surface-initiated atom transfer radical polymerization of 2-(methacryloyloxy)ethyl phosphorylcholine (MPC) and 2-(methacryloyloxy)ethyltrimethylammonium chloride (MTAC), respectively. NR measurements were performed on an ARISA II reflectometer using white neutron with wavelength of 0.25 - 0.88 nm at the J-PARC pulsed-neutron source. Figure 2 shows the typical NR of poly(MPC) brush in D₂O and 5.0 M NaCl/D₂O solution. NR at poly(MTAC)/D₂O and poly(MPC)/D₂O interface revealed that the grafted polymer chains were fairly extended from the substrate surface, while the thickness of poly(MTAC) brush was decreased in 5.0 M NaCl/D₂O solution due to the screening of the repulsive interaction between polycations by hydrated ions. Interestingly, no change in SLD profile was observed in poly(MPC) brush even in a salt solution probably due to the unique interaction properties of phosphorylcholine units.

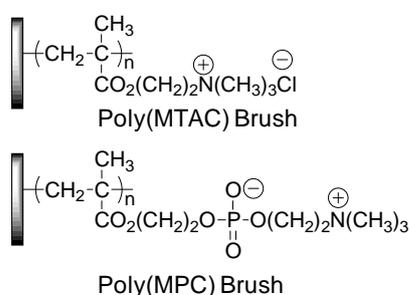


Figure 1. Chemical structure of poly(MTAC) and poly(MPC) brushes

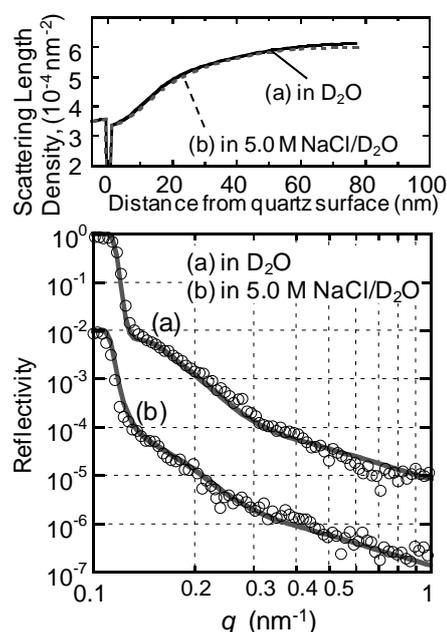


Figure 2. NR curves of (a) poly(MPC) brush/D₂O, (b) poly(MPC) brush/ 5.0 M NaCl in D₂O. The corresponding neutron scattering length density (SLD) profiles along with the distance from quartz surface are shown above. Scattering vector $q = 4\pi \sin \theta/\lambda$.