

Electrodeposition of Poly(Ethylene Glycol) to Metals

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INTRODUCTION: Poly(ethylene glycol: PEG) is a biofunctional molecule on which adsorption of proteins is inhibited. Therefore, immobilization of PEG to metal surface is an important event to bio-functionalize the metal surface, for inhibition of protein adsorption, blood compatibility, lubrication in blood vessel, and antibacterial property. In this study, PEG modified both terminals or one terminal with amine bases was immobilized onto titanium surface using electrodeposition and the mode of mobilization was characterized.

METHODS: Both terminals of PEG were modified with NH_2 to form positive electric charge in aqueous solutions. Also, PEG charged only one terminal was prepared. Molecular weights of both PEGs were about 1000. Commercially pure titanium disk with grade 2 was metallographically polished and ultrasonically rinsed in acetone and deionized water.

Titanium was charged as cathode and anode was platinum on electrodeposition. PEG was dissolved to 0.3-mol/l 1-NaCl solution as a concentration of 2mass%. The pH of solution was 11. The resultant solution was used as an electrolyte for electrodeposition at ambient.

The thickness of immobilized PEG layer was determined with ellipsometry. The immobilization mode to titanium surface and chemical bonding were determined using X-ray photoelectron spectroscopy (XPS).

In order to confirm the prevention of plasma protein adsorption to titanium surface with immobilization of PEG, albumin was adsorbed by immersion in albumin-containing solution and observed with a fluorescence microscope.

DISCUSSION & CONCLUSIONS:

Figure 1 shows the change in thickness of PEG immobilized layer determined using ellipsometry. These thicknesses are measured in air, so the real thickness in solutions is larger than these values. The thickness of the immobilized layer increased with the increase of charged potential. Also, the thickness was larger than that in immersed specimen.

Changes in the ratios, $[\text{C-O}, \text{C-N}]/[\text{C-C}, \text{CH}_2]$, in C 1s peak as charged potential are shown in Fig.2. Photoelectron signals in XPS abruptly

decays to depth direction. Therefore, C-N bond located at inside of the immobilized PEG layer. In other words, N exists at the interface between PEG and titanium. This phenomenon is also confirmed with result from N 1s peak. In addition, strong bonding, -N-OH was formed between amine and titanium oxide by electrodeposition while ionic bonding by immersion. Therefore, PEGs are immobilized as shown in Fig. 3.

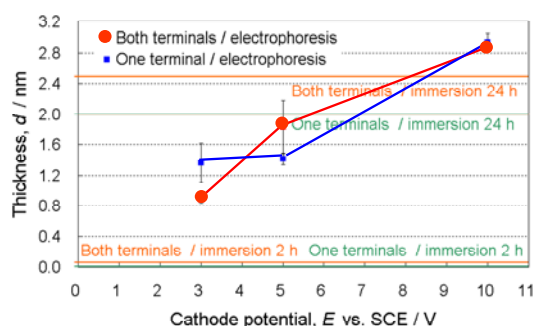


Figure 1: Change in thickness of PEG immobilized layer.

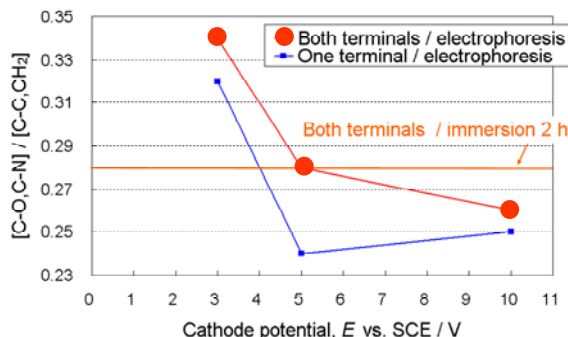


Figure 2: Change in the ratio, $[\text{C-O}, \text{C-N}]/[\text{C-C}, \text{CH}_2]$, in C 1s peak as charged potential.

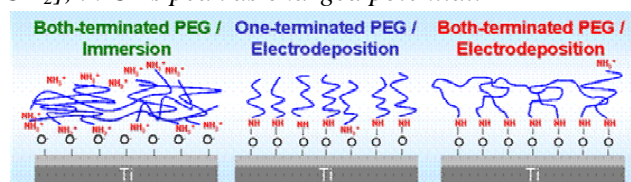


Figure 3: Schematic model of immobilized mode of PEG to titanium surface.

CONCLUSIONS: Control of Immobilization mode of PEG modified with NH_2 to titanium surface by electrodeposition is feasible. This technique could be applied to all metallic materials.