Super-hydrophilic Silicone Hydrogels with Phospholipid Polymer IPN for Newly Contact Lenses

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Statement of Purpose: Silicone hydrogels, defined as hybrid materials from silicone and hydrophilic polymer, have been applied to commercial soft contact lenses (SCLs) materials. However, incompatibility between two components and surface hydrophobicity derived from silicone chain regulated designing of materials. The purpose of this study is to make super-hydrophilic property on the silicone hydrogels by interpenetrating polymer networks (IPNs), which are combinations of two polymer networks that are synthesized in juxtaposition. The entanglement of two cross-linked polymers leads to the development of forced miscibility and results to good dimensional stability. We use bis(trimethylsilyloxy)methylsilyl propylglycerol methacrylate (SiMA) polymer for the enhancement of oxygen permeability and 2-methcryloyloxyethyl phosphorylcholine (MPC) polymer[1] for improving the surface hydrophilicity and anti-biofouling property of the silicone hydrogels.

Methods: SiMA-ipn-MPC was synthesized as following method; after being swelled with various concentration of MPC solution containing crosslinker and photoinitiator, crosslinked SiMA gels were UV cured (Fig.1). Copolymers hydrogels of MPC and SiMA (SiMA-co-MPC) were also prepared. Surface hydrophilicity of each material was evaluated as static contact angle (SCA) measured by captive-bubble method. Surface elemental composition was measured by X-ray photoelectron spectroscopy (XPS). Oxygen permeability (Dk value) was evaluated by electrochemical method. Amount of bovine serum albumin (BSA) adsorbed on the hydrogels was determined.

Results and Discussions: Optical property of SiMA-ipn-MPC hydrogels was enough for SCLs. Fig.2 (a) shows the dependence of the equilibrium water content (EWC) and SCA on the MPC unit content (wt%) of SiMA-ipn-MPC hydrogels. The EWC increased with the MPC content in both types of hydrogels. However, while the SCA of the SiMA-ipn-MPC hydrogels decreased drastically with an increase in the MPC content, that of the SiMA-co-MPC hydrogels was relatively constant. It was found during the measurement that no air bubbles were adsorbed on the surfaces of SiMA-ipn-MPC containing more than 30 wt% of MPC unit and the SCAs of these samples were recorded as 0°. This was a direct indication of the super-hydrophilicity of these hydrogels. The difference in the surface hydrophilicity of the hydrogels was related to the difference in surface compositions of the MPC units synthesized by the hybridization method. Fig.2 (b) shows the results of the XPS measurements. The P/Si ratio in the SiMA-ipn-MPC hydrogels increased drastically with the MPC content, unlike that in the SiMA-*co*-MPC hydrogels. This increase did not correspond to the theoretical values. The results indicated that the MPC units in the SiMA-ipn-MPC hydrogels were enriched at the surface.

Fig.3 (a) shows the dependence of oxygen permeability on EWC. The oxygen permeabilities of the two types of hydrogels synthesized in this study decreased with an increase in the EWC. This indicated that the oxygen permeable property of the SiMA units is retained. Fig.3 (b) shows the results of protein adsorption test. Amount of BSA adsorption was decreased due to MPC composition. This suggested that protein resistance property of MPC units is retained. Compared with commercial SCLs, each hydrogel showed good protein adsorption resistant ability.

Conclusions: The obtained SiMA-ipn-MPC hydrogels had high optical property due to well entanglement of polymer networks formed independently. The surfaces have super-hydrophilicity because of surface enrichment of the MPC units. Oxygen permeable property of PSiMA chains and protein adsorption-resistance property of MPC units were combined by construction of IPN structure.

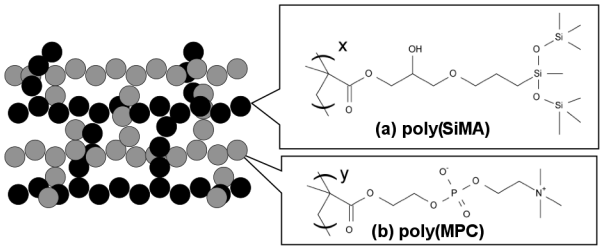

Fig.1. Structure of PSiMA-ipn-PMPC hydrogels.

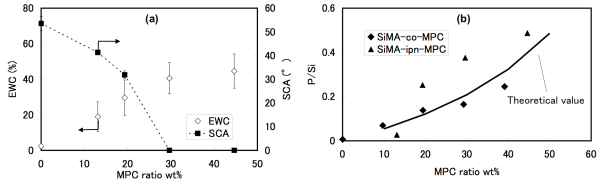

Fig.2. (a) EWC and SCA in IPN hydrogel system. (b) P/N values in both hydrogel systems.

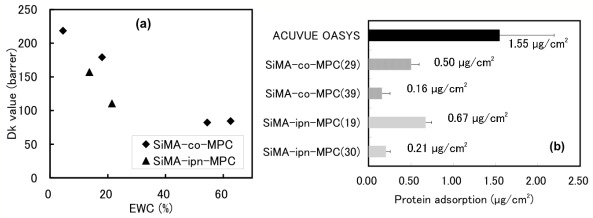

Fig.3. (a) Oxygen permeability vs EWC and (b) amount of adsorbed protein on the hydrogels. (Hydrogels containing y wt% of MPC unit were denoted such as SiMA-co-MPC(y) or SiMA-ipn-MPC(y)).

[1] T.Goda, K.Ishihara, *Expert Rev. of Med. Devices*, **3**, 167 (2006).