Increase of cell adhesiveness on poly(ethylene terephthalate) fabric by coating of sintered hydroxyapatite nanocrystals

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Statement of Purpose: Hydroxyapatite (HAp) has attracted considerable attention as hard-tissue-compatible material, because it bonds directly to bone when implanted. Recently, we have fabricated an inorganic-organic composite consisting of sintered HAp nano-scaled crystals and biomedical polymers (such as silk fiber) via covalent bonding at the interface to develop a soft tissue-compatible material. If our HAp nanocrystal coating technique can be applied to medical polymers other than silk, the uses are expected to spread widely in medical fields.

Polyester has been used as a typical and popular biomedical polymer in medical fields. Medical devices made of polyester, for example, artificial blood vessels, generally, are coated with collagen or gelatin in order to increase interaction with living cells or tissue. The use of animal-derivative proteins is, however, feared due to the possible outbreak of infectious diseases such as bovine spongiform encephalopathy (BSE).

In this study, HAp nanocrystals were covalently linked onto PET fabric, which surface was modified by graft polymerization with γ-methacryloxypropyltriethoxysilane (MPTS). The coating of HAp is biologically safe due to no biological derivative substances.

Methods: HAp crystals with an average diameter of 50 nm were prepared by an alternating emulsion system and subsequently calcined at 800˚C for 1 h. Graft polymerization of MPTS onto alkaline-hydrolyzed PET fabric was conducted using H_2O_2 as an initiator [1]. To characterize the surface-modified samples, X-ray photoelectron spectroscopy (XPS) was used. Coating of HAp nanocrystals on the poly(MPTS)-grafted PET fabric was soaked in the HAp suspension (2.0 wt/v%) in ethanol for 1 h at room temperature to adsorb the crystals on the grafted PET. The fabric adsorbed with HAp particles was heated at 80˚C for 2 h under vacuum (1 mmHg). Human umbilical vein endothelial cells (HUVEC) were plated onto the HAp/PET composite incubated for 4 h. The morphology of the cells on the samples was observed by scanning electron microscope (SEM).

Results / Discussion: There are many methods of radical donation on a polymer surface in order to graft polymerize with vinyl monomers on PET, such as using high-energy radiation of γ-rays, benzoyl peroxide, hydrogen peroxide, persulfate, etc. In our case of graft polymerization of MPTS on PET, H_2O_2 in benzyl alcohol was used as an initiator because H_2O_2 treatment is easy to handling and a large facility is not necessary. The weight gain of poly(MPTS) increased with increase in the reaction time, eventually reaching a plateau value of about 3.5 wt%. The poly(MPTS) grafted on PET was also confirmed by XPS measurement,

HAp crystals were coated on PET fabric through covalent bonding by the reaction between OH groups on the HAp crystals and ethoxysilyl groups on the poly(MPTS)-grafted PET. To evaluate the cell adhesiveness on the HAp/PET composite, HUVEC was incubated on the composite at 37˚C for 4 h, and observed by SEM. As shown in Fig. 1 (a) and (b), many cells adhered on HAp/PET fabric as well as collagen-coated PET, while only a few cells adhered on the original fabric.

Conclusions: A novel composite consisting of nano-scaled HAp crystals and PET through covalent linkage was developed. HUVEC adhered more plentifully on the HAp/PET composite compared to the original PET and to the same degree as collagen-coated PET after 4-h incubation. The coating of sintered HAp nanocrystals is a simple method in order to make a polyester substrate bioactive without a coating of animal-derivative adhesion proteins such as collagen or gelatin. It is also a fact that the coating of HAp nanocrystals is superior in the terms of biological safety [2].

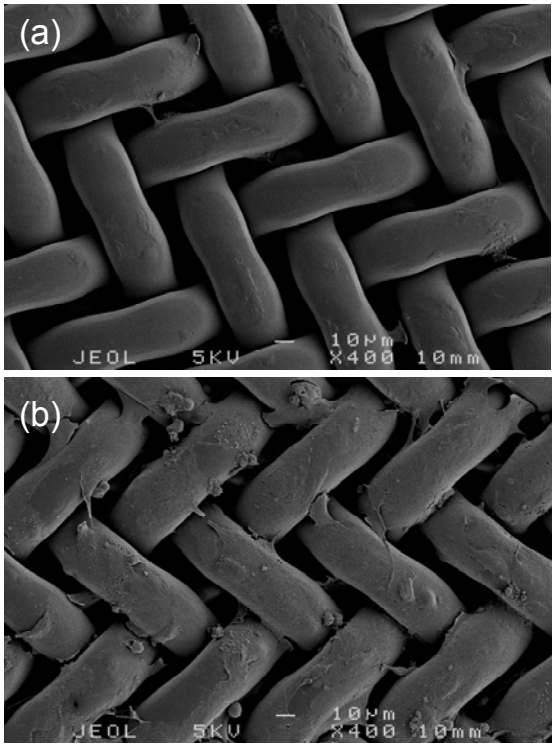

Fig. 1 SEM photographs of HUVEC after incubation for 4 h on (a) original PET and (b) HAp/PET composite

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