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論 文 内 容 の 要 旨
Abstract of Dissertation

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A hospital-acquired infection usually appears three days after a patient is admitted to a hospital or other health care facility. In the problem, it has been thought that the low bio-affinity of medical catheters often causes bacterial infection through the permeation interspaces between the catheters and skin tissues. Thus, the surface modification of the biomaterials such as silicone resin for the catheters is desired for improving the biocompatible as well as the antibacterial properties. In this thesis of “Study on Preparation of Hydroxyapatite Nanoparticle Films and Their Cytocompatibility Evaluation for Biomedical Applications” was classified into four chapters.

In chapter 1, “General Introduction”, hydroxyapatite (HAp: ($Ca_{10}(PO_4)_6(OH)_2$)) nanoparticles (NPs) possess excellent biocompatibility, bioactivity, and osteoconductive properties, which promote the biomineralization in bone tissue, due to their similarity in chemical composition to the apatite found in the hard tissues. However, the bulk HAp crystals had the low mechanical strength, which limits their applications. Therefore, it was demonstrated that the HAp NPs has been deposited or coated over the bioinert materials, obtaining the enhanced mechanical, thermal and rheological properties with higher biocompatibility and bioactivity. In this study, the synthesis of HAp NPs and subsequent formation of the NP films on the bioinert materials were investigated for determining their hydration, protein adsorption and subsequent cytocompatibility for possible medical applications.

In Chapter 2, “Study on Preparation of Elliptical Hydroxyapatite Nanoparticle films and Their Protein Medication Ability for Cell Adhesion”, the elliptical HAp NPs were synthesized by a wet chemical method using a Poly(oxyethylene) cholesteryl ether ($ChEO_{10}$) as a template. The $ChEO_{10}$-HAp NPs were deposited on a gold substrate by an electrophoretic deposition at the applied voltage of 100 V, obtaining the $ChEO_{10}$-HAp NP films. The hydration structures, fibrinogen (Fgn) adsorption mechanism, interfacial interactions and conformational information on the $ChEO_{10}$-HAp NP films were successfully clarified using a surface plasmon resonance (SPR) and Fourier transform infrared spectroscopy (FT-IR) techniques, demonstrating the higher affinity of Fgn for the HAp NP film with the specific hydration structures. The physicochemical properties of the $ChEO_{10}$-HAp NP films affected the protein conformation and orientation upon the adsorption through the hydration-protein interactions, leading to the effective bioactivity for the cell adhrsion.

In Chapter 3, “Preparation and Biological Evaluation of Nanoparticle Zinc-substituted Hydroxyapatite Film”, elliptical Zn-doped HAp (Zn:HAp) NPs containing carbonate ions were synthesized by a wet chemical method with the Zn^{2+} concentration to (Ca^{2+} + Zn^{2+}) of 0.0, 2.5, 5.0 and 10 mol%. An electrophoretic deposition at the voltage of 100 V was used for the surface modification of biomedical polymers through a titanium coat. As a result, the Zn:HAp NP films containing carbonate ions on the surfaces were successfully achieved. Furthermore, the fibroblast compatibility as well as antibacterial activity against by the film surfaces was confirmed by the biological experiments. In particular, the films made from the Zn:HAp NPs with (Ca+Zn)/P=2.00 and Zn/(Ca+Zn)=5 mol% is the best possibility for the surface modification.

In Chapter 4, “Summary”, the elliptical HAp NP films were summarized to provide the improved hydration structures as well as the enhanced the protein adsorption states, and the cytocompatibility, suggesting their possible use in the biomedical applications.