Department of Bioceramics

1. Staffs and Students (April, 2010)

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2. Purpose of Education

Bioceramics such as hydroxyapatite and tricalcium phosphate have been clinically applied for inorganic substitutions in orthopedic and dental field. Main objective of bioceramics in the graduate course is to provide students opportunity to study ceramic materials science such as structure and synthesis, and also study materials characterization technology. Students are also taught on investigation of osteoconductive mechanism by bioceramics.

3. Research Subjects

1) Development of Electrovector Ceramics

Some ceramics, such as a hydroxyapatite, are able to be ionically polarized by thermoelectrical treatments. Consequently, the polarized ceramics have large and time-durable induced electrostatic charges on their surfaces. The effects of the induced charges profoundly dominate the proximate few millimeter regions. We named the effects *Electrovector Effects* and develop *Electrovector ceramics* defined as ceramics emiting the *Electrovector Effects*.

2) Local control of electrical space by erectrovector ceramics

The electrical strength and distribution formed by electrovector ceramics are detected by materials scientific, electrochemical and crystal chemical methods. The mechanism of electrical polarization, especially the defect formation and the crystal deformation induced by fluctuation of ionic distribution in electrovector ceramics, and establishment of control technology in electrovector ceramics.

3) Manipulation of biological responses by Electrovector Ceramics

The electrostatic energies of the *Electrovector Effects* aforementioned dominate the limited proximate areas and can control reactions locally. Therefore, the *Electrovector Ceramics* can manipulate biological responses in a target space by both of the surface character and the electrostatic energies of the *Electrovector Ceramics* at ion and tissue levels. We have demonstrated that the *Electrovector Ceramics* enhanced protein adsorption, proliferation, adhesion, and differentiation of cultured cells on the ceramics as well as osteoconductivities *in vivo* by molecular biological and immunological detections.

4) Development of applicatable devices by ceramic technologies

We apply the *Electrovector ceramics* aforementioned to implant systems, such as artificial bones, bone joints, tooth roots, and are developing implantable devices with autograft-like osteoconductivities. We are undergoing improvements of sol-gel method for hydroxyapatite thin film coating and materials for vascular regeneration. We are extending our researches based on ceramic technologies farther, such as a control of oral environment, an improvement of oral esthetics, more effective and precise diagnosis systems for clinical laboratory medicine.

4. Publications

Original Article

1. Kobayashi M, Saito H, Mase T, Sasaki T, Wang W, Nakamura M, Tanaka Y, Nagai A, Yamashita K. Polarization of Hybridized Calcium Phosphoaluminosilicates with 45S5 type Bioglass. Biomed Mater 2010; 5: 025001 (5pp).
2. Nakamura S, Kobayashi T, Nakamura M, Itoh S, Yamashita K. Electrostatic Surface Charge Boosting Bone Ingrowth of Porous Ceramics. J Biomed Mater Res A 92 (1): 267-275, 2010.
3. Nakamura M, Nagai A, Tanaka Y, Sekijima Y, Yamashita K. Polarized Hydroxyapatite Promotes Spread and Motility of Osteoblastic Cells. J Biomed Mater Res A 92 (2): 783-791, 2010.
4. Nakamura M, Nagai A, Okura T, Sekijima Y, Hentunen T, Yamashita K. Enhanced Osteoblastic Adhesion through Improved Wettability on Polarized Hydroxyapatite. J Ceram Soc Jpn 118 (6): 474-478, 2010.
5. Tanaka Y, Iwasaki T, Nakamura M, Nagai A, Katayama K, Yamashita K. Polarization and Microstructural

Consideration of Ceramic Hydroxyapatite Electrets. J Appl Phys 107 (1): 01410, 2010.
6. Kobayashi M, Saito H, Mase T, Sasaki T, Wang W, Nakamura M, Tanaka Y, Nagai A, Yamashita K. Polarization of Hybridized Clacium Phosphoaluminosilicates with 45S5-type Bioglasses. Biomed Mater 5 (2): 025001, 2010.
7. Okura T, Monma H, Yamashita K. Na^+-Fast Ionic Conducting Glass-Ceramics of Silicophosphates. J Electroceram 24 (2): 83-90, 2010.
8. Tanaka Y, Yoshida M, Nakamura M, Nagai A, Hashimoto K, Toda Y, Yamashita K. Bioactivity and Water Durability of Alumina-Zirconia Ceramics Blended with Micro-sized HA Particles. J Ceram Soc Jpn 118 (6): 498-501, 2010.
9. Sagawa H, Itoh S, Wang W, Yamashita K. Enhanced Bone Bonding of the Hydroxyapatite/b-Tricalcium Phosphate Composite by Electrical Polarization. Artif Organs 34 (6): 491-497, 2010.
10. Wang W, Itoh S, Yamamoto N, Nagai A, Yamashita K. Electrical Polarization of β-Tricalcium Phosphate Ceramics. J Am Ceram Soc 93 (8): 2175-2177, 2010.
11. Wang W, Itoh S, Yamamoto N, Okawa A, Nagai A, Yamashita K. Enhancement of Nerve Regeneration along the Chitosan Nanofiber Mesh Tube on which Electrically Polarized β-Tricalcium Phosphate Powder is Immobilized. Acta Biomater 6 (10): 4027-4033, 2010.
12. Imamura Y, Tanaka Y, Nagai A, Yamashita K, Takagi Y. Self-Sealing Ability of OCP-Mediated Cement as a Deciduous Root Canal Filling Material. Dent Mater J 29 (5): 582-588, 2010.

Invited presentation

1. Yamashita K. Introduction to Vector Materials Science and Bioengineering, The International Symposium on Visualization in Joining & Welding Science through Advanced Measurements and Simulation, Osaka, Japan, Nov 11, 2010.
2. Yamashita K. Physical, Chemical, and Biological Phenomena within Vector Space Developed around Polarized Hydroxyapatite and Related Ceramics, The 3rd International Conference on Cermaics, Osaka, Japan, Nov 16, 2010.

Presentation

1. Nakamura M, Hentunen T, Salonen J, Sekijima Y, Nagai A, Yamashita K. Characteristics of Human Osteoclasts Cultured on different Bioceramics. 23rd European Conference on Biomaterials, Tampere, Finland, Sep, 2010.
2. Nakamura M, Soya T, Hashimoto K, Nagai A, Yamashita K. Polarized Hydroxyapatite in Silk Fibroin Film Increases in vitro Organization of Endothelial Cells into Capillary-like Networks. 3rd Internatonal Congress on ceramics, Osaka, Japan, Nov 2010.
3. Nagai A, Yamashita K, Maruyama S, matsushita N, Okada K, Abe N, Tsukamoto M, Son K, Wang X, Xie G, Inoue A. Responses of osteoblast to surface modified bulk metallic glass. The International Symposium on Visualization in Joining & Welding Science through Advanced Measurements and Simulation, Osaka, Japan, Nov, 2010.
4. Nagai A, Yamazaki Y, Chuhan M, Tsutsumi Y, Hanawa T, Toyama T, Yamashita K. The Influence of the Polarized Titania Coating on MG63 Cells. 3rd Internatonal Congress on ceramics, Osaka, Japan, Nov 2010.