Department of Bioceramics

1. Staffs and Students (April, 2009)

Professor	Kimihiro YAMASHITA
Associate Professor	Akiko NAGAI
Assistant Professor	Miho NAKAMURA
Graduate Student	Seiko OHBA

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. Wada N, Nakamura M, Tanaka Y, Kanamura K, Yamashita K. Formation of Calcite Thin Films by Cooperation of Polyacrylic Acid and Self-generating Electric Field due to Aligned Dipoles of Polarized Substrates. J Colloid Interf Sci 330:374-379, 2009.
2. Nakamura S, Kobayashi T, Nakamura M, Yamashita K, Enhanced in vivo Responses of Osteoblasts in Electrostatically Activated Zone by Hydroxyapatite Electrets. J Mater Sci: Mater Med.; 20: 99-103, 2009.
3. Li X, Sogo Y, Ito A, Mutsuzaki H, Ochiai N, Kobayashi T, Nakamura S, Yamashita K, LeGeros RZ, Fabrication and in vivo Historogical Evaluation of a Novel Zn-containing α-Tricalcium Phosphate Cement,.Mater. Sci. Eng. C 29:969-975, 2009
4. Okura T, Saimru M, Monma H, Yamasita K. Ionic conductivities of Nasicon-type glass-ceramic superionic conductors in the system Na_2O-Y_2O_3-XO_2-SiO_2 (X = Ti, Ge, Te). Solid State Ionics 180(6-8):537-40, 2009.

5. Tanaka Y, Nakamura M, Nagai A, Toyama T, Yamashita K. Ion conduction mechanism in Ca deficient hydroxyapatite whisker. Mater Sci Eng B-Solid 161:115-119 ,2009.
6. Wada N, Tanaka Y, Nakamura M, Kanamura K, Yamashita K. Controlled Crystallization of Calcite Under Surface Electric Field Due to Polarized Hydroxyapatite Ceramics. J Am Ceram Soc 92(7):1586-1591, 2009.
7. Ito E, Obayashi S, Nagai A, Imamura M, Azuma H. Regulation of myometrial contractivity during pregnancy in the rat: potential role for DDAH. Mol Hum Reprod, 15 :507-512, 2009.
8. Nakamura M, Nagai A, Hentunen T, Salonen J, Sekijima Y, Okura T, Hashimoto K, Toda Y, Monma H, Yamashita K. Surface Electric Fields Increase Osteoblast Adhesion through Improved Wettability on Hydroxyapatite Electret. ACS Appl Mater Interfaces, 1 (10): 2181-2189, 2009.
9. Okabayashi R, Nakamura M, Okabayashi T, Tanaka Y, Nagai A, Yamashita K. Efficacy of polarized hydroxyapatite and silk fibroin composite dressing on epidermal recovery from full-thickness porcine skin wounds. J Biomed Mater Res Applied Biomaterials B 90: 641-646, 2009.
10. Wang W, Itoh S, Tanaka Y, Nagai A, Yamashita K, Comparison of enhancement of bone ingrowth into hydroxyapatite ceramics with highly and poorly interconnected pores by electrical polarization. Acta Biomaterialia 5(8):3132-3140, 2009.