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EMERGING RESEARCH FRONTS - 2010

April 2010

PDF

Tadashi Kokubo & Hiroaki Takadama talk with *ScienceWatch.com* and answer a few questions about this month's Emerging Research Front Paper in the field of Materials Science. The authors have also sent along images of their work.

Article: How useful is SBF in predicting in vivo bone bioactivity?

Authors: **Kokubo, T;Takadama, H**

Journal: BIOMATERIALS, 27 (15): 2907-2915, MAY 2006

Addresses: Chubu Univ, Coll Life & Hlth Sci, Dept Biomed Sci, 1200

Matsumoto, Kasugai, Aichi 4878501, Japan.

Chubu Univ, Coll Life & Hlth Sci, Dept Biomed Sci, Kasugai, Aichi 4878501, Japan.

Pictured top to bottom: Tadashi Kokubo & Hiroaki Takadama

SW: Why do you think your paper is highly cited?

This paper describes how useful a simulated body fluid (SBF) is in predicting the bone-bonding ability of a material. The principal property required for bone substitutes is a bone-bonding ability.

Most of the scientists working in the field of biomaterials for bone substitutes are interested primarily in the bone-bonding ability of the material of their research subject. This paper provides a simple and convenient method for evaluating the bone-bonding ability of a material. Some researchers evaluate the bone-bonding ability of their material by using SBF and cite this paper.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

This paper describes a new methodology for evaluating the bone-bonding ability of a material. The bone-bonding ability of a material has been exclusively examined by means of animal experiments. However, animal experiments require special facilities, special technicians, and the ongoing care and sacrifice of animals.

In contrast to this, the method described in our paper provides a simple and convenient method for evaluating the bone-bonding ability of a material in a short period of time through the use of SBF, without the need to perform animal experiments.

SW: Would you summarize the significance of your paper in layman's terms?

1. The number of animals sacrificed can be considerably reduced by using this method.

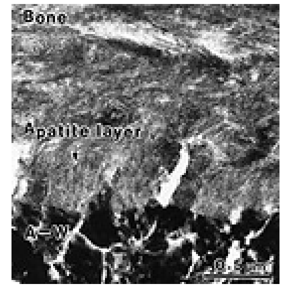
2. The bone-bonding ability of various kinds of materials with different compositions and structures can be easily evaluated in a short period of time through the use of this method. As a result, the relationship of the bone-bonding ability of a material with its composition and structure is revealed and the general principle governing the bone-bonding property of a material is understood.

3. Based on this principle, a new kind of a bone-bonding material can be developed. For example, bone-bonding Ti metal and its alloys were developed through the use of this principle, and have been clinically used as artificial hip replacement joints in Japan since 2007.

SW: How did you become involved in this research and were any particular problems encountered along the way?

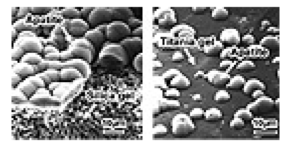
Tadashi Kokubo: When I started my research on developing a new kind of bone-bonding material with high mechanical strength, no guiding principle for obtaining bone-bonding material had previously been known.

Figure 1 [+] details



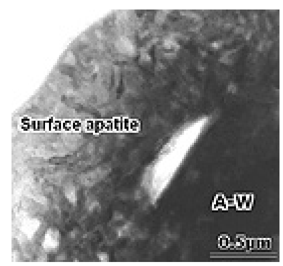
Transmission electron micrograph of interface between...

Figure 2 [+] details



Transmission electron micrograph of cross section...

Figure 3 [+] details



Scanning electron micrograph of apatite formed...

Each material was implanted into bone defects in animals such as rabbits, and their bone-bonding abilities were mechanically tested several weeks later. A period of at least 16 weeks and the sacrifice of numerous animals were required for evaluating the bone-bonding ability of one material. It was difficult to derive a general principle governing the bone-bonding ability of a material from data gathered using only a few animal experiments.

During a study of the bone-bonding mechanism of a glass-ceramic which we synthesized, we found that it had bonded to living bone through an apatite layer which was formed on its surface in the living body, and that this apatite layer can be reproduced on its surface even in an acellular simulated body fluid (SBF) with ion concentrations nearly equal to those of human blood plasma.

Based on these findings, it was assumed that a material able to form apatite on its surface in SBF forms the apatite on its surface in the living body and bonds to living bone through the apatite layer.

It was confirmed for various kinds of different bone-bonding materials that this assumption is valid. Then, it was proposed that the bone-bonding ability of a material can be evaluated by examining apatite formation on its surface in SBF.

However, there were only a few kinds of resorbable materials which bond to living bone, without apparent apatite formation on their surfaces. Therefore, the bone-bonding ability of a material must be finally examined by the use of animal experiments.

SW: Where do you see your research leading in the future?

1. On the basis of our guiding principle for obtaining bone-bonding material, various kinds of novel bone-bonding materials with different functions could be developed.

2. The reason why material which forms apatite on its surface in the living body bonds to living bone could be revealed on a molecular level.

3. The reason why there are only a few kinds of exceptional materials also could be revealed on a molecular level.

SW: Do you foresee any social or political implications for your research?

1. Our research contributes to a reduction of animal sacrifice needed for evaluating the bone-bonding ability of a material.

2. Our research contributes to a reduction of time and cost needed for evaluating the bone-bonding ability of a material.

3. Our research contributes to the development of new kinds of novel bone substitutes.

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KEYWORDS: BIOACTIVITY; BONE; HYDROXYAPATITE; IN VITRO TEST; OSTEOCONDUCTION; SBF; SIMULATED BODY-FLUID; P-RICH LAYER; CERAMIC A-W; APATITE FORMATION; GLASS-CERAMICS; CALCIUM-PHOSPHATE; NA2O-CAO-SIO2 GLASSES; CAO.SIO2 GLASSES; SILICA-GEL; SURFACE.

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Pictured top to bottom: Tadashi Kokubo & Hiroaki Takadama

Return to interview.

Figures and Descriptions

FIGURE 1:

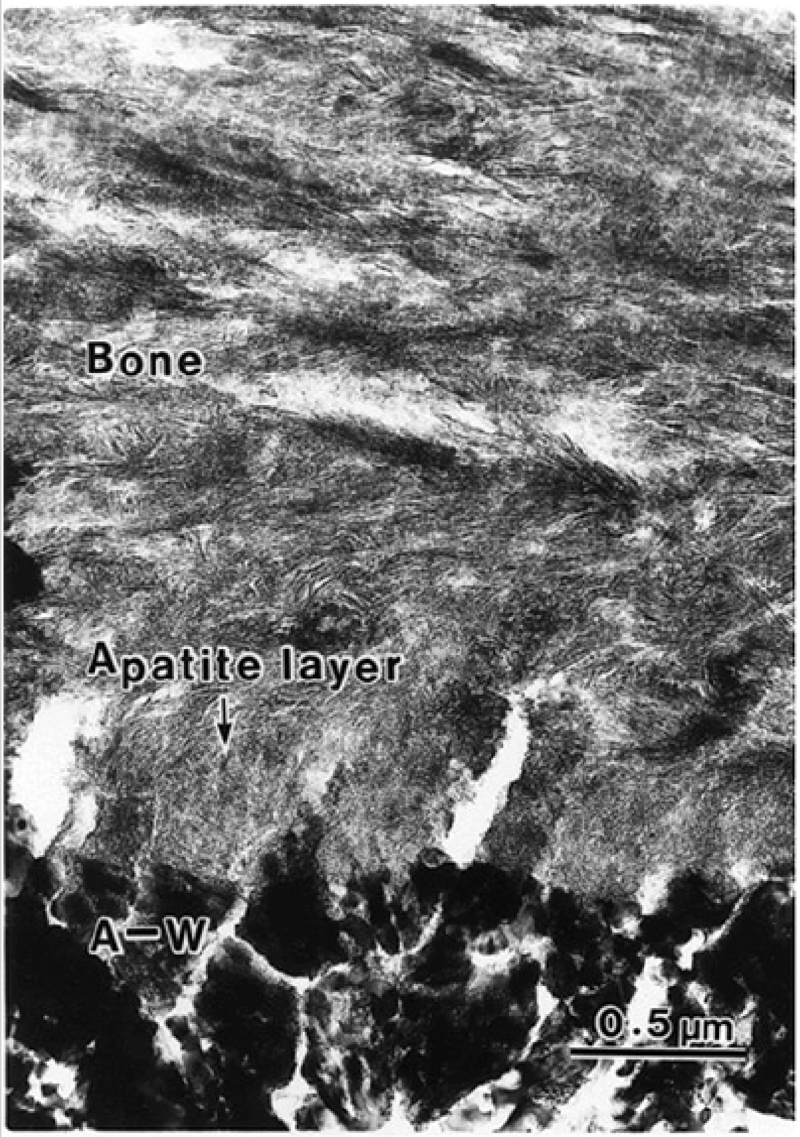

FIGURE 1 DESCRIPTION:

Transmission electron micrograph of interface between glass-ceramic A–W and rat tibia. The glass-ceramic formed an apatite on its surface in the living body and bonded to the bone through the apatite layer.

FIGURE 2:

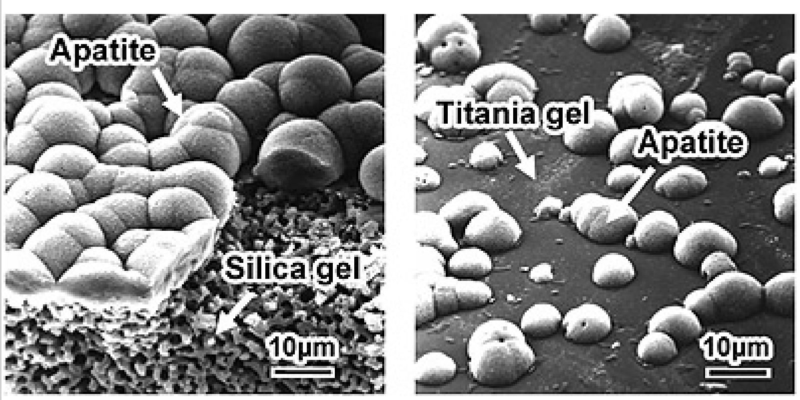

FIGURE 2 DESCRIPTION:

Transmission electron micrograph of cross section of apatite layer formed on glass-ceramic A–W in SBF.

FIGURE 3:

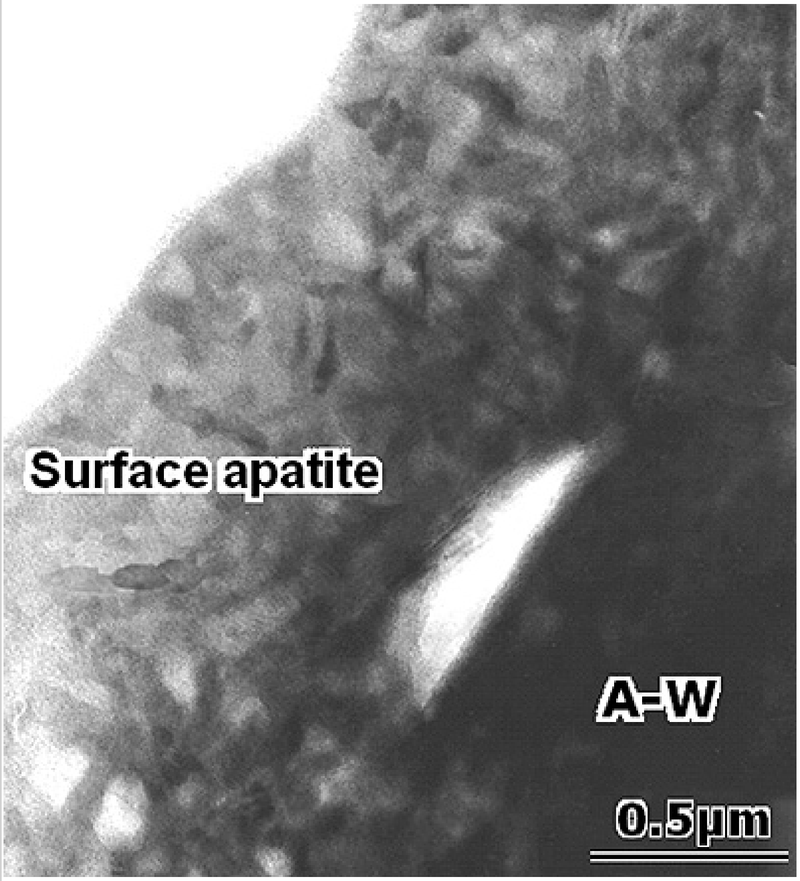

FIGURE 3 DESCRIPTION:

Scanning electron micrograph of apatite formed on silica gel (left) and titania gel (right) in SBF.

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