Microporous Ti implant compact coated with hydroxyapatite produced by electro-discharge-sintering and electrostatic-spray-deposition

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Statement of Purpose: In order to improve the bone in-growth properties and implant fixation behavior, hydroxyapatite (HA) is commonly applied to Ti implants as a coating material. The direct bone bonding capacity of HA is known as osteoconductivity, which means that HA allows direct formation of bone on its bioactive surface by acting as a template [1]. There are several methods for coating Ti with HA, such as plasma spraying or sputter-deposition. However, coating properties in terms of coating chemistry and morphology can be varied only to a limited extent [2]. On the other hand, an electrostatic-spray-deposition (ESD) method is relatively simple and inexpensive process for the coating inorganic thin films with a variety of chemical and morphological properties [3].

Methods we have first deposited HA thin film on the microporous-surfaced Ti implant compact by using an ESD technique. With this process, precursor solution that contains nano-scaled HA powders is pumped through out a nozzle. A high voltage, applied between the nozzle and substrate, produces the sub-micro droplets subjected to be uniformly deposited onto the microporous structure of Ti compact. As-deposited HA coatings on the substrate were then heat-treated and their physical characteristics were investigated in terms of morphology, crystallography, and surface chemistry. EDS Ti compacts before and after ESD coating were characterized in terms of morphology, crystal structure, and surface chemistry by using scanning electron microscopy (SEM), x-ray diffractometer (XRD), and x-ray photoelectron spectroscopy (XPS), respectively.

Results: It is seen that a solid core is automatically formed by the discharge in the center of the compact which is surrounded by a microporous layer. The solid core was composed of powder particles which were deformed and welded together. Figures 1 show SEM images of EDS Ti compact coated with HA by ESD under current experimental condition. HA particles were quite uniformly distributed through out the porous-surfaced structure of Ti compact. HA-coated Ti compacts were further heat-treated at 700 °C for 2 hours in a high vacuum. The heat-treated HA coating was also observed to consist of relatively equiaxed grains with sizes of about 100–300 nm in diameter. Any pores or cracks have not been found on the surface. Comparing with the reference spectrum of pure HA powder, the spectrum of heat-treated HA coating shows very similar patterns in the 2 theta range around 33°, indicating that no phase transformation has been occurred after the heat-treatment. The heat-treated HA coatings were further analyzed by XPS measurements. The peak at 531.6 eV in O 1s is attributed to PO_4^{3-} and OH^-. The binding energy value of this peak corresponds to that of HA in the NIST database [4].

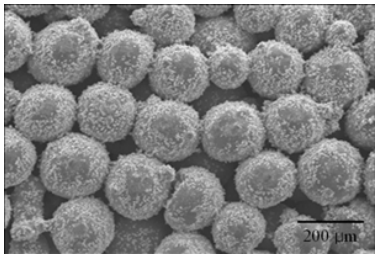

Figure 1. SEM micrographs of as-deposited HA coating on the EDS Ti compact

Conclusions The HA coating layer on the porous-surfaced Ti compact consisted of highly crystalline apatite phase with the Ca/P ratio of about 1.67.

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