Cell Culture on the Nano-sized and Functionalized Ti-6Al-4V Alloy by Plasma Electrolytic Oxidation

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Ti-6Al-4V alloys are promising in the field of dental and orthopedic implants due to their excellent biocompatibility, high corrosion resistance, and excellent mechanical properties. However, Ti-6Al-4V alloys have been difficult to meet all clinical requirements and surface modifications have been performed to improve the functionality such as the biological, chemical and mechanical properties of the material. For this reason, functional surface coatings as plasma electrolytic oxidation (PEO) have been introduced.

Ti-6Al-4V ELI disk was the substrate to be used in the experiment. Pretreatment of the samples was ground with 100-2000 grit sandpaper, the discs were rinsed with distilled water after polishing and ultrasonically cleaned with ethyl alcohol for 10 minutes. The washed specimen was used as the anode and the carbon rod was used as the cathode. DC power of 280 V was applied to all specimens for 3 minutes. The electrolyte used in PEO was prepared by mixing calcium acetate monohydrate (Ca $(CH_3COO)_2{\cdot}H_2O$), calcium glycerophosphate ($C_3H_7CaO_6P$), zinc acetate dehydrate ($((CH_3CO_2)_2Zn{\cdot}2H_2O$), strontium acetate hemihydrate ($Sr(CH_3COO)_2{\cdot}0.5H_2O$), magnesium acetate tetrahydrate ($((CH_3COO)_2Mg{\cdot}4H_2O$), manganese(II) acetate tetrahydrate ($Mn(CH_3COO)_2{\cdot}4H_2O$) and sodium metasilicate nonahydrate ($Na_2SiO_3{\cdot}9H_2O$).

For cell culture test, MC3T3-E1 mouse osteoblasts were cultured on the specimens for cell proliferation test.

The surface characterization of the PEO-coated surface was analyzed by field-emission scanning electron microscopy (FE-SEM) and energy dispersive X-ray spectroscopy (EDS). The surface area of the pores was measured using an image analyzer (Image J). Also, the phase of the specimen was analyzed with a thin film X-ray diffractometer (TF-XRD) at a radiation scanning range of 20 ° to 45 °

PEO is a new method of forming ceramic coatings on light metals such as titanium alloys. This electro chemical process uses a high voltage to generate spark discharge, and this occurs when the PEO voltage is higher than the dielectric breakdown voltage of the oxide film. PEO has proven to be a simple, controllable, and cost effective process. And the functional elements were added to the PEO coating to add the ions to the electrolyte to enhance bioactivity. Especially, calcium (Ca), phosphorus (P), zinc (Zn), strontium (Sr), manganese (Mn), magnesium (Mg), and silicon (Si) which are constituents of the body\'s bones, are added to the electrolyte of the ion, because they contain various crystalline minerals. And also, biocompatibility was investigated by examining cell attachment and proliferation on the surface and cytotoxicity of MC3T3-E1 cells, which are typical osteoblast cells, on a thick ceramic oxide coating film formed on the Ti alloy surface.

In this study, cell culture on the nano-sized and functionalized Ti-6Al-4V alloy by PEO was investigated by using various experimental methods.

The fila-podia ofthe cells can be seen to expand well into the pores around the pores due to theinfluence of the added functional material.

The cells covered the pore and extended well. The cells coveredthe pore, and it was observed that the side branches extended toward the pore.

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