Anodic oxidation of dental implants surface

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INTRODUCTION: To obtain coatings on titanium and its alloys containing bioactive elements, many methods could be applied. Modification of the surface of titanium implants by anodic oxidation is relatively easy and inexpensive. It enables good adhesion to the substrate and allows for homogeneous oxide coatings to be obtained, which can be enriched with biocompatible elements (i.e., calcium and phosphorus) during the process. There are two types of anodic oxidation processes. The first type involves oxidation at a voltage that is lower than the breakdown voltage of the oxide layer. The second type involves oxidation at a voltage higher than the breakdown voltage of the oxide layer and is called PEO. This technique results in the formation of numerous micropores on the anodised metal surface. The ions contained in a bath solution can penetrate into the oxide layer during the course of the glow discharge effect on the substrate, which occurs during PEO.

METHODS: The investigations were performed with use of a pure titanium. The pretreatment of samples was conducted as follows: polishing with abrasive paper of 800 granulation, rinsing in distilled water and cleaning ultrasonically for 5 min. After etching, alloy samples were anodised in a bath containing a source of Ca and P. The anodisation was performed at different voltages (100-500 V) at a current density 10 A dm^{-2} for 5 min. After anodising, the samples were rinsed with distilled water and cleaned ultrasonically with 2-propanol and deionised water. For the purpose of anodising, a DC power supply (PWR800H, Kikusui, Japan) and cooled electrolyser were used. The morphology and chemical composition of the anodic layer formed on the titanium surface were examined using a scanning electron microscope (SEM, Phenom Pro X) and an energy-dispersive X-ray spectrometer attached to the SEM. should be set as one block, as below, and a maximum of four references may be used. A bioactivity of the titanium samples was determined with use of a simulated body fluid

RESULTS: Anodising of samples in the bath containing the source of calcium and phosphorous at the final voltages 200-400 V led to the porous structure of oxide layer, which is typical for PEO process. In the first seconds of the process, there is a significant increase of voltage, practically to the voltage of 100 V, at which spark anodizing begins, accompanied by breakthrough of the oxide layer. Anodisation in solution with Ca and P resulted in buildup of these components in the oxide layer (EDX analysis). Such result behaviour can promote the adsorption of specific ions following the crystallisation of hydroxyapatite in a tissue environment (Fig. 1).

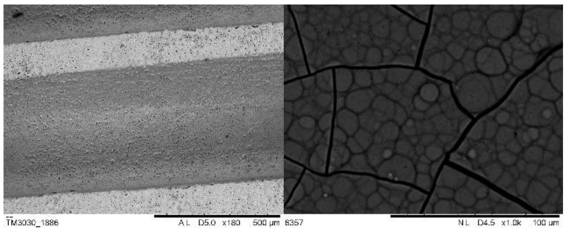

Fig. 1: The SEM images of a titanium implant after PEO process (left image) and a titanium sample surface after 3-week immersion in SBF

DISCUSSION & CONCLUSIONS: The modification of titanium implants by PEO can be performed in different electrolytic solutions, resulting in different surface properties. In most cases, positive results are obtained with respect to enhanced bioactivity, which has been proved by the application of the PEO process by most important dental implant producers. Thus, this process represents the future of implant surface modification for improving bone adhesion.

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