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Plasma Surface Modification of Titanium for Hard Tissue Replacement

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Surfaces play an important role in the response of artificial materials and devices to the biological environment. One reason is that the physical, chemical and biochemical properties of the implant surface control performance-relevant processes such as protein adsorption, cell-surface interaction and cell/tissue development at the interface between the body and the biomaterials. Titanium and its alloys have been used widely in clinic because of their relatively low modulus, excellent fatigue strength, excellent formability, good machinability, superior biocompatibility and corrosion resistance. However, clinical application has been limited due to the poor bone conductivity. Many methods have been applied to modify the surface of titanium in order to improve its biological and mechanical properties, and the techniques include plasma spraying, ion implantation, Sol-Gel coating, as well as chemical and biochemical modification. In this work, plasma surface modification techniques were used to improve the bioactivity of titanium. Several kinds of new ceramic coatings, wollastonite, di-calcium silicate and their composite coatings, were deposited onto titanium surface using plasma spraying. The bioactivity and biocompatibility of these coating were investigated using simulated body liquid soaking test and osteoblasts seeding test. The results indicate that these coatings possess good bioactivity and biocompatibility. Plasma ion immersion implantation and deposition (PIII-D) was also utilized to implant and deposit bioactive thin films, including Ca, P, and Ca-P-O PIII-D. The compositions and structure of these thin films were studied using scanning electron microscopy (SEM), secondary ion mass spectrometry (SIMS) and X-ray photoelectron spectroscopy (XPS). The bioactivity of these thin films was also evaluated by simulated body liquid soaking tests. The results indicate that the bioactivity of titanium is indeed improved by plasma surface modification.