電漿表面功能化對二氧化鈦相變化及顯微結構之研究

Research of Phase Transition and Microstructure on Titanium Oxide Film by Plasma Functionalization

中文摘要

諸多研究指出，鈦金屬與其合金具有極高的生物相容性，非常適合做爲人體的植入物，然而鈦金屬與其合金之所以具極佳的生物相容性(Biocompatibility)主要是與其表面的氧化層有關，研究指出植體表面氧化層厚度與錶面結構對於細胞初始的攀附行爲、增殖及分化有密切的關係。而本研究將利用氧氣電漿鈦金屬表面做氧化處理，並使其表面呈現奈米化結構，藉此表面處理來提高鈦金屬之生物相容性。而結果顯示，經電漿處理後之表面氧化層，其相由α相 轉變爲 α + TiO 再轉變爲α + TiO + ??-TiO2，這樣的結果是於先前研究中沒發現過的，而??-TiO2 可有效提高植體的骨整合。此外，氧化層中形成的奈米 TiO + ??-TiO2 相之奈米結構可提高蛋白質的貼附，藉此提高細胞的貼附及血液反應，藉此提高生物相容性，並有效提高骨整合。

英文摘要

Metals are becoming increasingly popular as surgical implants in the cardiovascular, neurosurgery, maxillofacial, orthopedic and dental fields by many researches. They are due to their excellent biocompatibility and mechanical properties. As mentioned above, the surface characteristics of the implant, such as pore sizes/roughness, oxide thickness are related to initial cell behaviors and enhancing osseointegration. It can be good for osseointegration if the implant can effectively keep the oxidation layer with nanoporousity and increasing oxide thickness. Based on the present study, in order to gain the thick oxidation and the nanoporous structure, the titanium hydride is the main factor in forming thick nanoporous oxide layer.

This study investigated the feasibility of using oxygen plasma discharging on titanium for forming a biocompatible layer between the bone plate and bone tissue. Plasma discharging formed a nanostructural oxidation layer on the titanium bone plate. The nanostructural oxidation layer revealed oxygen and titanium bonding states following oxygen plasma discharging. A (α ?_ (α + TiO) ?_ (α + TiO + ??-TiO2)) phase transition was observed within the titanium matrix during plasma discharging. This result has never been previously reported. The plasma oxidation with argon pretreatment not only produces titanium oxide layer, but also results in formation of nanostructural titanium oxide phase. Nano-rutile-TiO2 (??-TiO2) can be enhanced osseointegration of implant such as orthopedic and dental implants. In addition, nano-(TiO + ??-TiO2) phases were formed on the nanostructural oxidation layer by

plasma discharging. Formation of a nanostructural rutile-TiO_2 on oxidation layer is related with the cell and blood reaction and distribution selectivity, then promoting hemocompatibility and protein binding as well as osseointergration. Therefore, surface oxidation by plasma discharging is thus believed to improve the biocompatibility and tissue healing. Furthermore, plasma-discharging not only enhances phase transformation on titanium surface, but also generates a nanostructural oxide layer, improving the bioactivity and hemocompatibility of bone plate.