奈米多孔性氧化層對鈦基植體初期血液相容性之影響研究

Research of Initial Hemocompatability on Titanium-Based Implants with and without Nanoporous Titanium Oxide Film

中文摘要

諸多研究顯示，鈦金屬及其合金於人體有極高的生物相容性(biocompatibility)，非常適合做爲人體的植入物，然而其之所以具極佳的生物相容性主要是與鈦金屬表面的氧化層有關，研究指出植體表面氧化層厚度與孔徑大小對於細胞初始的攀附行爲、增殖及分化有密切的關係。若能有效增加氧化層厚度與降低植體表面孔徑尺寸將對骨整合會有所助益。於文獻指出氫化鈦是形成網狀奈米多孔性氧化層結構主要因子，並且能有效增加氧化層厚度。因此，本研究以電化學陰極處理方式使鈦基金屬表層形成一層氫化鈦薄膜，再以電化學陽極處理，使表面形成一層網狀奈米多孔性的二氧化鈦(TiO2)結構，再以接觸角量測儀分析鈦試片改質後表面親疏水性的表面能變化。以 X 光光電子能譜儀(XPS)分析膠原蛋白吸附於鈦金屬後其化學鍵結的改變；以低掠角 X 光繞射儀(GIXRD)及拉曼光譜儀(Raman)來探討處理後的氧化層結構特性，再利用穿透式電子顯微鏡(TEM)來觀察植體與組織間界面的變化。藉由 clotting time 的測試來驗證此二氧化鈦層的血液相容性具有促進組織癒合能力，進而改善鈦植體與骨之間的初期骨整合作用。此氧化層可提升表面的親水性且擁有較快的血液凝結特性，進而能夠進一步改善骨組織的癒合能力及促進骨整合，以期植體植入後能引導及促進組織快速復原。

英文摘要

The purpose of the present study was to evaluate the influences of titanium hydride on the formation of nanostructural titanium oxide by anodization following cathodic pretraetment. The physico-chemical surface properties were investigated by scanning electron microscopy, cross-sectional transmission electron microscopy, thin film x-ray diffractometry, and x-ray photoelectron spectroscopy. In addition, the hemocompatibility of nanonporous titanium oxide was also investigated and discussed clearly. Nanoporous structure was formed after anodization with cathodic pretreatments. The titanium hydride is formed by cathodic pretreatments. Titanium hydride was a sacrificial layer on titanium following anodization. The sacrificial layer has a γ-TiH2 phase. The γ-TiH2 is a tetragonal nanostructure and its lattice constant is a = 3.12 nm. Furthermore, it was formed within titanium matrices during cathodization. The nanostructural γ-TiH2 decomposes after anodization. Furthermore, the nanoporous Ti formed by dissolution of TiH2 was changed to nanoporous TiO2. The TiH2 plays an important role in forming nanoporous TiO2. The triangle-like γ

-TiH2 was observed on the Ti matrix and grain boundary. In the α-Ti matrix, an α-Ti $\rightarrow$ γ-TiH2 transition occurred during cathodization. This result has never been previously reported. The anodization with cathodic pretreatment not only produces titanium hydride layer, but also results in formation of nanostructural titanium oxide. Nanoporous titania can be enhanced osseointegration of implant such as orthopedic and dental implants. Furthermore, the blood compatibility is obviously enhanced as increasing the oxide thickness. The nanonporous structure and thick oxide film play important factors in promoting the hemocompatibility.