ETUDE ÉLECTROCHIMIQUE COMPARATIVE D'UN ALLIAGE (TiNi) ÉLABORÉ, AVEC UN IMPLANT DENTAIRE EN MILIEU SIMULÉ

Soumaya MEDDAH

Soutenue en: 2018

Abstract: Good mechanical compatibility with cellular tissue and corrosion resistance, as well as excellent biocompatibility in body fluids, are required for titanium-based alloys to be materials of choice for biomedical applications such as orthopedic implants and dental. The present thesis aims to obtain TiNi binary alloys developed by vacuum induction, as a possible alternative for dental applications. The TiNi alloys developed as part of this thesis work contain Ni contents ranging from 40 to 60%. The choice of this composition was made, first to check the influence of the Ni content on the formation of the structure and the morphology of the phases and secondly the repercussions of this structure on the final properties of the alloy to know; the mechanical properties, tribological and electrochemical and bioactivity. TA6V4 alloy is used for comparison.For this purpose, the chemical composition of the TiNi alloys and the microstructural evolution was determined by scanning electron microscopy (SEM) coupled to the EDS. The formation and growth of the phases was followed by X-ray diffraction. Instrumented hardness measurements were made to assess the hardness and Young's modulus of the alloys. The coefficient of friction of the TiNi alloys and the wear rate were determined by dry sliding at different loads. The electrochemical characterization in Hank's solution and artificial saliva has been studied by stationary techniques and by EIS at different immersion times. The tribocorrosion behavior was performed in artificial saliva to understand the tribocorrosion mechanisms of TiNi and TA6V4 alloys. The bioactivity tests were performed in the SBF solution after 21 days of immersion. The SEM / EDS and RX results show that the two alloys Ti50Ni50 and Ti40Ni60 have a TiNi type matrix (NiTi), and Ti2Ni and Ni2Ti type precipitated phases. The revealed microstructure for the Ti60Ni40 alloy is a Ti2Ni-based matrix comprising the NiTi intermetallic. This same alloy had the lowest Young's modulus, while the Ti40Ni60 alloy had superior superelasticity, than the other titanium alloys (Ti50Ni50, Ti60Ni40 and TA6V4).All TiNi alloys exhibit better tribological behavior compared to the TA6V4 alloy which results in high wear resistance and low wear. Abrasive and adhesive wear mechanisms have been identified as degradation mechanisms for TiNi and TA6V4 alloys, with the predominant adhesive mechanism for TiNi alloys. The Nyquist and Bode impedance diagrams for all TiNi and TA6V4 alloys show capacitive loops with two time constants, indicating that the passive film is formed of two layers namely, a compact passive internal barrier layer and a porous outer layer. The electrochemical study revealed that all alloys have a passive character. The corrosion resistance of the TA6V4 alloy is greater than that exhibited by the various TiNi alloys. TiNi alloys showed hydroxyapatite formation under in vitro bioactivity conditions of SBF.

Keywords : Titanium alloys, Young module, superelasticity, wear behavior, corrosion resistance, impedance, bioactivity.