Fretting-corrosion behaviour and repassivation evolution of Ti in artificial saliva solutions in the presence of corrosion inhibitors and pH variations

Abstract

Degradation of Ti dental implants is a common process usually caused by mechanical stress and/or by the physiological environment (human saliva) that surround the implant. These types of implant are most of the time subjected to micro-movements at the contact region with bone or at the implant/porcelain interface (due to the transmitted mastication loads) and chemical solicitations (oral environment). Such implant becomes part of a tribocorrosion system, which may undergo a complex degradation process that can lead to implant failure. Additionally, the passive film, which naturally grows on the metallic implant surface, can be scratched or destroyed during the insertion and implantation into the hard tissue by abrasion with bone and other materials.

In this work, two different tribological arrangmets were studied. Fretting-corrosion and reciprocating pin-on-plate tests were performed in different equipments specially adapted for tribocorrosion experiments. Artificial saliva was used as electrochemical solution and an alumina ball (ϕ = 10 mm) was used as counterbody. Citric acid was added to artificial saliva in order to investigate the influence of a pH variation on the tribocorrosion behaviour of the material. Additionally, three different inhibitors were added to investigate the action of cathodic and anodic reactions on the electrochemical response. Also, the influence of inhibitors which might be included in the formulation of tooth cleaning agents or medicines was investigated. During fretting tests, the degradation mechanisms were investigated by electrochemical noise technique, which provided information on the evolution of corrosion potential and corrosion current during fretting tests. In reciprocating tests, two different electrochemical conditions were imposed: OCP and potentiostatic control in the passive region of the polarization curve (1V) of Ti samples. Also, to obtain more detailed information on the characteristics of the original and reformed passive film, EIS measurements were made before and after the mechanical damage. In both cases, all samples were characterized using SEM, EDS, and AFM techniques.

Depassivation and repassivation phenomena occurring during the tests were detected, and are discussed. The pH decrease and the presence of anodic inhibitors demonstrate a helpful influence in the improvement of the tribocorrosion properties of cp Ti. pH decreases The repassivation evolution of commercially pure Ti seems to be affected by pH decreases. No improvement in the repassivation kinetics was suggested with the presence of corrosion inhibitors, in artificial saliva solution.