Tribocorrosion behaviour of titanium grade 2 in reciprocating sliding conditions in artificial saliva solutions

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The demand for metallic materials in medical and dental devices is large; metals and alloys are widely used as biomedical materials and are indispensable in the medical field. In particular, toughness, elasticity, rigidity, and, some times, electrical conductivity are essential properties for metallic materials used in medical devices. In dentistry, titanium is used for restorations, orthodontic wires, and dental implants.

Materials implanted in the human body are intermittently stressed with loads, which are repeated in a tremendous amount of cycles. During mastication, dental implants are simultaneously subjected to corrosion by the oral environment and to the sliding-wear process by bite forces. Dental wear can be attributed to mastication where the teeth are worn by attrition and abrasion. The main aim of the present study was to investigate the tribocorrosion behaviour of titanium grade 2 in reciprocating sliding conditions in contact with artificial saliva solutions. Particular attention is given to the relationship between mechanical damage and the electrochemical behaviour of the material.

Sliding-corrosion experiments were performed using a reciprocating ball-on-flat contact configuration and the open circuit potential was monitored during the test. Also electrochemical impedance spectroscopy was used to obtain a more detailed description of the corrosion mechanisms and to characterise the passive layer that forms on the titanium surface. To reproduce the oral environment around the dental implant, some additives (citric acid, anodic, cathodic and organic inhibitors) were added to simple artificial saliva constituted mainly by NaCl and KCl, and with a pH between 5 and 7. A corundum ball was loaded on the top of the flat rectangular sample at a normal force of 10N. Linear peak-to-peak displacement amplitude of 3 mm at vibrating frequencies of 1 Hz was applied to the tribocorrosion system. The tests were performed for 11160 cycles. The surface roughness and topography of the titanium samples were evaluated prior to testing.

In relation to the friction profile, for all solutions, no significant differences were observed. In fact, the aqueous environment used doesn't have sufficient viscosity to cause changes in the friction behavior. Regarding the weight loss results it is possible to conclude that titanium in artificial saliva solution with citric acid present the high weight lost. Additionally, cathodic and organic inhibitors solutions exposed a higher tendency for corrosion, forming an oxide passive film with lower protection characteristics.

Keywords: Titanium, dental implants, tribocorrosion.