Fretting corrosion comparison between 316L SS and CoCrMo alloys. Effect of Ti content on cast alloysCoCrMo.

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1. Introduction

160,000 total hip prostheses are implanted each year, in France (250,000 in USA). One in every 30 Americans has a hip prosthesis. Fretting corrosion, friction under small displacements (Tribocorrosion), has been identified as one of the worst mechanism of degradations concerning metallic implants [1]. Three metallic alloys principally are used for orthopedic implants: Ti-6Al-4V, CoCrMo and 316L. It is well known that Ti-6Al-4V alloy does suffer from fretting corrosion degradations. As a consequence and it is not used for femoral head, for example. In order to study the typical damages of CoCrMo and 316L by fretting corrosion, specific investigations were carried out on a unique device for controlling mechanical and electrochemical parameters. This work aims at investigating differences of fretting corrosion resistance between both alloys.

2. Materials and methods

From the experimental point of view, the fretting corrosion device has been described in [2], Figure 1.

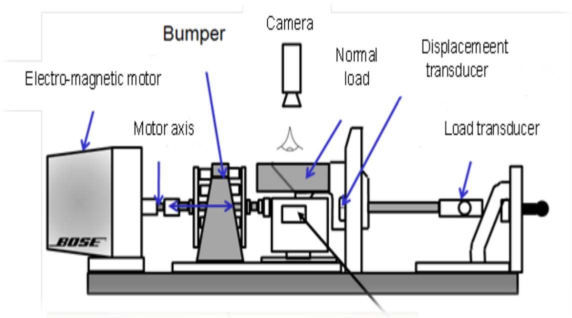

Fig. 1 Fretting corrosion Device, principles

On the mechanical conditions, the relative displacement between samples in contact is equal to ± 40µm and the tangential load is monitored during 4 hours of continuous fretting corrosion. Moreover two additional parts are available on this device: a camera that allows observing live degradations due to transparency of polymer sample (Poly MethylMetAcrylate, PMMA) and an electrochemical setup for following Open circuit potential or current at applied potential. Moreover wear volumes and imaging were investigated thanks to 3D profilometry (Brukernanaoscope®, Veeco, NT9100).

Metallic samples were 316L SS and CoCrMo, used as prosthetic implant(ISO 5832 IV), and specific CoCrMo alloy, cast alloy, with different contents of Ti (from 0 to 1weight %). Electrochemical experiments have been investigated, especially at Open Circuit Potential, OCP.

3. Results and discussion

OCP experiments have been investigated. For all samples, as expected, OCP decreases during fretting corrosion experiments. A specific attention has been paid on wear volumes of metallic samples for comparing performances of all materials. The Figure 2 shows this evolution.

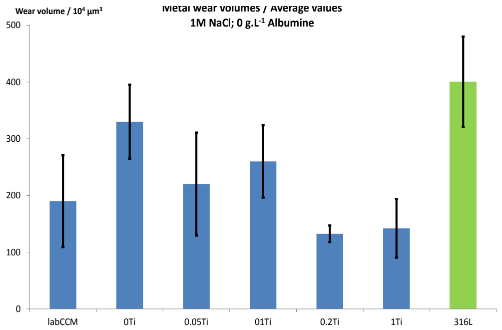

Fig. 2 Wear volumes evolution; LabCCM is usual CoCrMo; XTi is the Ti content (weight %) of cast alloys and 316L

All wear volumes of CoCrMo are lower than the one related to 316L, each time, two experiments have been investigated allowing calculation of the confidence interval at 95%. A one-way ANOVA analysis shows that there is no difference between all CoCrMo alloys, usual one (Lab CCM) and cast alloys with different contents of Ti. Moreover the dissipated energy according to the time highlights the same trend. From Scanning Electron Microscopy, wear track area of metallic samples show different patterns. 1%Ti of cast CoCrMo alloy highlights some residual intermetallic precipitates and insights of localized corrosion between these particles, precipitates, and the matrix, hypothesis close to [3].

4. Conclusions and outlooks.

These data highlight a better resistance; wear volumes, of CoCrMo alloy than the one of 316L under fretting corrosion tests. Further investigations will detail the materials behavior at applied potential for getting some insights of current density evolution under fretting corrosion. Thus a synergistic discussion would be led.

References

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