Comparative Tribological study of biomaterials AISI 316L and Ti6Al7Nb

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1. Abstract:

The aim of this study is to evaluate the tribological behavior of high-strength titanium alloys: Ti–6Al–7Nb and AISI 316L stainless steel for Surgical Implants (Total hip prosthesis). The tribological behavior is evaluated by a wear tests, using Tribometres ball - on –disc and sphere - on - plane. These tests consisted of measuring the weight loss, and the friction coefficient of SS AISI316L. The Oscillating friction and wear tests have been carried out in ambient air with Oscillating Tribotester In accord with standards ISO 7148, ASTM G99-95a, ASTM G 133 – 95 under different conditions of normal applied load (3N, 6N and 10N) and sliding speed (1mm/s, 15mm/s and 25mm/s), as a counter pairs we used the ball of 100Cr 6, 10 mm of diameter.
These tribological results are compared with those carried out a Tribometer type pin on disc under different conditions of normal load applied P (19.43, 28 and 44N) and sliding speed (600 rpm and 1020 rpm). The behavior observed for both samples suggests that the wear and friction mechanism during the tests is the same, to increase the resistance to wear and friction of biomedical alloy used in total hip prosthesis (femoral stems) the surface coating and treatment is necessary.

2. Materials and Methods

The microstructure was studied using optical microscopy (OM, LEIKA DMLM). The chemical composition was acquired using spectrometer (SPECTROLAB) and energy-dispersive spectroscopy (EDS, PHILIPS XL 30 ESEM-FEG, and EDX IMIX-PTS). The phases present in figure 5 were identified by X-ray diffractometry (XRD, INTEL CPS 120/Brucker AXS) using Cu Kα generated at 40 kv and 35mA. Scanning electron microscopy Hitachi S-520 and energy dispersive X-ray analysis (EDX) were used to study the chemical composition of the Ti Alloys (figure 4). The roughness on 3D was studied using (Surface Data Veeco: Mag 5.0X, Mode VSI).

2.1 Tribology study

In this work, pin-on-disc, ball-on disc and sphere-on-plane tribological tests (Figures. 1,) were carried out using the following prosthetic materials: AISI 316L SS, Ti-6Al-7Nb steel alloy against 100C6 and abrasive paper number 320 (Sic).

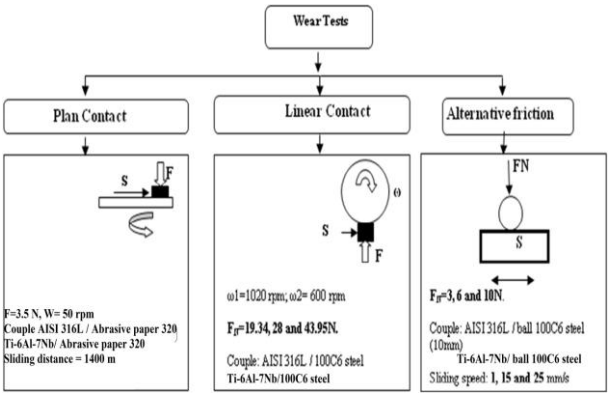

Fig.1 Schemas of defferents wear tests

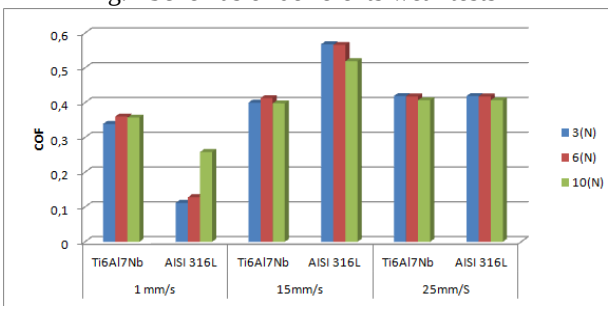

Fig.2 Mean Friction Coeffition of AISI 316L and Ti-6Al-7Nb

3. Discussion

The obtained results show that the weight loss quantifying the wear of a soft body slipping on a hard surface is proportional not only to the distance from the slip, but also with the normal load applied.
The sliding speed has for a principal effect to act on the temperature of the contact zone. The going beyond a critical speed involves the surface fusion of the most fusible body.
The increase in the temperature of the contact with the speed induced to structure transformations and increases the reactivity of surfaces with respect to the environment (oxidation in the presence of air). Above a certain temperature and thus for speeds of slip higher than a breaking value, the oxide film, resulting from a permanent oxidation, is reconstituted with the fur as it is destroyed by wear. The behavior observed in both samples under different condition suggests that the wear mechanism during the test is the same for the Ti alloys samples, to increase the wear and friction resistance of biomedical titanium alloys used in total hip prosthesis (femoral stems) the surface coating and surface treatment is necessary.