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Mechanical properties and electrochemical impedance of austenitic stainless steel ASTM F138 and Ti7Nb6Al alloy

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Abstract - The austenitic stainless steels are used in surgical implants because the high stiffness and ultimate strength, besides the good corrosion resistance. Nowadays, the Ti7Nb6Al alloys are replacing the austenitic stainless steel ASTMF138 as surgical prostheses, due to the optimum compromise between biocompatibility, corrosion resistance and mechanical properties. The aim of this study was to compare the mechanical properties of the austenitic stainless steel AISI F138 with the Ti7Nb6Al alloy. Electrochemical impedance spectrum measurements of both alloys were obtained too. The preliminary results confirm the current use of the Ti7Nb6Al in the substitution of the austenitic stainless steels in surgical implants.

The research of new materials to use in the clinical problems has been constant in the last few years. In prostheses surgical, alloys of several chemical compositions are used in the stages of correction position [1]. For this objective, the austenitic stainless steel ASTM F138 has been used due to the high elasticity modulus (E) and optimum corrosion resistance in the human body. Currently, Ti7Nb6Al alloy is being used as substitutes to the austenitic stainless steel one, in surgical applications where mechanical properties and corrosion resistance are very important requirements [2]. In this work, specimens with 2.5 diameter of austenitic stainless steel ASTM F138 and Ti7Nb6Al alloy were pulled in a universal testing machine. Microhardness and electrochemical impedance spectrum measurements were obtained in these samples too. The stainless steel presents better mechanical properties than the titanium alloy. In relation to the impedance spectrum obtained in NaCl solution, it is observed in the Figures 1 and 2, that the charge transfer resistance of the stainless steel is approximately 7,2 ohm/cm^2 while the one of the Ti7Nb6Al is approximately 17,0 ohm/cm^2 [3]. It means that were significant differences between the values and it shows that the Ti7Nb6Al is a useful alternative to manufacture other components for surgical implants with excellent biocompatibility and acceptable mechanical properties.

Table 1: Mechanical properties of specimens with ∅ 2,5mm.

Alloys	Yield Strenght (MPa)	Ultimate Tensile (MPa)	HV (100g)	E 10^3(MPa)
ASTM F138	1292 ± 31	1545 ± 29	432 ± 15	198 ± 3
Ti7Nb6Al	1149 ± 14	1295 ± 30	428 ± 15	116 ± 3

L_o=50mm

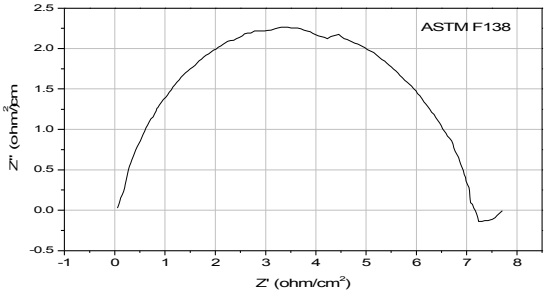

Figure 1: Nyquist diagram of stainless steel ASTM F138.

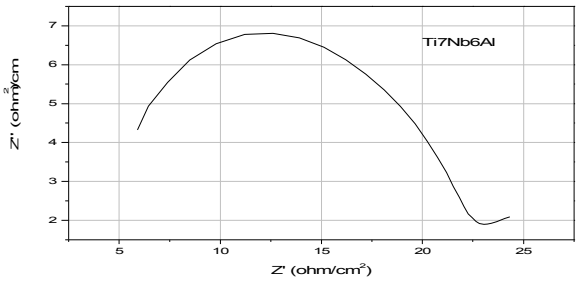

Figure 2: Nyquist diagram of Ti7Nb6Al alloy.

References

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