EFFECT OF SILICON CONTENTS ON THE PROPERTIES OF NEW TITANIUM ALLOY

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Abstract
The use of prostheses promotes the increase of well-being in the population and that is why nowadays we are trying to better understand the results and success in achieving osseointegration of these elements. This gives way to the use of biomaterials. In order to define the characteristics of these materials, analyses and tests are required to determine their behaviour when the material is to be used and applied as an implant. So this research mainly aims to evaluate how silicon influences the mechanical characteristics by comparing two novel titanium alloys.

Introduction
These days, new alloys with a low modulus of elasticity and low cytotoxicity are being researched and developed because of the hip's significant weight bearing capacity and the issues associated with the biomaterials currently in use. Consequently, the decision has been made to look into the potential biomedical uses of the S1 (62% Ti, 15% Mo, 7% Zr, 15% Ta, 1% Si) and S2 (57,25% Ti, 20% Mo, 7% Zr, 15% Ta, 0,75% Si) samples further.

Experimental
The arc remelting process was used in an argon environment to create the alloys. This method was used at the Gheorghe Asachi Technical University in Iasi, Romania, at the Faculty of Materials Science and Engineering. To achieve the required homogeneity, the alloys were melted, then remelted six times (three times in each face), and finally formed into an ingot. Furthermore, part of the ingots were given to Las Palmas de Gran Canaria University (Las Palmas de Gran Canaria, Spain) for their testing and preparation.

To prepare the samples for metallography, they were polished with silicon carbide papers and 0.1 silicon carbide papers and 0.1 micrometre alumina suspensión and after the first examination, the samples were subjected to a Kroll reagent attack.
To perform the microhardness tests, 12 points were taken with forces of 1 gram, 5 gram and 10 gram to calculate and express the Vickers hardness (HV), in accordance with ISO 14577-1:2015. For Electrochemical Tests, each sample was placed in an electrochemical cell with three electrodes for the electrochemical tests: the samples acted as the working electrodes, a saturated calomel electrode served as the reference electrode, and a platinum electrode acted as the counter electrode.

Results and discussion

The compounds and phases that make up a metallic substance are arranged spatially in metallography, together with any impurities or potential mechanical faults.

Vickers hardness versus scan length graphs for both samples exhibit widely spaced maxima and minima, indicating the presence of both soft and hard areas on their surfaces. It is also confirmed that the harder the sample, the higher the percentage of silicon and the applied load. Elechtrochemical tests show that Sample 1 is more stable as Sample 2.

A semi-logarithmic scale of the current results shows the outcomes of the linear polarization technique, which was used to measure the alloys' rate of corrosion. Compared to the other samples under investigation, Sample 2 exhibits higher values of anodic corrosion potential and current (Ecorr and Icorr, respectively), which indicate how much the alloy has been oxidized.

Conclusion

The samples' surfaces displayed biphasic dendritic patterns following their exposure to the Kroll reagent. When silicon was added, the dendrites shrank because silicon is a potent grain refiner in titanium alloys. It encourages the development of fine grains that impede the spread of cracks and strengthen the material's resistance to fatigue.

The potential values of both samples increased during the immersion period without decreasing. By creating a protective oxide layer on the alloy surface, silicon oxide slows down the rate of oxidation and increases the alloys' resistance to deterioration from bodily fluids.

Two distinct phases, *hard and soft*, of the material's microstructure were found by measuring the hardness at various loadings.

Overall, every sample exhibited favorable chemical and biological properties. So we could say that both samples would behave favourably in the human body.

References

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