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SEM Study of a Ti-Ta-Sn Ternary Alloy by Powder Metallurgy

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T Ti metal alloys are widely used in the field of biomaterials due to their excellent mechanical properties. In this work, the microstructure and porosity of a metallic foam of Ti-Ta-Sn alloy were observed by means of SEM scanning electron microscopy, which aims to obtain greater resistance to corrosion, toughness, hardness, and resistance to wear, with an elastic modulus and elastic limit approximate to that of human bone. However, we must consider the phenomenon of protection against stress, produced by the mismatch between the elastic modulus of human bone (~0.01–25 GPa) [1] in order to decrease the elastic modulus of Ti base alloys (~ 45-110 GPa) [2]. For the manufacture of the foams, there are different methods, according to the method used, the type of porosity with the favorable mechanical properties will be obtained. The manufacture of closed porosity by the graduated distribution of pores (Plasma spraying) and random distribution of pores (gas injection into the metal melt and Decomposition of foaming agents). The manufacture of open porosity foams can be homogeneous (Sintered metal powders, Sintered metal fibers, Space holder method, Replication, Combustion synthesis, Plasma spraying), non-homogeneous (Orderly oriented wire mesh, Vapor deposition, Ferromagnetic fiber array, Rapid prototyping), and functionally classified (Rapid prototyping, Electro discharge compaction) [3]. The space holder fabrication method to produce a Ti-based alloy with bcc (β-phase) crystal structure, considering that they exhibit a low modulus of elasticity and fatigue strength, compared to hcp (α-phase) crystal structure offers us a good resistance to creep. The elements Ta and Sn are used as stabilizers at room temperature of the β-phase crystal structure. Open porosity foams promote osseointegration and cell adhesion in biomaterials [1]. To achieve the desired microstructure, it was performed by powder metallurgy, choosing the amount of 13%Ta and 12%Sn so that a bcc crystal structure was achieved after the consolidation process. In this case, no spacer was used, only the powders were 75% v/v Titanium, 13% v/v Tantalum, and 12% v/v Tin. The powder particle size of Ti (~150 μm), Ta (<63 μm) and Sn (<71 μm) by manufacturer Merck®. The powders were mixed for 30 minutes at a revolution of 30Hz using the principle of impact-friction grinding, the powders already mixed were deposited in a cylindrical steel matrix with a diameter of 8mm, compacted at 430 Mpa. Obtaining the 8mm long green sample, it was later sintered in a conventional furnace with a controlled argon atmosphere with a temperature curve of 18-1200 ºC with cooling of 1200-100 ºC with a temperature decrease of 3ºC per minute). The SEM micrographs show in figure 1 a) (50x) the agglomeration of powders that did not merge with the sample, leaving a macroporosity. Figure 1 c) (500x) by backscattered electrons shows the differences in the chemical composition due to the difference in contrast and the relief of the surface. The porosity characteristics of the foam, a clearer image in three-dimensional appearance can be observed by secondary electrons, the porosity caused by the sintering process, this morphology is produced during a mixing and compaction process due to the

fact that the powder particles suffer deformation. The micropores exhibit sizes below 8 μm, in both cases there was no homogeneity of porosity, see Figures 1 b) (50x) and 1 d) (500x). In this investigation, procedures that were carried out for the elaboration of the ternary alloy of Ti-Ta-Sn by powder metallurgy are presented. In conclusion, during the fabrication of foams with this space holder method, strategies to address dust separation, sample contamination, homogeneity, and pore shape must still be considered. We can consider that it has great potential for biomedical applications.

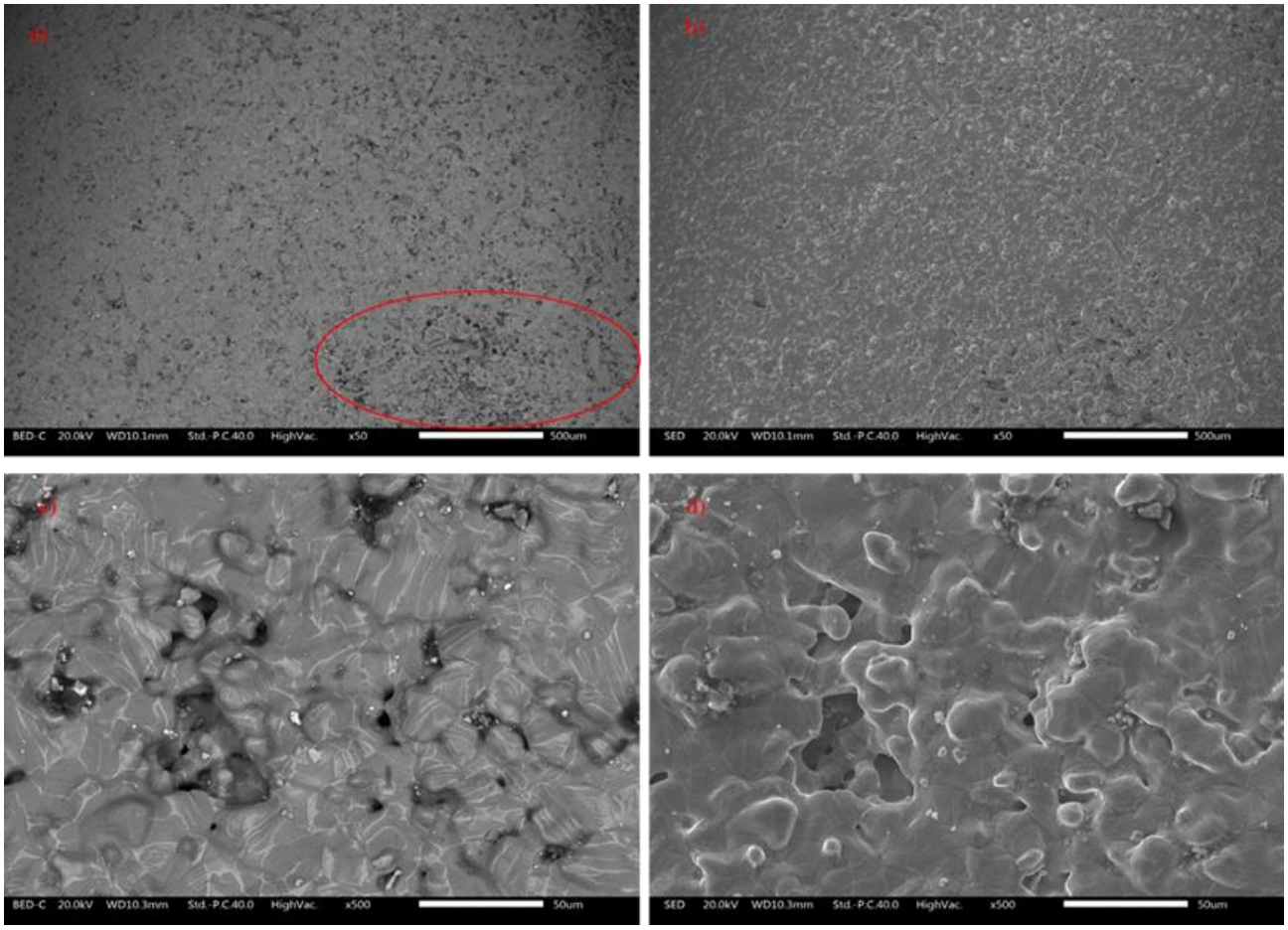

Figure 1. SEM images of foam, a) and c) BED (50x and 500x) SED b) and d) (50x and 500x).

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