Study of the influence of sintering parameters on the final microstructure of scaffolds using the Ti-13Nb-13Zr alloy

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Resumo:
Concerning biomaterials, titanium and its alloys have been used to restore bone functions due to its outstanding properties. In this context, Ti-13Nb-13Zr alloy calls attention, because of its good biocompatibility, high corrosion resistance, superior mechanical properties and lower elastic modulus. However, metallic biomaterials have some lack of biological recognition on the surface. To overcome this restraint and improve biocompatibility, metallic biomaterials can be manufacture as scaffolds. One of the techniques available to obtain scaffolds is the powder metallurgy. In this work, scaffolds of Ti-13Nb-13Zr were obtained by powder metallurgy. Firstly, powders of Ti (99.95%wt), Nb (99.99999%) and Zr (99.0%) were weighted so that a powder mixture was obtained with the composition 74wt.%Ti+13wt.%Nb+13wt.%Zr. Half of the mixture was named “control condition”. The other half was milled in a Fritsch Pulverisette mill with isopropyl alcohol (controlling agent), and was named “alcohol condition”. After that, powders in both conditions were characterized by scanning electron microscopy (SEM). Each half of powder was pressed and sintered at 1000°C and 1200°C (1 and 4 hours for both temperatures). These sintering temperatures were predicted by Thermo-calc© simulations. The samples were characterized using X-ray diffractometry, SEM with coupled EDX (SEM-EDX), optical microscopy and microhardness Vickers test. From the results it could be verified that at higher times and temperatures of sintering, alpha-Ti becomes more homogeneously distributed within the beta-Ti matrix. Moreover, alpha-Ti with lamellar structure becomes thinner. The porosity of the samples varied from 12 to 30% in volume, and the maximum porosity of 30% was reach for the “alcohol condition” sintered at 1000°C for 1 hour. Increasing the sintering time at 1000°C to 4 hours decreased the porosity to 20%. The same porosity percentage (20%) was observed for the “control condition” sintered at 1000°C. Increasing sintering temperature to 1200°C decreased the porosity to 15%, but showing the highest hardness for both sintering times (~ 300 kgf/mm²). This behavior was possibly due to necking bond formation among the powder particles and densification. In general, higher sintering temperatures and times decreased the porosity but increased the hardness of the samples, which was partially expected. A balance between such parameters must be achieved to improve the homogeneity of porous, phases and hardness, to use the material as scaffolds for bone regeneration.