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Porous implants obtained using gelatin through powder metallurgy

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Abstract – The metallic biomaterials, such as titanium and its alloys, have been studied mainly to improve the quality and bone repair time of implants. The aim was to get Ti-13Nb-13Zr implants produced by powder metallurgy technique, with controlled addition of gelatin. To obtain porous samples, during the thermal treatment, the output of carbon promotes formation of porosity with open-interconnected channels in the material. We observed a significant increase in the porosity with the use of gelatin, obtaining this way a mean apparent porosity of 30%.

The metallic biomaterials, such as titanium and its alloys, have been studied mainly to improve the quality and bone repair time of implants. A kind of topographic feature that can be manufactured in implants is the interconnected porosity, in which pores are large enough to allow the required vascular nourishing to the continuous mineralization of new bone tissue [1]. By powder metallurgy (PM) technique, it is possible to obtain parts with form and dimensions coming to end (Near-net shape), avoiding the step of machining [2]. The manipulation of metals in the form of particulate allows the addition of components reaching a satisfactory homogeneity, and controlled porosities. The aim was to get Ti-13Nb-13Zr implants produced by PM technique, with controlled addition of gelatin. The hydrogenated and particulate metals (TiH_2, NbH and ZrH_2) were stoichiometry weighted for the alloy and ground, with speed of 300rpm/90minutes. From alloy powder, were added 5, 10 and 15 wt% of gelatin, homogenized and dissolved in boiling water to achieve high viscosity. The resultant paste was dried in oven at 30°C for 24 hours. Before sintering, the powders were submitted to cold isostatic pressing (138 MPa) and thermal treated in a vacuum oven (10^{-2} mBar) at 300°C/90 min; to totally remove gelatin and carbon residues from samples. The samples were sintered at 1150°C/14 hours/10^{-5} mBar. Four groups of samples were analyzed, with the following variables (% Referring to the amount of gelatin): Ti-13Nb-13Zr (no added), Ti-13Nb-13Zr + 5%, Ti-13Nb-13Zr + 10%, Ti-13Nb-13Zr + 15%. The characterization was made by SEM and energy dispersive spectroscopy (EDS). To obtain porous samples, during the thermal treatment, the output of carbon promotes formation of porosity with interconnected channels in the material (Figure 1). In samples, alloy with addition of gelatin were observed, less heterogeneity than in alloy without gelatin, this may have been propitiated by the presence of pores and channels, damaging the alloy element dissemination. However, by the semi-quantitative analysis of SDS, the samples obtained with the addition of gelatin showed only alloy elements, without presence of contaminants. Thus, all gelatin used for processing was removed during the thermal treatment. We observed a significant increase in the porosity with the use of gelatin, obtaining this way a mean apparent porosity of 30%.

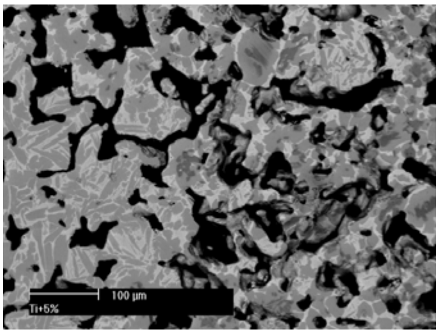

Figure 1: SEM of Ti-13Nb-13Zr + 5% sample.

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