INFLUENCE OF Mo SUBSTITUTION BY Nb AND EFFECT OF B ADDITION ON Co-Cr-Mo BIOMEDICAL ALLOYS

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Co-Cr-Mo are widely known for biomedical applications in dentistry and later as knee and hip artificial joints due to high mechanical and fatigue strength, Young modulus and corrosion resistance. The objective of this work was to evaluate the microstructure characterization influence of Mo substitution by Nb and the effect of boron addition on Co-Cr-Mo biomedical alloys. Arc-melt ingots of 30 g and suction copper mold cast samples in cylinder shape (2, 4, and 6mm in diameter) were characterized by scanning electron microscopy (SEM), X-ray diffraction (XRD) and measurements of Vickers microhardness. The XRD pattern for $Co_{64}Cr_{32}Mo_4$ (%at) alloy lead to the identification of α-Co and ε-Co phases, solid solutions of Cr and Mo with Co, as usual for the biomedical Co-Cr-Mo alloys. The Mo substitution by Nb in the $Co_{64}Cr_{32}Nb_4$ (%at) alloy lead to a stabilization of ε-Co phase and an increase in the fraction of this phase, decreasing the fraction of α-Co phase, in comparison with commercial $Co_{64}Cr_{32}Mo_4$ (%at) alloy. The cylinder copper mold cast (CMC) sample of $Co_{64}Cr_{32}Mo_4$ and $Co_{64}Cr_{32}Nb_4$ (%at) alloys showed an average Vickers microhardness of 508 ± 30 and 375 ± 16 HV, respectively, decreasing 26% de hardness of alloy with Mo substitution by Nb. Due to rapid solidification imposed during copper mold casting, both $Co_{64}Cr_{32}Mo_4$ and $Co_{64}Cr_{32}Nb_4$ (%at) alloys showed dendritic microstructure. On the other hand, the addition of boron (B) to $Co_{64}Cr_{32}Mo_4$ (%at) alloy in different contents: $(Co_{64}Cr_{32}Mo_4)_{100-x}B_x$ (x= 20, 25 and 30at%B) alloys lead to significant changes in the phases formed and the microstructure of solid solution Co-Cr-Mo alloy. For the $(Co_{62}Cr_{34}Mo_4)_{80}B_{20}$(%at) alloy, the slowly cooled sample (arc-melt ingot) showed precipitates of Co_3B intermetallic phase dispersed in a matrix of mostly ε-Co and some fraction of α-Co phase. Copper mold cast $(Co_{62}Cr_{34}Mo_4)_{80}B_{20}$(%at) sample in cylinders of Ø = 2 and 4 mm in diameter showed a very refined microstructure of borides Co_3B dispersed in a matrix of mostly ε-Co phase. For $(Co_{62}Cr_{34}Mo_4)_{75}B_{25}$(%at) alloy, the equilibrium microstructure showed hipereutectic constituent α-Co + Co_3B besides precipitation of Co_2B intermetallic dispersed in a remaining ε-Co matrix, for slowly cooled sample (arc-melt ingot). When rapid solidified through CMC, the $(Co_{62}Cr_{34}Mo_4)_{75}B_{25}$(%at) alloy showed a metastable microstructured with mainly borides Co_2B dispersed in a matrix of α-Co phase. For higher addition of 30at%B, in the $(Co_{62}Cr_{34}Mo_4)_{70}B_{30}$(%at) alloy the arc-melt ingot showed boride Co_2B nucleated inside bigger Co_3B precipitates dispersed in a matrix of α-Co phase. CMC samples showed very refined Co_3B precipitates dispersed in a α-Co matrix. The cylinder CMC samples of $(Co_{64}Cr_{32}Mo_4)_{100-x}B_x$ alloys showed maximum Vickers microhardness of 1146 ± 38 (x = 20at%B) and 1170 ± 49 (x = 25at%B) and 1374 ± 84 HV (x = 30at%B).

[1] Cook SD, Weinstein AM, Sander TA, Klawitter JJ., Retention characteristics of porous rooted Co-Cr-Mo alloy dental implants, Biomat Med Devices Artif Organs. **10** (1982) 123-46