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A NOVEL BIO-HEA BASED ON TiZrNbTaMn FOR POTENTIAL USE AS ORTHOPEDICAL IMPLANTS

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SUMMARY

High entropy alloy (HEA) is a recent engineered material that combines five or more alloy elements in a proportion closer to equiatomic (CASTRO; JAEGER; BAPTISTA; OLIVEIRA, 2021). As a result of the hard solution hardening and the cocktail effect, these alloys generally exhibit superior mechanical strength, ductility, corrosion, and wear resistance than the conventional metallic materials (CHEN; SUPRIANTO, 2020). Recent studies have investigated the potential use of HEAs in biomedical applications, especially for orthopedic implants, which require high mechanical strength and low elastic modulus. However, biomedical implants interact constantly with tissues and cells in the human body, so it is compulsory to obtain Bio-HEAs with a set of specific properties. This study aims to design, process, and characterize a novel Bio-HEA composed of non-toxic elements (Ti, Nb, Zr, Ta, and Mn) for possible application as biomedical implants. In this study, TiNbZrTaMn and TiNbZrTaMo alloys were produced in non-equiatomic proportions, following some ab initio design predictions. The samples were cast by argon arc-melting and subjected to a heat treatment for microstructural homogenization at a vacuum of 10^{-7} Torr, 1273 K, for 720 minutes with slow cooling. The samples were characterized by density, EDS, XRD, optical microscopy, SEM, TEM, elastic modulus, Vickers microhardness, cytotoxicity test, wettability, and corrosion experiments. The chemical characterizations indicated a good quality of the samples and slightly higher densities (around 9 g/cm^3) compared to other commercial materials. The structural characterization indicated the majority of BCC crystalline structure, as predicted by the ab initio design parameters. The microstructural

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characterization showed the formation of irregular structures composed of grain boundaries, characteristic of the BCC crystalline structure, and acicular structures, characteristic of the HCP and orthorhombic phases. The obtained Bio-HEAs showed low elastic modulus (around 80 GPa) and high Vickers microhardness (around 500 HV) compared to other commercial materials. The electrochemical and MTT tests indicated an excellent cell adhesion and cell viability of the alloys, a hydrophilic surface favorable to the cells, and good corrosion resistance. The TiNbZrTaMn sample presented a better combination of mechanical, electrochemical, and biological properties, showing great potential for use as a biomaterial, especially in the orthopedical region. (Financial support: CNPq and FAPESP)

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