Design of a novel Bio-HEA based on TiZrNbTaMn for potential use as orthopedical implants

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In the last years, high entropy alloys (HEAs) have been developed for many applications and recognized for their superior strength, ductility, and corrosion resistance, which has attracted attention by the biomedical industry. Thus, the current research effort is looking for the development of Bio-HEAs with properties compatible with use as implantable materials [1]. This project 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 alloys were cast by arc-melting and subjected to a heat treatment for microstructural homogenization. Then, thermal aging treatments were performed at 300 ºC, 400 ºC, and 500 ºC for 6 hours. The samples were characterized by density, EDS, chemical mapping, XRD, optical and scanning electron microscopy, elastic modulus and Vickers hardness measurements, and cytotoxicity test. The chemical characterizations indicated a good quality of the samples, and the structural characterization indicated the majority of BCC crystalline structure, as predicted by the *ab initio* design parameters. The microstructural characterization showed the formation of dendritic structures for the TiNbZrTaMo alloy. In the TiNbZrTaMn alloy, the microstructure was composed of grain boundaries, characteristic of the BCC crystalline structure. The samples produced showed a low elastic modulus (around 80 GPa) and good biocompatibility in relation to some commercial biomaterials. The TiNbZrTaMn sample presented the lowest elastic modulus, showing great potential for use as a biomaterial, in special in the orthopedical region, where the low Young's modulus can attenuate the stress shielding effect.

Acknowledgments: CNPq and FAPESP

References:

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