ABSTRACT

The work aimed to design the properties of titanium alloys with β and pseudo β structures containing molybdenum (Ti-Mo). The effect of molybdenum content was investigated (10-35 at. %) on phase transformations and mechanical properties of alloys obtained in the processes of mechanical synthesis and powder metallurgy (both cold and hot approach). On the other hand, a comparative analysis of the structure and properties of Ti23Mo alloys was carried out depending on the processing method. Proposed procedures of surface treatment led to the formation of apatite layers on selected alloys. Fluorapatite was deposited on the oxidized surface (MAO) of the Ti23Mo alloy by the application electrophoretic deposition method. After hydrothermal treatment of Ti31Mo alloy, the surface layer mostly consists of the $Ca_{10}(PO_4)_6(OH)_2$ with $CaHPO_4 \cdot 2H_2O$. The Ti31Mo alloy was also modified by introducing hydroxyapatite and selected antibacterial additives.

For the processed biomaterials was followed analysis of: structure by an X-ray diffractometer, microstructure by optical microscopy, scanning or transmission electron microscope, corrosion resistance in Ringer's solution by a potentiostat, wettability angles by droplet deposition, and mechanical properties (Young's modulus, hardness). The antibacterial activity of composites against *Staphylococcus aureus* was studied. The in vitro cytocompatibility of synthesized materials was also assayed for osteoblasts and fibroblasts.

Molybdenum as a Ti (β) phase stabilizer allowed to obtain single-phase alloys by applicated the hot pressing process or pseudo-β alloys by the cold pressing and sintering process. The application of the mechanical synthesis process leads to nano-scale size object formation. The lowest Young's modulus was obtained for composites with low porosity (95 GPa, 4%) or alloys with high porosity (Ti31Mo 55 GPa, 29%). The modification of the surface layer caused improvement of the corrosion resistance of the alloys and the wettability of the surface, thus improving the proliferation of bone cells. The viability of osteoblasts and fibroblasts was higher or similar for composites compared to microcrystalline titanium. Moreover, for biomaterials containing silver or cerium (IV) oxide, the reduction factor for *S. aureus* bacteria was over 97%.

The obtained ultrafine grain biomaterials have better properties than microcrystalline titanium, which causes their potential use as medical implants. Produced composites containing Ti-based alloys and bioceramic and antibacterial additives as a reinforced and surface modification of alloys resulted in the reduction of Young's modulus, improved corrosion resistance, and biocompatibility.