Description for the general public

The aging of modern societies is a challenge for the field of implantology. Despite the continuous development of biomaterials and methods of their production, there is still the problem of implant loosening and damage, as well as post-operation infections. These problems result from poor connection of the implant with the bone tissue and bacteria adhesion to the biomaterial surface. **The objective** of the project is to enhance biological properties of new generation titanium alloys with β structure. The improvement is going to be achieved by manufacturing of oxide nanotubular structure on their surface. The presence of an oxide layer, in particular with a developed surface, improves the biocompatibility and osteointegration processes within the implant-bone interface. The main advantage of the investigated Ti alloys with β structure is the reduced Young's modulus as well as the fact that they contain only vital elements with low toxicity. Therefore, they show great potential for applications in many fields of medicine, including the orthopaedics and dentistry. Although the topic of nanotubular layers on pure titanium has been quite well recognized, surface modifications in the form of nanotubes on titanium alloys still remains a technological and scientific challenge. The few publications concerning this subject indicate several problems associated with anodization of titanium alloys. The alloying elements can act as electrochemical microcells causing changes in the rate of layer dissolution and affecting the formation of layers with inhomogeneous thickness. Different crystallographic orientation of grains (in particular of different phases in two-phase alloys) may determine the direction of growth of the nanotubes and lead to the formation of layers with disordered structure.

In the project, an attempt to solve the problems occurred during the fabrication process of nanotubular oxide layers on titanium alloys will be made. For this purpose, the project will be implemented within three tasks with the following **specific objectives**:

- selection of fabrication parameters of nanotubular oxide layers on new generation titanium alloys with sinle- and two-phase structure;
- detailed characterization of the morphology and physicochemical properties of the obtained oxide layers;
- assessment of the biological potential of nanotubular layers on the investigated titanium alloys.

Surface modifications in the form of nanotubular oxide layers will be performed on two titanium alloys: (1) β -phase Ti-24Nb-4Zr-8Sn and (2) two-phase α + β Ti-13Nb-13Zr. These alloys show a significantly reduced Young's modulus in comparison to other metallic biomaterials, which is equal to 49 and 79 GPa, respectively, and it is close to the bone modulus (10-40 GPa). The electrochemical anodization process using electrolytes based on organic solvents such as glycerol and ethylene glycol will be used to create nanotubular structures. The following process parameters will be optimized: voltage applied, anodization time and annealing temperature of layer. In the next stage of the project, characterization of morphology and physicochemical properties of the formed layers will be performed. For this purpose, scanning electron microscopy (SEM), X-ray microanalysis (EDX), X-ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES) and X-ray diffraction (XRD) will be applied. The correlation between the morphology of the layer and the substrate microstructure will be determined by a combination of research techniques such as metallography, SEM observations and the electron backscattered diffraction (EBSD) method. Finally, the assessment of the biological potential of nanotubular layers will be conducted including: (1) a contact angle measurement; (2) an incubation of the layers in a SBF solution imitating human body fluids with subsequent evaluation of the degree of mineralization through SEM/FTIR/XPS analysis; (3) cell adhesion, proliferation and cytotoxicity test using osteoblast cells.