Along with the development of civilization, a significant prolongation of life occurred. At the same time, we became exposed to the increasing number of civilization illnesses, especially those related to elderly age. On of such diseases is osteoporosis, an illness attributed to the bone density loss which results in an increased susceptibility to fractures. As a consequence, a need for bone implantations significantly increased. Naturally, the need for new, multifunctional prosthetic materials and methods for their synthesis also emerged.

Among different techniques for synthesis of implantable materials, one with the increasing interest are methods related to the nanotechnology, such as anodic oxidation (anodization). Similarly, rapidly developing 3D printing is becoming more and more used. What is more, by combining both approaches it may be possible to create a material that will possess desired mechanical properties (similar to those for bone) and have appropriate porosity, shape or even color. It is extremely important especially when regenerative or reconstruction medicines are being concerned. A possibility to synthesize personalized implant will give an opportunity for faster and more effective treatment of fractures or reconstruction of significant bone losses. Moreover, due to the incorporation of such materials with, e.g., drug molecules, which will inhibit bacterial infections, the healing process and patient's convalescence will take much less time.

Therefore, the project hypothesis says that by combining computer modeling, 3D printing and anodization methods it is possible to synthesize multifunctional three-dimensional titanium-based materials with complex micro and nanoporosity that will have desired properties. Authors of this project suggest that such materials will have an ability to enhance osseointegration and at the same time, due to the incorporation of e.g., antibiotics, suppress bacterial adhesion to the implant surface. Therefore, proposed within this project materials, seems to be an interesting alternative for the conventionally used implants.

Computer modeling methods will be applied in order to predict the porous structure and mechanical properties of titanium scaffolds. Such three-dimensional models will be then printed using a selective laser melting (SLM) method. Subsequently, synthesized titanium scaffolds will be used for the anodization process in order to receive nanostructural titanium oxide layers on Ti. Then, as-received structures will be functionalized by the deposition of silver and/or zinc oxide nanoparticles that are known for their antibacterial properties. Moreover, drug release test from the synthesized 3D porous scaffolds will be performed. Two model pharmaceuticals will be used for the determination of release kinetics. The microbiological tests will be applied for the assessment of antibacterial properties of the selected samples. Finally, bioactivity and biocompatibility of the synthesized structures will be examined.

The results obtained within this project will give an upright description of novel three-dimensional and multifunctional biomaterials based on titanium. Furthermore, the evaluation of their applicability will be possible, which may have a significant impact on the development of different fields of science and medicine.