Statistical data related to the average lifetime and society aging, clearly indicate the necessity to continue scientific works in the area of materials devoted to implants (including dental implants) in order to broaden spectrum of their applications and to improve patients comfort. Functional properties of metallic implants could be enhanced by the proper designing of their chemical composition, microstructure and by the application of surface treatments. This project offers a complex approach to tailor the properties of Ti-based biomaterials, that includes all of the mentioned paths. The factor, which limits the application area of biocompatible materials such as commercially pure titanium and Ti-13Nb-13Zr alloy, is their low mechanical strength, which is not sufficient in case of load-bearing implants. Mechanical properties of the metallic biomaterials are strongly governed by the number of grain boundaries and dislocation density. Application of the large plastic deformation is an effective approach to increase the content of both microstructure components, which consequently enable to obtain ultrafine grained or nanocrystalline materials with superior mechanical strength. In this project, this approach will be exploited to create a new class of Ti-based biomaterials, which surfaces will be subjected to further modifications in order enhance their bioactivity.

Thereby, **the main aim of this project** is to design a hybrid surface functionalization treatment of modern Ti-based biomaterials for dental implantology. Two, ultrafine grained/nanostructured materials with enhanced mechanical strength and differential phase composition have been selected to experiments: commercially pure α Ti and near β Ti-13Nb-13Zr alloy which contains biocompatible alloying elements and demonstrates lower elastic modulus than other metallic biomaterials. Owing to their greater mechanical strength, compared to the standard biomedical microcrystalline commercially pure Ti, new Ti-based materials fabricated within this project could be used for the implants with reduced dimensions. This makes the surgery procedure more bearable and allows to its conducting in case of patients for whom application of the standard implants is difficult or even not possible. Success of implantation is governed not only by appropriate mechanical properties, but also by morphology, chemical composition and physicochemical properties of biomaterial surface. Specific biological responses could be governed by strong mechanical interlocking and chemical bonding between implant material and adjacent bone. Mechanical interlocking could be improved by creating specific surface topography while chemical bonding is altered by the presence of bioactive species on the surface. Thereby, in order to affect both characteristics, in this project a novel, hybrid surface functionalization treatment on bulk UFG/nanostructured materials is proposed which includes following steps: (i) surface modification by the mechanical, chemical and laser treatments or their combinations, (ii) designing and fabricating bioactive coatings on the previously modified surfaces.

Our latest investigations demonstrated that nanostructure influences not only the mechanical properties but also the surface physicochemical properties by increasing reactivity and changing topography of the biomaterial. In this project following aspects will be analyzed: (i) How defects introduced during large plastic deformation and crystallographic texture affect the results of particular steps of surface functionalization? (ii) What surface features (e.g. topography/chemical composition/wettability) influences the adhesion of the bioactive coatings? In order to find answers on the questions arises, detailed analysis of microstructure, crystallographic texture, mechanical properties and physicochemical surface properties will be carried out for commercially pure Ti and Ti-13Nb-13Zr fabricated using large plastic deformation methods. Then, ultrafine grained or nanocrystalline materials will be subjected to selected combinations of treatments in order to develop surfaces with differential topography and wettability. The next step will be related to the conduct electrophoretic deposition (EPD) process in order to create bioactive coatings on the modified surfaces of ultrafine grained/nanostructured materials. EPD coatings will be characterized in terms of their morphology, quality and continuity of the connection with metallic substrates as well as in terms of their bioactivity and stability in the solution which simulates the conditions as can be found in the human body. The complex approach to design the hybrid surface functionalization method of deformed bulk substrates will broaden the knowledge in the area of fundamental research and may contribute to understand the complex relationship between the microstructure, surface features and final characteristic of bioactive EPD coatings. The project will contribute to the creation of new class of implants made from nano-biometals with bioactive coatings obtained using hybrid surface treatments.