Degenerative diseases of hip and knee joints have been ranked at the 11th place of the most frequent health disabilities observed worldwide. In case of patients who experience chronic pain and severe limitation of their mobility, Total Hip Arthroplasty (THA) gives a chance to significantly improve the quality of their life. Modern hip implant replacements demonstrate modular construction that is composed of femoral stem with tapered neck joint that connects to a femoral head. Such modularity is beneficial in case of the necessity of revision surgery, and allows to use different materials for particular parts of the implants. Currently, titanium (α+β) phase Ti-6Al-4V alloy is commonly used for the femoral stems, which are expected to be well-fixed with the femoral bone. Selection of Ti-6Al-4V alloy is related to its unique combination of sufficient mechanical strength, relatively low elastic modulus, and ability to osseointegration. However, alloying elements in Ti-6Al-4V (Al, V) are claimed to be potentially toxic to human health. Aluminum ions are believed to induce the neurological disorders. Moreover, released Al ions demonstrate a strong tendency to bind with proteins adsorbed on the metallic surfaces, possibly leading to Ti-6Al-4V corrosion in the long-term. Vanadium ions are known to be cytotoxic and carcinogenic. Corrosion and wear are believed as one of the reason of implants' rejection, and the possibility of releasing harmful V and Al ions in the realistic wear-corrosion conditions, contributed to the development of a new generation of titanium-based materials, that contain only biocompatible chemical elements, such as metastable β phase alloys. First modular hip implants with stems made from metastable β phase alloy demonstrated insufficient wear resistance in the physiological fluids which was explained by its very low ductility. **This projects offers the solution to this problem** by exploiting a new group of metastable beta-phase titanium alloys created based on Ti-Mo system, that offers a unique set of features derived from the activation of additional deformation mechanisms. Alloys will demonstrate the desirable combination of high mechanical strength and ductility. **The general objective** of this project is to fabricate a new metastable titanium β phase alloys based on Ti-Mo system which are capable of the complex conditions as can be found at the metallic interfaces of modular total hip replacements. First stage of this project will be related to fabrication of the alloys and selecting those that offer the best combination of mechanical properties (mechanical strength/ductility/work hardening rate) and corrosion resistance in the clinically relevant conditions (including the presence of proteins, and reactive oxygen species: ROS, that are produced during post-operative inflammation). This will be done by tailoring the chemical composition of the alloys from Ti-Mo system and by designing appropriate heat treatments. The next step will be to verify the wear resistance of selected alloys in the solutions containing ROS and proteins, and to compare results with those obtained for the less biocompatible Ti-6Al-4V. Proposed methodology will enable to understand degradation process of fabricated alloys in the initial post-operative period, which is essential in terms of success of the implantation. However, ROS that are aggressive to titanium materials, could be generated also in further lifespan of implant, e.g. in case of exposure to irradiation during patient's radiotherapy. Particularly hip implants, could be exposed to the irradiation during the radiotherapy of prostate cancer. Thereby, alloys devoted to wear tests in corrosive solutions will be subjected to irradiation procedures, in order to simulate and understand the effect of potential radiotherapy on the degradation of previously inserted implants. This part is particularly innovative, and there is a lack of literature data related to this aspect.

This project will give a fundamental knowledge and numerical description of the influence of particular processes involved in the degradation of fabricated alloys in the complex wear-corrosion conditions that are clinically relevant in case of hip replacements. **Expected result of this project** is to fabricate the metastable beta-phase alloy that offers wear-corrosion characteristics similar to Ti-6Al-4V alloy, that is currently used for femoral stems, but at the same time is neutral to the patient`s health. **Although the project is focused mainly on broadening the knowledge related to the degradation phenomena of biomaterials**, obtained results could open an avenue for designing a new generation of the biocompatible metastable beta-phase Ti alloys with enhanced wear resistance in the peri-implant conditions, that could increase safety and longevity of hip replacements.