Severe plastic deformation (SPD) methods are an effective way to fabricate bulk, nanocrystalline titanium. The associate grain refinement and increase in dislocations density provide an intensive strengthening effect that results in a mechanical strength similar to that of titanium alloys. Nanocrystalline, commercially pure (cp) titanium is a more biocompatible alternative in biomedical applications than the Ti6Al4V commonly in use. The possibility of fabricating relatively large products is favourable in terms of nanocrystalline titanium development. Nowadays, much attention is devoted to providing a good balance of mechanical properties, including ductility, in the strengthened state, since this is crucial for potential applications.

Among the few ways available to enhance the ductility of nanomaterials, only one approach can be applied for one-phase nanocrystalline cp-Ti: low-temperature annealing, which increases ductility without any significant loss of strength. An increase in ductility is associated with a decrease in dislocation density, and thereby with an increase in the ability of the material to undergo strain hardening. However, it should be noted that the strength of the nanotitanium also increases after annealing. This abnormal effect, known as "hardening by annealing", is the subject of the present analysis, which has to be extended to other functional properties of nanostructured Ti. **The overall objective** of the project is to provide insight into the microstructural factors affecting the mechanical and functional (corrosion resistance, biocompatibility) properties of nanocrystalline cp-Ti after low-temperature annealing.

The hypothesis of this project is as follows: the nanostructure changes induced by low-temperature annealing result not only in a significant improvement in the mechanical properties of nanocrystalline cp-Ti (a simultaneous increase in both hardness/strength and ductility), but also in an enhancement of its corrosion resistance and biocompatibility.

In order to prove this hypothesis, samples of nanocrystalline hexagonal Ti with a different interstitial elements content (Ti 99.99, Ti Grade 2, Ti Grade 4) will be fabricated. Grain refinement will be obtained by the multiple-pass cold rolling process. It will be analysed whether the purity of titanium has an impact on the effectiveness of the above-mentioned method of deformation in terms of obtaining nanostructure. Fabricated samples will be subjected to low-temperature annealing within the temperature range of nanostructure stability. The heat treatment parameters will be selected based on DSC and hardness measurements. The influence of annealing on nanostructure evolution, including grain size, crystallographic texture, dislocation density and grain boundaries misorientation, will be also performed. This study will make it to determine the impact of titanium purity on the intensity of the "hardening by annealing" effect. In the next step, the influence of annealing on the following titanium properties: mechanical (yield strength, ultimate tensile strength, elongation), corrosion resistance (in simulated body fluid SBF and artificial saliva with fluoride ions), biocompatibility (protein adsorption, cell adhesion) will be evaluated. The research planned also includes studying the complex characteristics of those physicochemical surface properties that are essential in terms of corrosion behaviour and biocompatibility. The oxide layer structure (thickness, chemical/phase composition, surface topography) will be determined before and after low-temperature annealing. The experimental research will be supported by *ab initio* modelling, which will provide information about the atomic scale mechanisms related to the interaction of interstitial elements and dislocations.

The proposed project is of high scientific importance and concerns the latest trends in materials science in the field of nano- and biomaterials. Clinical tests of nanocrystalline titanium applications in dental implantology are advanced and currently under way. The larger strength of nanotitanium makes it possible to fabricate implants having a smaller radius, thereby minimizing the medical intrusion. An interdisciplinary and complex analysis of the effect of low-temperature annealing on the properties of nanocrystalline titanium will broaden knowledge in the area of fundamental research and may contribute to the design of new materials for bone implants that are optimal in terms of the technological process involved and the required properties. Low-temperature annealing, which is relatively cheap, can be used on the industrial scale as a post-deformation treatment in the case of nanocrystalline titanium obtained using severe or large plastic deformation. The theoretical research planned will have a significant impact on our understanding of the differences resulting from a rearrangement of dislocation structure during the low-temperature annealing of nanocrystalline titanium of different interstitial content.