Cardiovascular diseases are the most common cause of sudden deaths and chronic diseases. This problem has urged scientists to search for methods of treating these types of medical conditions in order to facilitate operating techniques and simplify complex cardiac surgery, such as bypass grafting. This has been made possible to a large extent thanks to the use of stents, which were introduced into reconstructive medicine in the late 70s of the last century. However, new material solutions, ensuring biocompatibility, and, above all, in the case of metal materials, reduction of blood clotting and elimination of the migration of the metals elements used in cardiac surgery materials into surroundings cells (i.e. the metallosis effect), are still being researched. These substances include stainless steels, titanium and its alloys, CoCrMo alloys, and recently NiTi alloy. Precisely because of their specific properties, such as: shape memory, superelasticity, plasticity, NiTi shape memory alloys are the subject of intense research in their application in cardiac implants such as expandable stents, heart valve rings or implants for patching arterial septal defects. The demand for cardiac implants, including stents, is enormous, for example in the U.S.A. alone in the year 2000, 1750 thousands stent implantations were carried out, which are introduced into the body using the relatively simple operational technique of angioplasty. The selection of materials, their biocompatibility and, above all, the elimination of the metallosis effect, currently represent a key issue, which is resolved among others by producing a variety of surface layers. The aim of the project is to develop the conditions for manufacturing the following layer types in NiTi shape memory alloy:

- titanium oxide TiO_2 (rutile) - the most thermodynamically stable titanium oxide,

and composite layers such as:

- titanium oxide (TiO_2) with an outer zone of an amorphous nitrogen-modified hydrogenated carbon (a-CNH) coating and
- titanium nitride (TiN) with a titanium oxide (TiO_2) interlayer and an a-CNH outer layer.

Such layers can be produced on complexly-shaped parts by means of the RFCVD process (production of a-CNH layers) and the innovative processes of nitriding, oxynitriding and oxidation in low-temperature plasma developed at the Faculty of Material Engineering of the Warsaw University of Technology as applied with regard to titanium and its alloys. They are the subject of our patents and patent applications (patent No. PL218575-B1, EU patent application No. EP2526977-A2, P. 403159 and PL393047-A1, EP2526976-A2). The research concept aims to demonstrate that the proposed innovative solutions will make it possible for the application of NiTi alloys on cardiac implants thus extending their life by increasing their corrosion resistance, modifying selected biological characteristics, eliminating the metallosis effect by creating new high-adhesion surface layers and achieving a defined surface nanotopography (topography), which in turn determines the wettability and surface energy of the layers. The surface layers will be of a homogeneous structure and will be applied onto complexly-shaped specimens, mainly cardiac implants. The thickness of the layers will be up to 150 nm, and they will be applied at temperatures of ≤ 300°C ensuring, as has been proven by our previous research, that the specific properties of the shape-memory alloy will not be jeopardised. In order to develop the conditions for producing the layers, the following of their characteristics will have to be defined: their microstructure, chemical and phase composition, surface nanotopography, wettability, surface energy, corrosion resistance, adhesion, blood platelet adhesion and aggregation. The research is of a fundamental nature, as both the proposed methods of producing the layers and the phase composition of the composite layers are innovative. The outcomes of the project will be the basis for the development of a new generation of cardiac implants made of shape-memory alloys. The results obtained will also help to extend the applicability of NiTi alloys by broadening their functional properties.