Cardiovascular diseases are one of the most common causes of death in developed societies. In many cases, people with late or extensive myocardial dysfunction as cardiomyopathy are not eligible for transplantation. For this group of patients the only solution is the supporting system of heart by application of artificial assist devices. Poland is one of the leaders among countries dealing with this type of issue in the cardiac surgery intervention. The development of support systems is essential and especially targeted for patients with the late heart failure. Under the project "Polish Artificial Heart" a family of prosthetic hearts have been developed. These solutions are currently in clinical and preclinical usage. The resulting chambers are dedicated also for children and implemented the latest global solutions to Polish clinics. It is a big progress, however never artificial elements will be as perfect as a natural tissue. The added value of the Programme Polish Artificial Heart has been generation of new projects related to the development of sciences both basic and applied. New material solutions are dedicated to continuously improving the quality of support chambers. Without a deep scientific knowledge the progress in this area is not possible. The current project concerns the development of basic science dedicated to this very important issue. The project is intended to develop scientific material surfaces, which enable integration with tissue. The project focuses attention on integration with the cardiac tissue and integration with a specific form of connective tissue like blood. Surface modification for both issues based on the same process of laser evaporation of part of the biocompatible layer, creating a suitable environment for a particular tissue. For myocardium integration, the metal surface will be refined by bio-hemocompatybility coatings. Such surfaces will be the starting point for further modification in the form of channels. Channeled surfaces will determine a controlled cell migration and proliferation. Interaction of endothelial cells with the material is highly dependent on the surface characteristics such as: topography, microstructure or mechanical properties. A controlled cellular response will be achieved by modifying the surface, which will consist of creating patterns in the form of wells or channels of different dimensions using the technique of the laser interference lithography. This technique determines a high resolution shape, size and distribution patterns. As a result, it is possible to control cell in the scale corresponding to biological processes. The surface periodization ensures optimal flow of oxygen and nutrients within a biomaterial which is a key importance for processes of adhesion and proliferation of cells. The project attempt will be made to produce these surfaces network of normal blood vessels. Stimulation of new blood vessel formation will be performed by additional modification, consisting in depositing of the finishing resorbable synthetic coatings having a function of the medicament carrier. By means of such a modification, factors stimulating the growth of blood vessels will be introduced. This solution has its premise in the construction of cardiac support pump, in particular a centrifugal pump, which has been developed at the "Laboratory of Artificial Heart" the Foundation for Cardiac Surgery Development. After consulting with the laboratory team there is a need the scientific development of the outer surface of the guide cannula, which improve the connection cardiac tissue in the apex (the lower part of the heart from the left ventricle) metallic element.

In the case of surface adsorbing protein, there is a need to improve hemodynamic conditions on the impeller centrifugal pump. Thus, more scientific issue is an adequate surface modification allowing the controlled adsorption of release protein from the whole blood in flow conditions. Biomaterials intended for direct contact with blood should exhibit high hemocompatibility of surface defined as the ability not to elicit an immune response and activate the coagulation cascade. The natural method of inhibiting the coagulation of blood is based on the protein layer that separates the surface from the blood environment. Therefore, the control of selective adsorption of blood proteins to the surface is a key issue in designing a hemocompatible material. The planned in the project surface modification of the titanium alloy by applying ultra-thin carbon coatings improves properties of biocompatible metallic substrates. Structuring the surface will ensure a controlled, selective adsorption of proteins.

Both issues raised by the project belong to basic sciences, however bear evidence later use in the important area of science which is the cardiac surgery.

The planned research work will expand scientific knowledge in the field of biomedical engineering and material knowledge. The proposed research activities are comprehensive interdisciplinary studies using experimental methods drawn from clinical solutions. By combining these techniques of the materials science and laboratory diagnostics project will enable the presentation of the impact of surface topography and microstructure to tissue-metal integration and adsorption of proteins to surface under high shear stress induced by blood flow.