



## **Forum Inżynierii Materiałowej**

### **Materials Engineering Forum**

- **The Materials Engineering and Metallurgy Committee of the Polish Academy of Sciences**
- **Polish Materials Science Society**

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## **Material engineering in regenerative cardiac surgery; "yesterday and today"**

**Roman Major**

**INSTITUTE OF METALLURGY AND MATERIALS SCIENCE, POLISH ACADEMY OF SCIENCES, REYMONTA ST.25, CRACOW, POLAND**

**R.MAJOR@IMIM.PL**

The first issue currently being developed is the topic of biological valves. It is a continuation of the idea proposed by Professor Zbigniew Religa, according to which based on the natural material of the extracellular matrix, bioactive valve prostheses are created. The valve scaffold is an acellular, xenogeneous or allogeneous tissue on which autologous cells are anodized in vitro or in vivo. Such a valve should have a potential for growth, self-repair and remodeling, similar to native tissue. A bioprosthesis of this kind should significantly bypass the limitations of commercial valve prostheses. The second issue, which is currently being implemented by the consortium partners in an international (Polish-Austrian) research and development project, and whose continuation is planned as part of the implementation project, concerns the mechanical valve for use in heart support chambers (Fig. 1).



Fig. 1. Technology readiness level of the heart assist system chamber a.) new valve prototype b.) chamber with implemented chamber

The main objective is to improve the effectiveness of treatment of patients with myocardial insufficiency, using heart support systems, by developing an innovative material solution consisting in the preparation of a composite material for contact with blood, understood as a combination of a metallic frame with a biocompatible layer in a polymer sheath, which will enable redesigning mechanical heart valves in ReligaHeart EXT (clinically applied VAD) and providing solutions for use in a pediatric blood pump (ReligaHeart PED). The results of the project are of great importance in terms of material, technological and biomedical aspects from the point of view of very active research and development work in Poland



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on the regeneration of the cardiovascular system developed within the Polish Cardiac Assist System - ReligaHeart. The commercial benefits will result from the possibility of production by Polish Small and Medium Enterprises (SMEs), which have 30 years of successes on the Eastern European market.

Another issue in the field of cardiac surgery is the development of fully hemocompatible blood pump rotors. The innovative ReligaHeart ROT rotary implantable blood pump was developed in the Foundation for Cardiac Surgery Development, a close associate of the consortium members. The chamber is in the preclinical research phase in patients with advanced myocardial dysfunction. It is a mechanical bearingless pump, equipped with a rotor suspended magnetically and hydraulically, which provides a flow of up to 10 l/min at 30-45% capacity. A fully magnetic rotor suspension system, without hydrodynamic bearings, is being developed to reduce shear stress on the blood and protect Von-Willebrand platelets and proteins from damage causing the risk of bleeding. ReligaHeart VASC, is currently under development and is designed for short-term cardiac support in cardiac shock. It has an implantable rotor system with a miniaturized motor and magnetic rotor suspension system.

#### Acknowledgments

Project supported by: The research was financially supported by: the statue work Z-2; Project no. 2016/21/N/ST8/00186 of the National Science Centre Poland; Project no. M-ERA.NET/2014/01/2016 "BioVALVE"