Hydrogel Coatings for Implantable Cardiovascular Devices
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Introduction
The aim of presented research was to develop a method for manufacturing hemocompatible coatings for blood-contacting devices. Application of artificial organs is remarkably limited by biomaterial-associated thrombosis, which involves platelet attachment and activation. These phenomena might lead to fibrin production and clot formation, which are highly unwanted effects – clots can impair the function of the medical device or, in more drastic situation, obstruct patient’s blood vessels, leading to strokes or even death. Thus, there is a need to modify the surface of materials, in order to produce highly hemocompatible layers. We present a method for fabrication of hydrogel coatings for cardiovascular devices. Polyvinylpyrrolidone was chosen as a hydrophilic polymer to produce hydrogel network due to its highly biocompatibility and wide applications in medicine.

Materials and Methods
Polyurethane (ChronoThane P-75A, CardioTech) was used as a base polymer for further modification. Polyvinylpyrrolidone (K90, Fluka) was grafted onto polyurethane surface using simple deep-coating technique. Firstly, polyurethane films were immersed in tetrahydrofuran for 10 minutes. In the second step, the PU films were immersed in water-isopropanol (in the ratio of 3:2) solution containing PVP (5%v/v) and glycerol (0,1%v/v) for 20 minutes. Samples were dried and characterized using Fourier transform infrared spectroscopy (FTIR) and scanning acoustic microscopy (SAM). Contact angle was determined with use of the sessile drop optical method. Swelling ratio of samples was also calculated. Blood-biomaterial interactions were evaluated using platelet analyzer (Impact-R) and flow cytometry. Briefly, a blood sample was applied onto characterized surface and placed in platelet analyzer. Shear stress was applied to simulate arterial flow condition leading to adhesion and aggregation of platelets. Platelets adhered to the surface were stained, observed by confocal microscopy and quantified. Additionally, blood samples from surfaces were collected after shear stress tests and analysed by flow cytometry.

Results
A simple method to fabricate hydrogel coating onto polyurethane surfaces was proposed. Samples coated with hydrogel are super-hydropilic – the average value of contact angle is 13° (Fig.1).

![Fig. 1. Drop of water onto polyurethane surface: a – unmodified PU, b – PU grafted with PVP](image)

SAM analysis of interface between PU and hydrogel layer did not demonstrate any delamination or microcracks. The level of platelet aggregation and adhesion after incubation of PU-PVP copolymer with blood was lower compared to unmodified PU.

Discussion and Conclusions
Polyurethane grafted with polyvinylpyrrolidone seems to be promising material for cardiovascular applications. Materials demonstrate appropriate mechanical and biological properties. It is planned to investigate presented biomaterials as a scaffold for endothelial cells growth during cardiovascular tissue engineering.

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