POLY LACTIC-*CO*-GLYCOLIC ACID (PLGA) AS BIODEGRADABLE LAYER USED IN CARDIOLOGY

AGNIESZKA HYLA, WITOLD WALKE*, WOJCIECH KAJZER, MARCIN BASIAGA, ZBIGNIEW PASZENDA

DEPARTMENT OF BIOMATERIALS AND MEDICAL DEVICES ENGINEERING, FACULTY OF BIOMEDICAL ENGINEERING, POLAND
*E-MAIL: WITOLD.WALKE@POLSL.PL

[ENGINEERING OF BIOMATERIALS 148 (2018) 110]

Introduction

Biocompatible PLGA can be found amongst a few synthetic polymers approved for clinical trials. As a biodegradable material, PLGA is totally reabsorbed in the organism within, depending on the given literature, from three weeks to several months. It is a material with a relatively short degradation time when compared to homopolymers PLA or PGA. Literature also differentiates the content of the respective components of polymers as a factor that modifies final properties of the composite [1]. Due to inherent limitations of co-polymer PLGA resulting from its construction, its various modifications aiming at increasing or decreasing its elasticity or degradation time depending on application are under way. It was found that PLGA, as a material featuring high biocompatibility and optimal degradation time, may also serve as a matrix for medicine or genes application, both independent and in connection with metallic implants [2,3].

Materials and Methods

The aim of the study was to analyze the effect of modifying the surface of metallic biomaterials (AISI 316LVM, L605, cpTi(Grade)) by applying layers of biodegradable poly(d,l – lactide – co - glycolide) 85:15 10% on the electrochemical properties. The surface was modified by the imposition of a single layer of PLGA by dip coating sol-gel method.

Potentiodynamic studies were performed using a potentiostat PGP-201 Radiometer Analytical SAS. As reference electrode a saturated calomel electrode NEK KP-113 was used, and as the auxiliary electrode - platinum PTP-201. To determine the values characterizing the corrosion resistance of tested samples, Stern method was applied. In order to assess the integrity of imposed PLGA layer ion permeability test was carried out after different times of exposure in the artificial plasma. The concentration of ions which permeated the solution was measured using a spectrometer JY 2000 manual Yobin-Yvon.

Measurements were carried out both on samples coated with PLGA and subjected electrochemical polishing process, before and after the 36-day and 72-day incubation in a solution of artificial plasma (pH 7.0 ± 0.2) at T = 37 ± 1°C.

Results and Discussion

Application of the layer of 10% poly(lactic-*co*-glycolic acid) 85:15 onto the surface of AISI 316LVM, L605 and cpTi (Grade4) results in substantial increase of resistance to pitting corrosion of those materials in the environment of artificial plasma simulating human blood. In all cases, a favourable increase of corrosion potential E_{kor} and polarisation resistance Rp was detected, and for steel Cr-Ni-Mo and cobalt alloy also the increase of the area of perfect passivation.

TABLE 1. Results of potentiodynamic test.

Sample	E_{corr}, mV	E_{tr}, mV	Rp, kΩcm^2
0 days exposure in artificial plasma			
316LVM	-166	+1050	293
316LVM (PLGA)	-111	+3100	1320
L605	-326	+870	947
L605 (PLGA)	-270	+1870	4250
cpTi	-235	>+4000	460
cpTi (PLGA)	-182	>+4000	7340
72 days exposure in artificial plasma			
316LVM	-187	+820	114
316LVM (PLGA)	-127	+770	83
L605	-274	+850	289
L605 (PLGA)	-132	+640	255
cpTi	-215	>+4000	393
cpTi (PLGA)	-173	>+4000	253

Ion permeation tests confirmed that the suggested layer of biodegradable polymer PLGA creates a sufficient protective barrier against the impact of artificial plasma, causing at the same time a significant decrease of the number of metallic ions that penetrated the solution, in comparison to the samples that were not covered, which was shown during 72-day exposure to artificial plasma at the temperature T = 37 ± 1°C - tab. 2.

TABLE 2. Density of the mass of ions of metals permeating the solution as the result of 72-day exposure to artificial plasma.

Sample	Elements						
	Fe	Cr	Ni	Mo	Co	W	Ti
	µg/cm^2						
316LVM	0,600	0,333	0,095	0,021	-	-	-
316LVM (PLGA)	0,276	0,138	-	-	-	-	-
L605	-	0,025	0,091	-	1,833	3,002	-
L605 (PLGA)	-	-	-	-	0,321	0,536	-
cpTi	-	-	-	-	-	-	0,933
cpTi (PLGA)	-	-	-	-	-	-	0,362

Conclusions

Based on these results, it was found that the imposition of 85:15 PLGA (10%) layer on the surface of metallic biomaterials improves resistance to pitting corrosion in human blood environment. It was also found that the applied layer non constitutes an adhesive environment for plasma chemical compounds, without exposing the metallic substrate. The proposed PLGA polymer layer effectively reduces the amount of metal ions which leaked into the solution during exposure in the artificial plasma. In conclusion, the study clearly shows that modification of the implants for contact with blood surface by applying a coating of a biodegradable polymer PLGA has a positive effect on their physicochemical and electrochemical properties, thus allowing the safe use in the environment of human blood.

References

[1] A. Frank A et al.: Study of the initial stages of drug release from a degradable matrix of poly(d,l-lactide-co-glycolide), Biomaterials, 25 (2014) 813-821.
[2] R. C. Mundargi et al.: Nano/micro technologies for delivering macromolecular therapeutics using poly(d,l-lactide-co-glycolide) and its derivatives, Journal of Controlled Release, 125 (2008) 193-209.
[3] H. K. Makadia, S. J. Siegel: Poly Lactic-co-Glycolic Acid (PLGA) as Biodegradable Controlled Drug Delivery Carrier, Polymers 3 (2011) 1377-1397.