GELATIN IMMOBILIZATION ON ELECTROSPUN ALIPHATIC POLYESTER FIBERS FOR TISSUE ENGINEERING

Oliwia Jeznach[1], Paweł Sajkiewicz[1], Dorota Kołbuk-Konieczny[1], Tobias Reich[2], Judyta Dulnik[1]

[1] Laboratory of Polymers and Biomaterials, Institute of Fundamental Technological Research, Polish Academy of Sciences, Pawińskiego 5B, 02-106 Warsaw, Poland,

[2] Department of Chemistry, Johannes Gutenberg University Mainz, Fritz-Strassmann-Weg 2,

55128 Mainz, Germany

psajk@ippt.pan.pl

Keywords: surface modification, nanofibers, aminolysis, gelatin

Introduction: Immobilization of cell adhesive proteins on the scaffold surface has become a widely reported method for improving the interaction between scaffold and cells [1]. Immobilization is performed using various methods based on chemical binding or physical interaction between biomolecules and polymer. Benefits, as well as weak points of both ways, are under discussion in the literature [2].

Methodology: In this study, three types of nanofibrous nonwoven material obtained by solution electrospinning - poly(caprolactone) (PCL), poly(L-lactide-co-caprolactone) (PLCL) 70:30, and poly(L-lactide) (PLLA) were subjected to chemical immobilization of gelatin, preceded by aminolysis and glutaraldehyde cross-linking. For a comparison, a method of direct physisorption of gelatin was also applied.

Results: It was shown that the concentration of gelatin on the material's surface depends on free amine groups concentration, being the lowest for zero amine groups concentration, i.e., for physisorption. The physisorption of gelatin is unexpectedly high, most probably as a result of various molecular interactions including ionic and hydrophobic interactions as well as interactions with carboxyl and hydroxyl groups created on the polyester surface by spontaneous hydrolysis in an aqueous medium during gelatin immobilization. However, it is observed that the gelatin layers adsorbed physically are relatively unstable compared to those adsorbed chemically after the

preceding aminolysis. An additional increase of gelatin content above the physisorbed level can be achieved by aminolysis leading to a non-zero surface concentration of amines. It is evident for this kind of immobilization that the sensitivity of gelatin immobilization on amine concentration is higher for PCL than for PLLA and PLCL. The highest level of efficiency of both physical and chemical gelatin immobilization results in the highest content of immobilized gelatin on PCL fibers. XPS analysis confirmed that gelatin concentration is higher for the chemically modified samples. On the basis of XPS results for PCL, the thickness of both physically and chemically immobilized gelatin layers was estimated to be less than 10 nm. For all gelatin-coated samples, complete wettability was observed, and the time of water drop absorption into the nonwoven was correlated with the surface concentration of gelatin.

Immobilization of gelatin, both through physical and chemical interactions, results in improved L929 cell attachment and spreading indicating a positive binding effect of gelatin. In the case of PCL, gradual increase in metabolic activity with gelatin content was observed. For the other two polymers, no clear correlation was observed, however, all nonwovens after modification were biocompatible.

Conclusions: It was shown that chemical immobilization could provide a higher concentration of gelatin on the fiber surface and the coating is more stable than in the case of physisorption. L929 cells imaging and results of metabolic activity tests indicate a positive effect of both physical and chemical modification on cell-scaffold interaction, whose intensity depends on the type of polymer fibers.

This research was funded by the Polish National Science Center (NCN), grant number 2016/23/B/ST8/03409.

References:

1. Richbourg, N. R. et al., J. Tissue Eng. Regen. Med., 13, 1275-1293, (2019).

2. Guo, J. et al., Int. J. Biol. Macromol. 142, 835-845, (2020).