SYNTHESIS OF POLY(L-LACTIC ACID)-HYDROXYAPATITE COMPOSITE AS MATERIAL FOR 3D PRINTING OF BONE TISSUE GROWTH STIMULATING IMPLANTS[1]

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Synthesis of new biodegradable materials is the promising area of reconstructive and regenerative surgery development. The implant made of biodegradable material serves as a temporary scaffold in the process of new tissues growth [1].

Poly(L-lactic acid) (PLLA) is one of the most attractive materials for biodegradable implants fabrication due to its ability to degrade to non-toxic lactic acid monomers [2]. However, the poor mechanical performance restricts applying of PLLA as a material for implants [3]. Implants fabricated from the PLA are not capable to maintain their morphology under the mechanical loads and require additional fixation [4].

In this research, biological mineral hydroxyapatite (HAp) was used to obtain biodegradable PLLA-based composites with enhanced mechanical performance and bioactive properties.

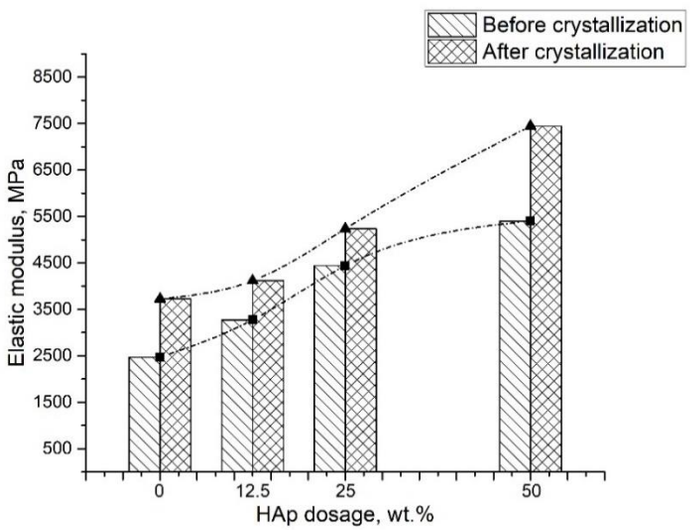

Fig. 1. Elastic modulus of PLLA-HAp composite at different HAp dosages before and after crystallization

Composites were produced from PLLA and biological HAp at different wt.% HAp content (0–50 wt.%). To produce PLLA-HAp filaments, composites were granulated and extruded through 1.75 mm nozzle. In addition, 100% PLLA filament was prepared for printing control samples. PLLA and PLLA-HAp filaments were used to print samples (20 mm in diameter, 2 mm in height) by using FDM 3D printing technology. Samples were divided into two groups, and then samples from one of the groups were crystallized.

The results of mechanical tests show the growth of elastic modulus with an increasing amount of HAp (Fig. 1). The maximum value of 7,4 GPa elastic modulus reached after crystallization of the composite with 50 wt.% filling of HAp. Furthermore, the decrease in the samples deformation during the crystallization was observed with increasing of HAp amount. The deformation decreased from 8.3% to 1.86% with an increase of HAp amount in the polymer matrix from 12,5% to 50%.

REFERENCES

[1] Dietmar W. Hutmacher. Scaffolds in tissue engineering bone and cartilage // Biomaterials. – 2000. – 21. - № . 2529-2543.

[2] Yuval Ramot, Moran Haim-Zada, Abraham J. Domb, Abraham Nyska. Biocompatibility and safety of PLA and its copolymers // Advanced Drug Delivery Reviews. – 2016. – 107. - № . 153-162.

[3] J.M. Chacona, M.A. Caminerob, E. Garcıa-Plazab, P.J. Nunez. Additive manufacturing of PLA structures using fused deposition modelling: effect of process parameters on mechanical properties and their optimal selection // Materials and Design. – 2017. – 124. - № . 143-157.

[4] F.S.Senatovn, K.V.Niaza, M.Yu.Zadorozhnyy, A.V.Maksimkin, S.D.Kaloshkin, Y.Z.Estrin. Mechanical properties and shape memory effect of 3D-printed PLA-based porous scaffolds // Journal of the Mechanical Behavior of Biomedical Materials. – 2016. – 57. - № . 139-148.

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