INFLUENCE OF HYDROXYAPATITE FILLING DEGREE ON MECHANICAL PROPERTIES OF 3D-PRINTED POLY(L-LACTIC ACID)-BASED IMPLANTABLE MATERIAL[1]

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Synthesis of new biodegradable materials is one of the most promising area of reconstructive and regenerative orthopedy development. The implant made of biodegradable material serves as a temporary scaffold in the process of new tissues growth and fully dissolves during osteosynthesis [1]. Poly(L-lactic acid) (PLLA) is highly attractive polymer for biodegradable implants fabrication due to its ability to degrade to non-toxic lactic acid monomers [2]. However, poor mechanical and bioactive properties restrict applying of PLLA as a material for orthopedic implants [3]. In this research biological mineral hydroxyapatite (HAp) was used to obtain biodegradable PLLA-based composite with enhanced mechanical and bioactive properties.

Composites were produced from PLLA and biological HAp at different wt.% HAp content (12.5, 25, 50 wt.%). To produce PLLA-HAp filaments, PLLA pellets were dissolved in chloroform and mixed with HAp powder, then composite mixtures were granulated and extruded through 1.75 mm nozzle. In addition, 100% PLLA filament was prepared for printing control samples. Samples were obtained using FDM 3D-printing technology. Samples were divided into two groups, and then samples from one of the groups were annealed at 110˚C for 12 hours to increase PLLA matrix crystallinity degree.

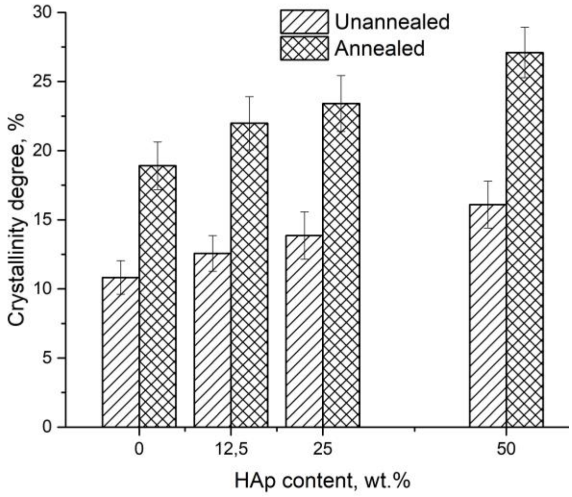

Figure 1. PLLA-matrix crystallinity

According to the XRD data, crystallinity degree was increasing from 10.83 ± 1.21% for pure PLLA to 16 ± 1.69% for composite with 50 wt.% of HAp (Fig.1). After annealing crystallinity increased by 9.51 ± 0.39% at the average for all materials.

Results of mechanical tests show the growth of Young's modulus of composites with an increasing of HAp content (Fig.2). The maximum elastic modulus value of 9.4 ± 0.71 GPa was reached for annealed composite with 50 wt.% content 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%.

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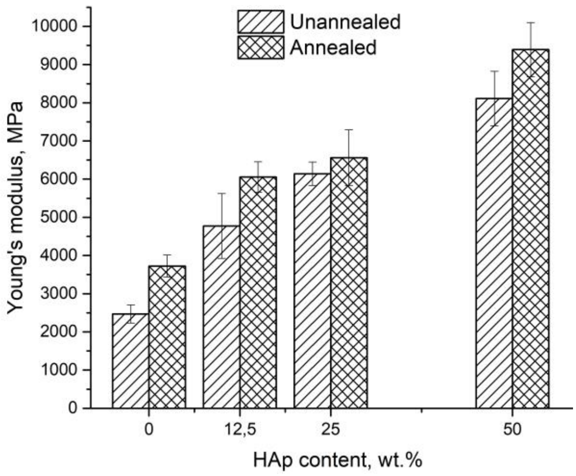

Figure 2. Young's modulus of obtained materials

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