MODIFICATION OF POLY(LACTIC ACID) (PLA) AND POLY(LACTIDE-CO-GLYCOLIDE) (PLGA) FIBRES BY CERAMIC PARTICLES

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Introduction

Fibres are a very interesting research object. Commercially available PLA fibres are obtained by melt spinning [1,2]. PLA and other aliphatic biodegradable polyesters have wide range of advantages - degradation ability (in body and in natural environment conditions), thermoplastic character, polymer solubility and processability by various techniques, making this group of polymers so attractive in medical and technical applications [1,3-5].
The objective of the study was determination of the influence of nano hydroxyapatite (HAp) and nano tricalcium phosphate (β-TCP) on the structure, properties and degradation behaviour of poly(L-lactide-co-D,L-lactide) (PLDLA) and poly(L-lactide-co-glycolide) (PLGA) fibres formed by the wet spinning process.

Materials and Methods

Fibres were made with Resomer LR (PLDLA - 70:30) and LG (PLGA - 82:18), medical grade product from Evonik (Germany). Two ceramic nano additives were used: HAp and β-TCP, a commercial product from Sigma-Aldrich.
Fibres were formed by wet spinning from 18.5% solutions of the PLDLA and PLGA in methylene chloride.
The fibres were drawn in several steps at increasing temperatures. The exact parameters of the coagulation and drawing process are protected by the Polish patent PL 399819 (2014) [6].
Fibres degradation studies were carried out in a simulated *in vitro* conditions at 37°C, in phosphate-buffered saline (PBS) and Ringer solution during 20 weeks.
Experimental part consisted of investigation performed on the fibres before, during and after degradation:

- intrinsic viscosity (Ubbelohde viscometer)
- tensile strength (Instron according to PN-EN ISO 5079:1999)
- microscopic structure (scanning electron microscopic SEM JSM 5400 J and SEM+EDS X-ray microanalyst FEI NOVA nanoSEM 23).

Results and Discussion

Research focused on determination the influence of basic parameters of the forming process on the structure and properties of PLDLA and PLGA fibres modified with ceramic nano particles enabled to obtain fibres with tenacity appropriate for further processing and medical use [7,8] (protected by the Polish patent PL [6]). Tensile strength in the range 140 - 300 MPa allows to use the fibres as a component of a polymer-fibrous composite supporting the bone tissue regeneration process. Ceramic particles introduction into a fibrous structure impacted into a different behavior of both polymers during wet spinning process, which end effect can be observed by tenacity decrease (FIG. 1). During degradation process an influence of ceramic particles has been observed (FIG. 2). Progressive degradation of the fibres material has been noted (TABLE 1).

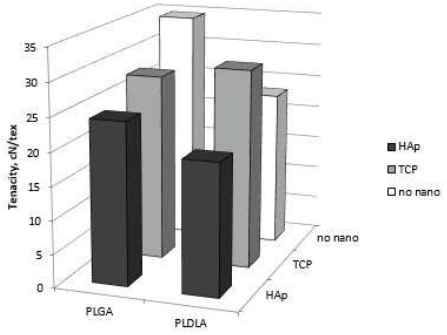

FIG. 1. Tensile strength properties for PLDLA and PLGA fibres.

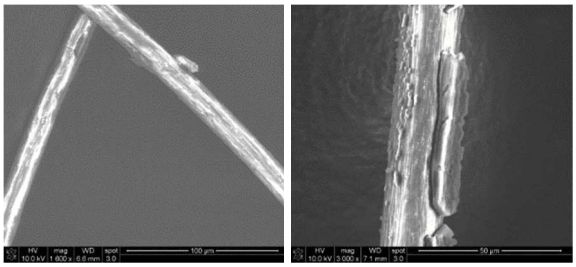

FIG. 2. SEM images of longitudinal view of PLGA fibres with HAp and TCP after 20 weeks in PBS.

TABLE 1. Fibres tenacity, intrinsic viscosity and mass change after 20 weeks of degradation in PBS.

Polymer	Type of nano-additives	Tenacity decrease [%]	Intrinsic viscosity decrease [%]	Mass increase [%]
PLDLA	-	57%	18%	14%
	HAp	60%	19%	15%
	TCP	70%	23%	11%
PLGA	-	75%	52%	8%
	HAp	91%	61%	13%
	TCP	61%	51%	11%

Conclusions

Fibres properties as well as progress and intensity of degradation depend mainly on the presence of HAp or TCP into a fibrous matrix. Their presence effect into a tenacity decrease and acceleration of the degradation.

Acknowledgments

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