THE INFLUENCE OF THE NANOHYDROXYAPATITE AND GELATIN ADDITIVES ON SELECTED PROPERTIES OF PDLG ELECTROSPUN FIBERS

MARCIN GWIAZDA*, EWA KIJEŃSKA, KATARZYNA ZALEWSKA-WIERZBICKA, WOJCIECH SWIESZKOWSKI

FACULTY OF MATERIALS SCIENCE AND ENGINEERING,
WARSAW UNIVERSITY OF TECHNOLOGY, POLAND
*E-MAIL: ST.M.GWIAZDA@GMAIL.COM

[ENGINEERING OF BIOMATERIALS 143 (2017) 39]

Introduction

Electrospinning is one of the most effective methods to obtain homogenous fibers with desired dimensions and properties [1]. This technique allows to utilize the solutions made of natural and synthetic polymers for fibrous meshes fabrication. Native proteins like collagen and gelatin improve the wettability and degradation rates of the synthetic material. On the other hand tricalcium phosphate and hydroxyapatite accelerate the regeneration of the bone by improving osteogenic and mechanical properties of the polymeric fibers [2,3]. M. Mehrasa et al. confirmed the influence of the gelatin PLGA and increase of their hydrophilicity [5]. In presented study investigation of the impact of the gelatin and nanohydroxyapatite addition on the improvement of the morphology and selected physical properties of the fibrous meshes was carried out in order to increase the biocompatibility of the PDLG electrospun fibers.

Materials and Methods

D,L-poly(lactic-co-glycolic acid) (PDLG) with 50:50 lactide to glycolide ratio was purchased from Corbion Purac, Netherlands. The solvent, 1,1,1,3,3,3-hexafluoro-2-propanol (HFP) was obtained from Fluorochem, UK. Nanohydroxyapatite and Gelatin (G) type A from porcine skin were obtained from Sigma-Aldrich. Electrospun solution was prepared by dissolving PDLG (PD) in HFP with 10% (w/v) concentration. The mixture was stirred vigorously for 24h. Nanohydroxyapatite (H) was added to the polymer solution with the weight ratios of PD to H of 95:5, 90:10 and 85:15, respectively. Gelatin was used initially in two concentrations within the solutions, with ratios of PD to G of 90:10 and 93:7. However, preliminary trials of electrospinning of mentioned solutions demonstrated the applicability for further experiments only the solutions with PD to G ratio of 93:7. Therefore this content of gelatin within composites was used in further studies. Similar, optimization of the hydroxyapatite content was carried out to obtain the fibers without particles agglomerates. Based on process conditions and SEM observations 10% content (w/w) within the composite for hydroxyapatite was selected. The fibrous substrate was formed via electrospinning method, when a high voltage of 7 kV was applied to the solutions. A collector covered with aluminum foil located at 15 cm distance from the tip of the needle was used. The flow rate was set at 1.0 mL/h. The electrospun fibers were dried in the drying oven for a few days. The Scanning Electron Microscope (SEM) was used to observe the morphology and to estimate the diameters of the obtained fibers. In order to investigate the wettability of the fibrous meshes the water contact angle measurements were conducted. To identify the chemical composition of the surface of obtained fibrous structures Fourier Transform Infrared (FTIR) Spectroscopy was applied. Finally, to determine the degradation rate of the particular types of samples electrospun scaffolds were immersed from 7 up to 30 days in Phosphate Buffer Solution and incubated in 37^{o}C.

Results and Discussion

The SEM images show the morphology of the PD, PDG, PDH and PDGH fibers (FIG. 1). The pure polymeric fibers have smoother surface but larger diameter compared to composite ones. A significant decrease of the fibers diameter from 1198 ±152 nm to 344 ±59 nm was observed along with an increase of the mass fraction of the gelatin and nanohydroxyapatite.

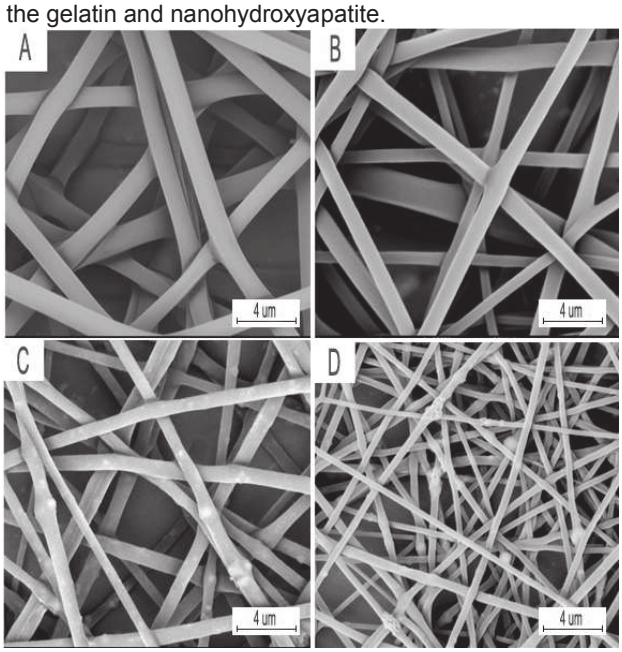

FIG. 1. SEM images of: (A) PD, (B) PDG 93:7, (C) PH 90:10 and (D) PDGH 83:7:10 fibers.

FTIR analysis of the composite fibers revealed peaks, which are characteristic for gelatin and hydroxyapatite. The wettability measurements showed a hydrophobic nature for the PDLG fibers. The gelatin addition caused an increase of hydrophilicity of the surface of polymeric fibers. The values of the contact angle were reduced from 131.74° ±2.25° for PDLG to 73.08° ±7.70° for PG, 126.19° ±1.06° for PH and 55.41° ±5.50° for PGH fibers. Mass loss during degradation was higher for the fibers containing gelatin than for the pure polymeric and polymeric/ceramic fibers. It is probably related to the solubility of the gelatin in aqueous solutions.

Conclusions

According to obtained results, modification of the PD fibers with gelatin and nanohydroxyapatite additives have a great influence in order to receive nanoscale fibers with improved biocompatibility and composite PDGH fibrous meshes are promising substrate in tissue engineering applications.

Acknowledgments

This work was financed by NCN grant No. DEC-2011/01/M/ST8/07742 and by NCBiR grant No. STRATEGMED1/233224/10/NCBR/2014.

References

[1] Kijeńska, E. et al. Chapter 2. In: T. Uyar and E. Kny, Electrospun Materials for Tissue Engineering and Biomedical Applications, 2017, 1st ed. pp.43-56.
[2] D. W. Hutmacher, Biomaterials. 21 (2000) 2529–2543.
[3] E. Kijeńska et al. Int J Polym Mater 2016, 65 (16): 807-815.
[4] M. Mehrasa, M. A. Asadollahi, et al., Int. J. Biol. Macromol. 79 (2015) 687–695.