EFFECT OF ELECTROSPINNING CONDITIONS ON PLA FIBERS MORPHOLOGY AND UV DEGRADATION

KAROLINA KOSOWSKA[1], MAGDALENA PROCNER[2], PIOTR SZATKOWSKI[1]*

[1] FACULTY OF MATERIALS SCIENCE AND CERAMICS, AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY, POLAND
[2] FACULTY OF CHEMISTRY, JAGIELLONIAN UNIVERSITY, POLAND
*E-MAIL: PSZATKO@AGH.EDU.PL

[ENGINEERING OF BIOMATERIALS 143 (2017) 60]

Introduction

Nowadays, electrospinning (ES) is very popular method to produce fibers in micro- and nanoscale. Many of researches have focused on optimizing process conditions and obtaining fibers with properties optimal for biomedical application [1,2]. The most important parameters are: type of polymer, diameter and orientation of fibers, degradability [3] and bioactive substances addition.
The aim of the study was to determine effect of ES conditions on the properties of polylactide (PLA) fibers and investigate the effect of UV irradiation on fibers.

Materials and Methods

The process was performed using ES device dedicated to obtaining this kind of materials. In the process, PLA (NatureWorks LLC, USA) powder was dissolved in mixture of N,N-dimethylformamide (DMF, Avantor Performance Materials Poland S.A) and dichloromethane (DCM, Avantor Performance Materials Poland S.A.) with different ratios (1:3 and 1:2,5) and used as a raw material. The parameters of ES were optimized (temperature of process ~49°C and concentration of PLA (11-15%)).
Scanning electron microscope (SEM) was used to check diameter and orientation of fibers. The aging under UV irradiation process was examined in a specially designed chamber. The source of aging was the UV-C 11W bulb, and the ozone being the product of the decomposition of oxygen from the air.

Results and Discussion

SEM micrographics were used to obtain information about fibers diameters produced under different conditions. The results dependence of temperature is shown in FIG. 1. Most fibers had a diameter in the range of 100 to 500 nanometers. Higher temperature in ES chamber improves material quality. Fibers were more homogeneous, thinner and more repeatable.
In the next step, UV ageing chamber (UV-C 11W~ equal half year exposure sun) was used to investigate PLA fibers behaviour under UV/ O_3 conditions. The maximum exposure time was 24 h. After that time, the fiber microstructure was completely destroyed (FIG. 2).

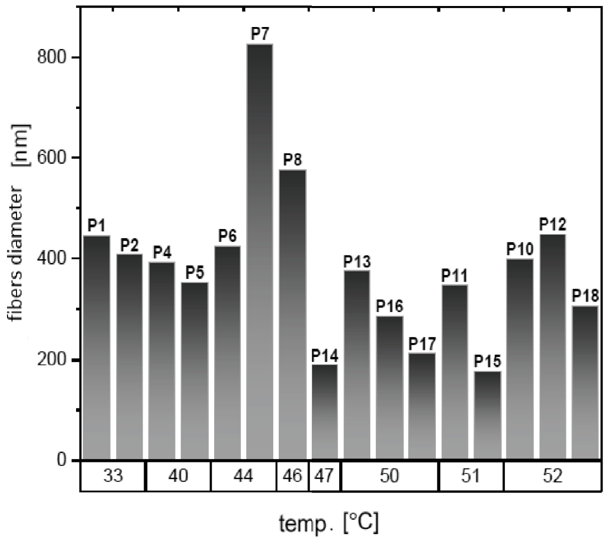

FIG. 1. PLA fibers diameters vs. temperature of ES process (P1-P18 number of sample).

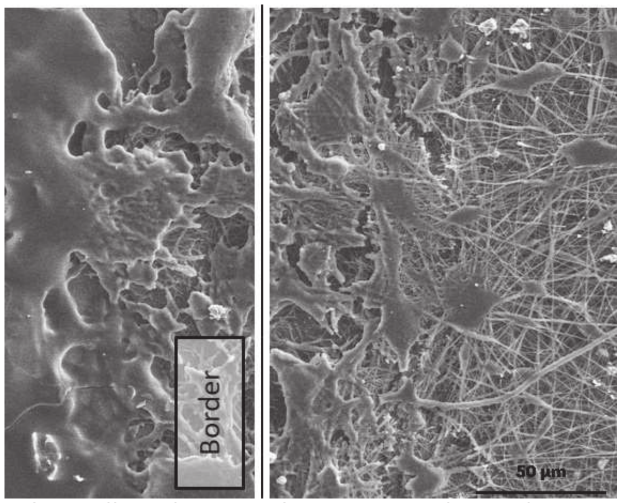

FIG. 2. Effect of UV and O_3 on the PLA fibers after 24 h exposition.

Conclusions

ES process is influenced by many factors: polymer concentration, temperature, type of solvent and solvents mixtures ratio. The results show that the best quality PLA fibers were obtained at a concentration of 13-15% and under temperature over the range 40-50°C.
PLA fibers are not resistant to UV irradiation. This is due to the chain build of the polymer. Chains under the influence of higher energy radiations are torn and split. This result in a significant weakening of the continuity of the layer composed of nano- and microfibers. PLA fiber materials for biomedical applications that may be exposed to sunlight (e.g. skin substitutes) have to be covered with a protective layer or contain UV-protecting substances.

Acknowledgments

This research was financed by the statutory research No 11.11.160.182 of Faculty of Materials Science and Ceramics, AGH University of Science and Technology, Krakow, Poland.

References

[1] J. R. Dias, P. L. Granja *et al.,* Prog. Mater. Sci. 84 (2016) 314-334
[2] B. Na *et al.,* Polymer 65 (2015) 55-62
[3] S. Lv *et al.,* Constr. Build. Mater. 144 (2017) 525-531