THE POLYMERIC EPD - THE INFLUENCE OF PROCESS PARAMETERS AND SOLUTION CHARACTERISTICS ON THE ELECTROPHORETIC MODIFICATION OF FIBROUS CARRIERS

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Introduction

The mechanism of electrophoretic deposition (EPD) is a simple and versatile method of surface modification which is used for the preparation of many different materials. It results in specific biological, chemical or mechanical characteristics and is predominantly used for metallic biomaterials or deposition of metals and oxides. Unfortunately, the knowledge of electrodeposition on fibrous carriers is very limited due to its complexity, uneven structure and specific spatial characteristics which can hinder the application of this method in textiles and in general - fibrous structures. In the study, two groups of parameters were investigated – the influence of the EPD process parameters (voltage, time, temperature) and solution characteristics (concentration, conductivity, surface tension) one the kinetics of the electrophoretic deposition of hyaluronate on the spun bonded PLA matrices. The kinetics was measured as mass gain of the substrate with the polymer layer over time.

Materials and Methods

The solutions of the selected concentration of sodium hyaluronate with two molecular weight variants (SH): M_w = 1,8 – 2,0 MDa and M_w = 80 – 130 kDa (Contripo Biotech, Czech Republic) were prepared using distilled water and mechanical stirring for 5 h. The solutions were used after degassing in ambient temperature. The PLA nonwovens were obtained by the spun-bond method and characterised in terms of surface mass, thickness, and air permeability with respective standards (PN-EN). The results are presented in TABLE 1. Surface tension measurements of deposition solutions were performed with a process tensiometer Radian Series 300 (Thermo Scientific, United Kingdom) using Wilhelmy's plate method. The conductivity of deposition solutions was measured with a multifunctionmeter – CX-701 (Elmetron, Poland) and conductivity sensor – EC-60 at T_{ref} = 25°C. The zeta potential was measured with Zetasizer Nano ZS (Malvern Analytical). The electrodeposition was carried out in the dedicated laboratory stand using the voltage range 15 – 60 V, temperature scope 15, 35° and 60°C and time 3-15 min. The samples were dried at room temperature until they reached a constant mass. The effectiveness of the process was measured based on the mass gain [g] over time. The analysis of surface morphology of samples was performed using scanning electron microscopy (FEI NOVA NanoSEM 230) equipped with a field emission electron gun (FEG). The FTIR analysis of the bulk sodium salts, unmodified and modified non-wovens was performed with the FTIR spectrophotometer (Thermo Scientific. Nicolet 6700). The measurement resolution was 4 nm and 64 scans were taken during the measurement.

TABLE 1. The structural characteristic of the spun-bonded PLA nonwoven

Surface mass	Thickness	Air permeability	Fibre diameter
[g/m^2]	[mm]	[l/m^2/s]	[um]
62.2	0.27	480	9.5

Results and Discussion

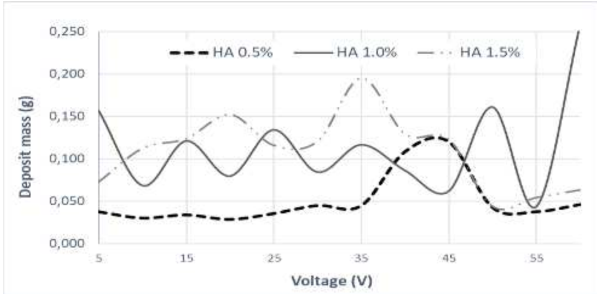

FIG. 1. The influence of polymer concentration and applied EPD voltage on deposit mass, EPD: 35V, 3 min.

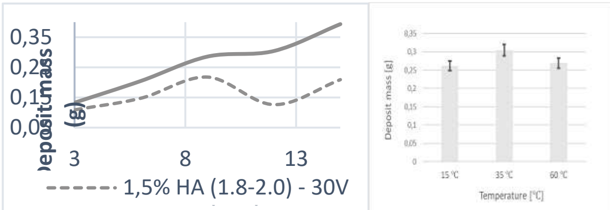

FIG. 2. The influence of voltage, temperature and time on deposit mass.

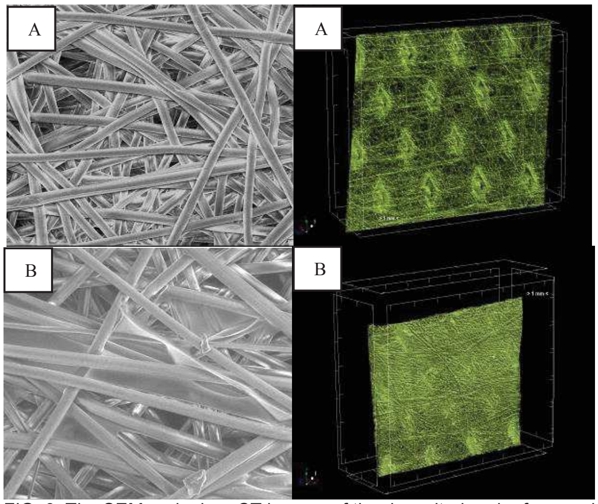

FIG. 3. The SEM and micro-CT images of the deposited and referenced samples. Solution: 1.5% HA, EPD: 35V, 3 min: A-reference, B-deposited.

Conclusions

The effectiveness of the EPD process depends on number of factors. Two main groups of parameters can be pointed – the process parameters and the deposit solution's characterization which play the most important roles. The study resulted in ordering of the knowledge on polymeric EPD on fibrous structures and allowed to indicate the selection of optimal conditions for the deposition of hyaluronic acid on fibrous PLA-based carriers. Based on the examination, the most optimal conditions were selected, i.e. sodium hyaluronate of M_w = 1,8-2,0 MDa, the concentration of 1,5% and process parameter V = 35V, T = 35°C and t = 3-15 min, for the surface modification of spun-bonded nonwovens.

Acknowledgments

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References

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