Electrospun nonwovens with poly(glycerol sebacate)

Piotr Denis[1], Paweł Sajkiewicz[1]

[1] Laboratory of Polymers and Biomaterials, Institute of Fundamental Technological Research, Polish Academy of Sciences, 02-106 Warszawa, Pawińskiego 5B, Poland, pdenis@ippt.pan.pl

Introduction

The objective of this research is to determine the conditions of forming, using electrospinning method, and then preparation and systematic characterization of the structure and properties of elastic nonwovens, which contain poly(glycerol sebacate) (PGS) and the other polymer – biodegradable polyester. The issue of the project concerns production of such two-component fibrous material, in which elastic properties of poly(glycerol sebacate) will be utilized. PGS will hopefully modify properties of the nonwovens towards potential applicability in the field of soft tissues engineering.

Experimental

PGS was synthesized using equimolar ratio of glycerol and sebacic acid monomers. Next it was blended with other biodegradable polyester (according to preliminary results with PLA) in 1:3, 1:1 and 3:1 ratios, and was electrospun using hexafluoroisopropanole (HFIP) solvent. Subsequently nonwovens were cured at high temperature (135^{o}C) within 24h or 48h, under vacuum in order to crosslink PGS. Electrospinning process was optimized at preliminary stage. First attempts were made using PLA49 polymer (Corbion), and next - PL32 polymer (Corbion) with lower molecular weight to be able to obtain solutions with higher concentrations. Concentrations were determined to obtain similar viscosities of the solutions, regardless to composition, as the PGS prepolymer does not bring almost any viscosity, which mostly comes from PLA.

Results and discussion

Preliminary SEM observations indicate that fibers are uniform, with very narrow distribution of diameters. PGS content of 25% does not affect much the morphology of cured fibers. At 50% and higher content of PGS, the nonwovens morphology after curing is considerably affected; at 75% PGS content (Fig. 1b), nonwovens after curing are almost "poreless".

Our results indicate that conditions suggested in experimental part does not make nonwovens more elastic, contrary to pure prepolymer which becomes elastomeric after treatment in such conditions. Applied crosslinking conditions were selected on the basis of two meaningful publications about optimizing PGS properties [1, 2]. What is good for pure PGS prepolymer, does not have to be good when considered its blend with other polymer, when PGS chains are diluted and potentially there can be steric barriers against effective crosslinking.

Rinsing nonwovens in ethanol, which is a solvent for PGS prepolymer, confirmed that after 48h of curing, more than 80% PGS within fibers shall be crosslinked. But, after treating with vacuum and high temperature, nonwovens become more rigid and brittle – unfortunately not more elastic. The major influence comes probably from PLA, which crystallizes at curing

temperature, and becomes stiff and brittle. Non-crystallizing PLA, with longer chains is considered to be used.

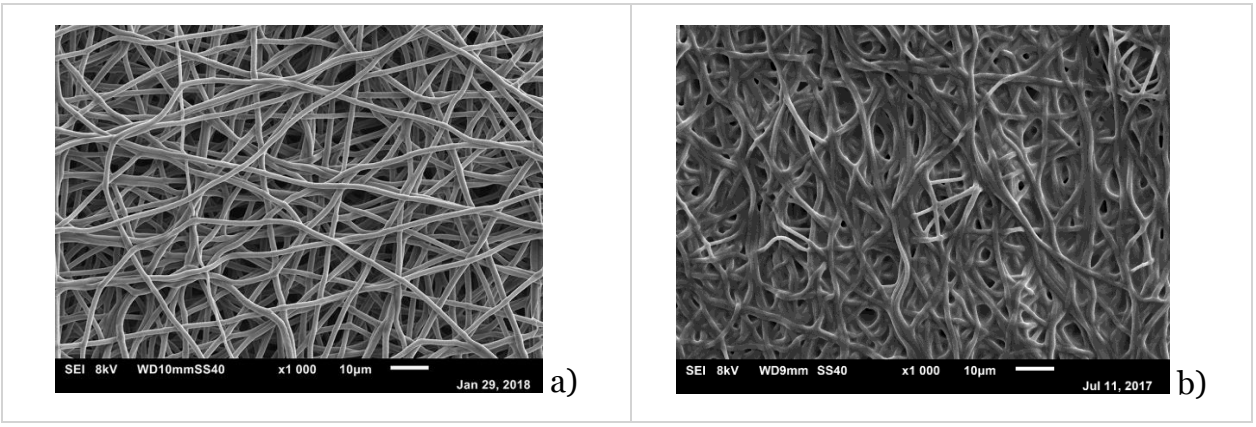

Fig. 1 *Electrospun and cured nonwovens of PLA: PGS, 1:1 ratio a) and 1:3 ratio b)*

Conclusions

Electrospinning of PGS blended with PLA does not bring difficulties, but obtaining elastomeric properties of nonwovens is problematic. Even though PGS has many potential advantages over other polyesters when soft tissue engineering is considered, its full utilization via electrospinning process is much harder in practice. Further investigations are planned, with different types of carrier polymer.

Acknowledgement

That research is supported by Polish National Science Centre (NCN), "Preludium" grant no. 2016/23/N/ST8/03692

References

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