Polish-Israeli Conference on Electrospinning and Tissue Engineering

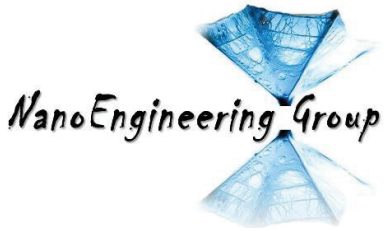
Programme and Abstracts

04 - 05 October 2018

Warsaw, Poland

Organizers

Laboratory of Polymers & Biomaterials at Institute of Fundamental Technological Research Polish Academy of Sciences (IPPT PAN) based on the fundamental knowledge in the area of polymer physics, materials science, chemistry and biotechnology, focuses its recent activity on biomaterials for tissue engineering. Great part of our activity is related to polymeric biodegradable scaffolds, mostly formed by electrospinning as nanofibrous structures, both for tissue regeneration and materials for controlled drug release.



Nano Engineering Group at Technion Israel Institute of Technology is focused on research in the field of molecular engineering of soft matter. The particular activities are related to the electrospinning including optimization of the parameters of the process, deep understanding of the fundamental physical facets of electrospinning as well as designing a composite materials for tissue engineering applications.

Objectives

The goal of PICETE conference is to bring together experts from around the world in order to exchange their knowledge, experience and research innovation in the basics of the electrospinning and the broad area of biomedical materials covering topics related to designing, fabrication, characterisation and tissue engineering applications.

The conference will include the following topics:

- Fundaments of electrospinning
- Optimization of electrospinning
- Properties of electrospun nanofibers
- Functionalization of electrospun nanofibers
- Electrospun nanofibers as scaffolds for tissue engineering/drug delivery systems
- Current trends in designing of polymeric biomaterials for tissue engineering/drug delivery systems

Electrospun nonwovens with poly(glycerol sebacate)

Piotr Denis, Paweł Sajkiewicz

Institute of Fundamental Technological Research,Polish Academy of Sciences;

Pawińskiego 5B, 02-106 Warsaw, Poland

Abstract

The objective of this research is to determine the conditions of forming, using electrospinning method, and then systematic characterization of the structure and properties of 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 was synthesized using equimolar ratio of glycerol and sebacic acid monomers. Efficiency of crosslinking of PGS depends on degree of esterification (DE) – the extent of reaction between carboxyl groups in sebacic acid and hydroxyl groups in glycerol. Prepolymer in soft-wax form features usually DE of around 45% - 65%. To achieve crosslinked PGS, first DE must be at 76% level minimum [1].

Two types of prepolymers were synthesized – one with relatively low DE (prepolymeric, Prep), and the other one with higher DE (semi-crosslinked, S-C). Next it was blended with poly(lactic acid) (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°C) within 3h - 48h, under vacuum in order to crosslink PGS. Electrospinning process was optimized at preliminary stage.

Our results indicate that nonwovens do not become much 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.

According to mechanical tests pure PLA has highest tensile strength, but at the same time it is the most rigid material with lowest elongation at break. Annealing in temperature of crosslinking reduces considerably stiffness of the samples – due to structural relaxation in PLA and crosslinking of PGS. Materials with semi – crosslinked prepolymer exhibit most elastomeric nature, with high elongations at break, relatively high tensile strength, and especially after crosslinking – low stiffness.

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.

Images

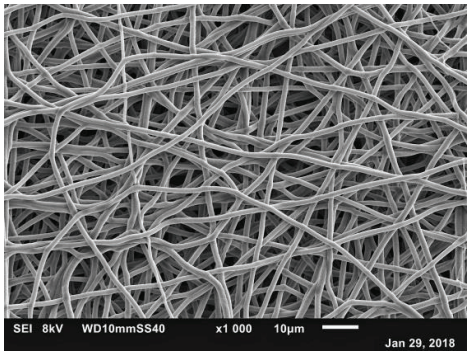


Fig 1. Electrospun PLA:PGS 50%:50% fibers

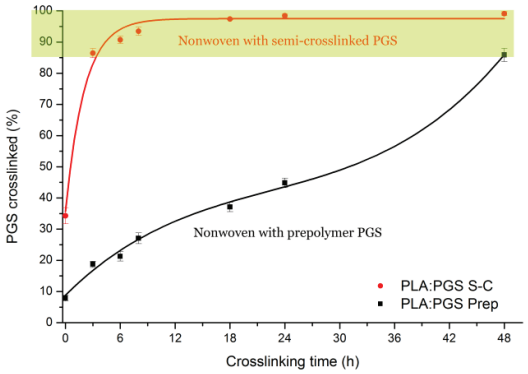


Fig 2. Crosslinking efficiency of PGS in nonwoven, by the example of electrospun PLA:PGS 50%:50% fibers, crosslinked during 24h; after 1h-long leaching in ethanol.

References

2. Li X, T-L Hong A, Naskar N, and Chung H-J, Criteria for Quick and Consistent Synthesis of Poly(glycerol sebacate) for Tailored Mechanical Properties, Biomacromolecules, 2015;16 (5):1525–1533
3. Conejero - García Á, Rivero Gimeno H, Moreno Sáez Y, Vilariño-Feltrer G,Ortuño - Lizarán I, Vallés – Lluch A, Correlating synthesis parameters with physicochemical properties of poly(glycerol sebacate), Eur Polym J, 2017;87:406-419

Acknowledgments

That research is supported by Polish National Science Centre (NCN), "Preludium" grant no. 2016/23/N/ST8/03692. PGS was synthesized in the Laboratory of Technological Processes, Faculty of Chemistry, Warsaw University of Technology. Authors would like to express their gratitude to Agnieszka Gadomska-Gajadhur, PhD and to Michał Wrzecionek, MSc for their contribution and commitment in this work.

Email: pdenis@ippt.pan.pl