INTERNAL STRUCTURE OF ELECTROSPUN NANOFIBERS FOR TISSUE ENGINEERING

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Tissue engineering is a fast-moving interdisciplinary area that combines medicine, cell biology, materials science, and nanotechnology allowing for regeneration of damaged tissues and organs. Polycaprolactone (PCL) is a biodegradable, nontoxic polyester with a low melting point of around 60°C. PCL is degraded by hydrolysis of its ester linkages in physiological conditions (such as in the human body) and it is generally accepted in biomedicine. Electrospining process enables to form nanofiber mats. There are several papers trying to optimize this process. One of them is a description of Kowalewski[1].Those 3D structures are very useful to help control cell functions in tissue engineering. Their external properties are similar to components in the extracellular matrix (ECM) and mimic its fibrillar structure, providing essential cues for cellular organization, survival and function[2].

The aim of our study is to investigate the influence of parameters of electrospinning on a structure of PCL nanofibers and their ability to support growth of hepatocytes. There are only few papers trying to analyze the internal structure of individual nanofibers[1,3].

PCL with Mw = 80,000 g/mole from Aldrich Chemical Co was used. Electrospinning was performed using two solvent mixtures: chloroform with N.N-dimethylformamide (DMF) and chloroform with methanol. In addition to standard analysis of geometry of nanofiber mats by microscopy, the analysis of internal structure was performed. The direct measurements of birefringence was performed using Pluta polarizing-interference microscope (Biolar PI) produced by Polish Optical Works (PZO) [Fig. 1.]. Crystallinity was determined from DSC measurements. Additionally, calculation of unknown intrinsic birefringences of crystal and amorphous phases has been done in order to estimate the molecular orientation of individual fibers from birefringence measurements. SEM observations were applied for estimation of morphology of growing hepatocytes.

Our results indicate that not only thickness of electrospun fibers but also the molecular orientation depends strongly on processing parametrs, like applied voltage, concentration and type of solvent used in elestrospinning. Molecular orientation as measured from birefringence is in general relatively weak and nonuniform along the fibers (Fig.1). DSC measurements show that the temperature of crystal melting as well as crystallinity is lower for nanofibres than for cast films. Crystallinity of constrained nanofibers determined from the area of melting peaks is around 0,4. This observation can be explained by low size and/or high concentration of defects in crystals formed during electrospinning. SEM images show preferred adhesion and great viability of hepatocytes growing on PCL scaffolds.

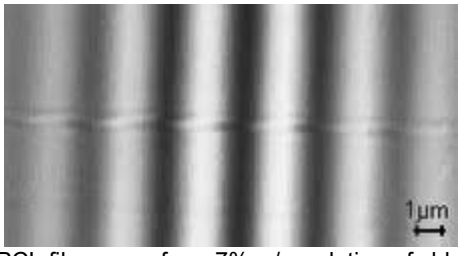

Figure 1. Fringed interference field for PCL fiber spun from 7% w/w solution of chloroform/methanol mixture at 10kV..

References

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