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OPTICAL INVESTIGATIONS OF STRUCTURE OF POLY (CAPROLACTONE) NANOFIBERS FORMED BY ELECTROSPINNING

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Although electrospinning has appeared in the literature for several decades, there is still a lack of quantitative data showing correlation between process parameters and a structure of nanofibers. Our work is aimed to better understanding of dependences parameters of electrospinning and the structure of nanofibers.

MATERIAL, FIBER FORMATION, FIBER FORMATION AND METHODS OFINVESTIGATIONS.

Polycaprolactone (PCL) with Mw = 80,000 g/mole from Aldrich Chemical Co. was used. Electrospinning of PCL solution was performed at various solution and processing parameters. Two different solvent mixtures were used - a mixture of chloroform and N.N-dimethylformamide (DMF) and a mixture of chloroform and methanol. Polymer concentration was in a range from 7 to 14%. Nanofibers were formed at applied voltage ranges from 5 to 30kV. The ground collection plate was located at a distance of 15 cm from the needle. For optical observations nanofibers were collected directly on cover glasses
Pluta polarizing interference microscope (Biolar PI) produced by Polish Optical Works (PZO) was used. This microscope is equipped with several Wollastone birefringent prisms, allowing a quantitative determination of the optical path difference caused by investigated object, which in turn is proportional to the birefringence. Optical birefringence is a measure of molecular orientation. Small diameters of investigated fibers requires special techniques of observation, allowing to increase an image resolution. Complementary results were obtained by scanning electron microscopy (SEM) and differential scanning calorimetry (DSC Pyris-1).

RESULTS

Data obtained by optical microscopy clearly show that the nanofibers are birefringent, indicating molecular orientation as a result of spinning process. Fig. 1 illustrates typical micrograph of PCL nanofiber registered in a fringed interference field.

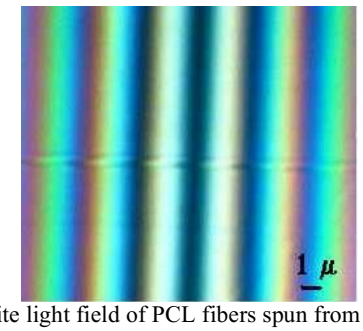

Fig. 1. Fringed interference white light field of PCL fibers spun from 7% solution of chloroform/DMF mixture at 20kV. Deviation of fringes in the registered position of fiber is directly proportional to birefringence.

Quantitative measurements of birefringence both in fringed field and uniform color field indicate the dependence of orientation on spinning parameters. PCL fibers formed from methanol/chloroform mixture arethicker than those obtained from a chloroform/DMF mixture. Estimation of a degree of molecular orientationrequires information on intrinsic birefringence as well as on degree of crystallinity. The later was provided by additional DSC measurements. Fiber diameters estimated from optical microscope were compared with data obtained by SEM.

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