Exploring methods for controlling the quality of random and aligned electrospun nanofibers

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Statement of Purpose: The use of electrospun fibers for tissue engineering purposes is a growing trend in regenerative medicine. The fibrous structure mimics the natural fibers present in the extracellular matrix (ECM), providing adequate support for cell proliferation. Controlling the quality of these products is not a simple task, especially when components are in very small amounts and in nanosizes. Therefore, the aim of this study was to explore three characterization methods as possible quality control methods for nanofibers scaffolds: Fourier transform infrared spectroscopy (FTIR), thermogravimetry (TG) and differential scanning calorimetry (DSC). As object of this study, we used PLGA and PLGA/PLL nanofibers, which consist of biocompatible polymers that have shown good cell proliferation properties (Kramer et al., 2011).
Methods: Random and aligned PLGA and PLGA/PLL nanofibers scaffolds were fabricated by electrospinning. PLGA nanofibers were electrospun using PLGA 14% w/w in chloroform/methanol (3:1), while PLGA/PLL nanofibers were spun from an emulsion of PLL solution (1.1 mg/ml distilled water) in the 14% w/w in chloroform/ methanol (3:1) PLGA solution (1 part aqueous to 18 parts organic). Scaffolds were characterized by FTIR (Cary 630 FTIR spectroscope, Agilent Technologies Inc., USA), TG (Seiko instrument TG/DTA 7200, SII Nanotechnology, USA) and DSC (Seiko instrument DSC 7020, SII Nanotechnology Inc., USA) and compared to their raw materials.
Results: No difference among raw PLGA, random or aligned PLGA nanofibers FTIR spectra was observed. PLGA/PLL nanofibers spectra have not detected the presence of PLL in the mixture, probably due to the small concentration of PLL in the scaffold. TG analysis (Figure 1) showed that random nanofibers are more stable than aligned nanofibers, but less stable than raw material. Addition of PLL to PLGA decreased the thermal stability of the scaffold.

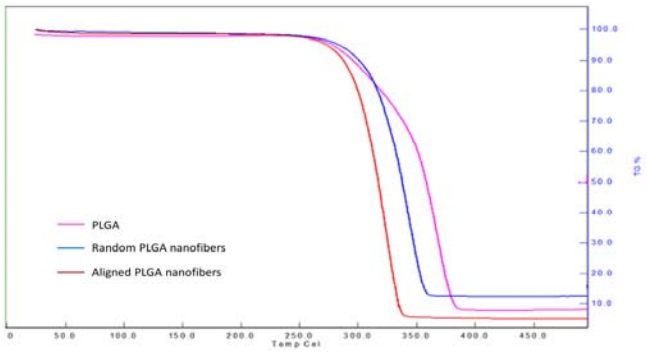

Figure 1. Thermogravimetric curves of raw PLGA, random and aligned PLGA nanofibers obtained at 10 °C min^{-1} under dynamic N_2 atmosphere.

DSC analysis showed no difference among raw PLGA, random or aligned PLGA nanofibers. Addition of PLL to PLGA has moved the phase transition peak to a higher temperature when compared to PLGA alone (Figure 2), either in random or aligned electrospun fibers.

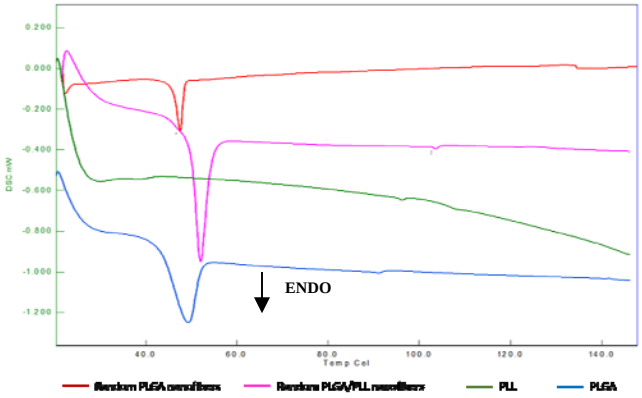

Figure 2. DSC curves of raw PLGA, raw PLL, random PLGA nanofibers, and random PLGA/PLL nanofibers obtained at 10 °C min^{-1} under dynamic N_2 atmosphere.

Conclusions: FTIR was not able to differentiate raw material from random or aligned fibers, neither PLGA/PLL from PLGA fibers. On the other hand, DSC analysis was able to differentiate PLGA from PLGA/PLL nanofibers, while TG analysis was able to tell random and aligned fibers apart, as well as PLGA and PLGA/PLL fibers. DSC and TG could be considered as methods for controlling the quality of random and aligned nanofibers.

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