Air-brushed Poly-DL-Lactic Acid Fiber Mats with Controllable Degradation for Tissue Engineering Applications

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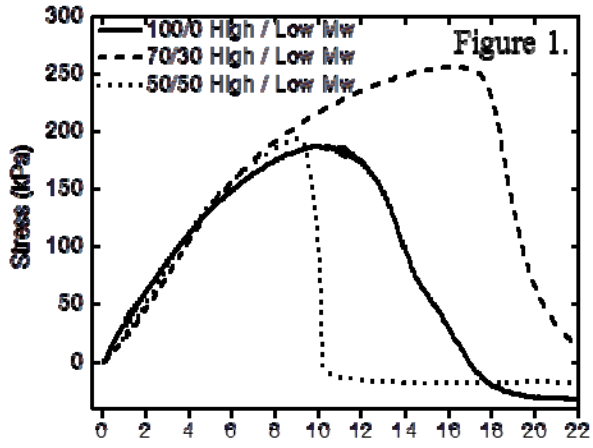
Statement of Purpose: Air-brushing allows for rapid polymer fiber deposition directly on various materials, including live tissues (1,2). Relatively simple operation and the ability to form 3D fiber scaffolds makes air-brushing useful in many tissue engineering applications. For successful tissue regeneration, multifunctional scaffolds need to have controllable architecture and degradation rates. Generally, little is known about air-brushed fiber mat degradation in *in-vitro* conditions. In this study, high (M_w ~100 kDa) and low (M_w ~25 kDa) molecular weight poly-DL- lactic acid (PDLLA) polymers were blended at 100:0, 70:30 and 50:50 ratios in acetone solvent. All formulations were successfully air-brushed and formed fiber mats.

Methods and Results: Structural properties of the mats were evaluated by scanning electron microscopy and analyzed using Image-J software (Diameter-J plug-in). The average fiber diameter (246.3 nm ± 68.0 nm) and the average micro-scale percent porosity (44.3 % ± 5.5 %) were similar for all tested polymer blend compositions. Similarly, Young's modulus showed no change with polymer composition and averaged 25.0 ± 2.6 kPa for all blends, Figure 1. Scaffold degradation in phosphate buffer solution (PBS) was investigated up to 12 weeks using gel permeation chromatography. The fastest degradation rate was observed in 50:50 blends (-3.0 kDa/week) and the slowest in 100:0 compositions (-1.3 kDa/week). The 50:50 polymer blend lost approximately 60 % and 100:0 composition only 12 % of its initial molecular weight at week 12, Figure 2.

Conclusions: The results indicate that PDLLA blends can be successfully air-brushed to form mats with controllable degradation rates. These rates can be tailored by changing the ratio of high vs. low molecular weight PDLLA while preserving the structural and mechanical integrity of the fiber mats.

References:

(1) Tutak, Wojtek, et al. "The support of bone marrow stromal cell differentiation by airbrushed nanofiber scaffolds." Biomaterials 34.10 (2013): 2389-2398. (2) Behrens, Adam M., et al. "In situ deposition of PLGA nanofibers via solution blow spinning." ACS Macro Letters 3.3 (2014): 249-254.



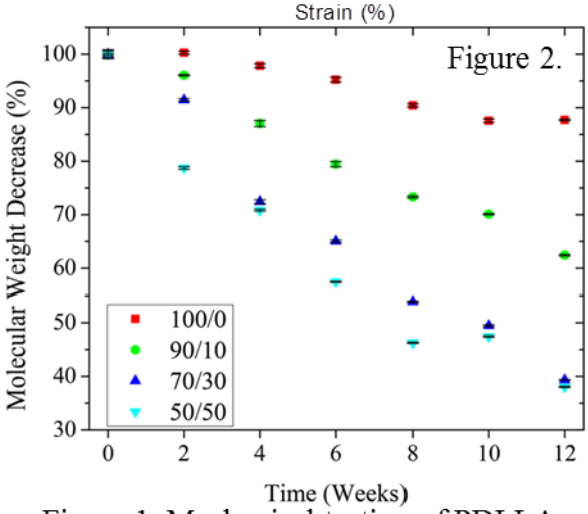


Figure 1. Mechanical testing of PDLLA polymer mats

Figure 2. PDLLA mat degradation in PBS