# High Surface Area Tissue Engineering Scaffolds with Multi-Grooved Fibers

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**Statement of Purpose:** The main paradigm of tissue engineering utilizes the approach where biomaterials can be designed and engineered to encourage living cells to repair and restore damaged tissues and maintain normal function. In general, the scaffolds should facilitate cell adhesion, promote cell growth, have a high porosity, be mechanically strong, and capable of being formed into desired shapes [1]. The appropriate design of tissue engineering scaffolds is critical to restoring native functionality, which will determine the success of these structures. Structures containing multi-grooved fibers with high surface area have gained interest due to their significantly enhanced fluid transport and capillary action [2]. In addition, scaffolds with high surface areas mimic biological environments that replicate native tissue function. In this study, a novel scaffold structure utilizing multi-grooved fibers was proposed to serve as a matrix for cell attachment and proliferation. The objective was to evaluate the effect of the increased surface area and groove size on the cell behavior as well as on the mechanical and degradation properties of the scaffold.

**Methods:** Multi-grooved cross-sectional fibers were produced using a bi-component spinning system (Fig 1). Polylactic acid (PLA) was used as the main "retained" polymer and EastOne™ water dispersible polyester was used as the "sacrificial" component to create the grooves. Fibers with different numbers of grooves and sizes were compared in terms of their mechanical, degradation properties and cell behavior. Hydroentangled nonwoven fabrics with different cross-sections were also compared.

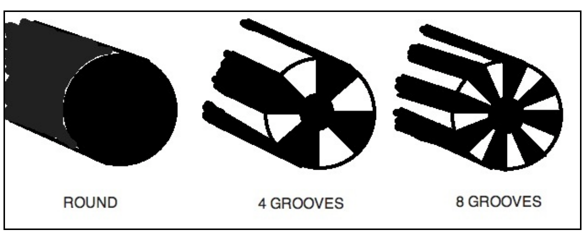


**Figure 1- A schematic of round and multi-grooved fibers (Black: PLA, White: EastOne™ sacrificial polyester)**

To characterize the fiber morphology and assess the complete removal of the sacrificial component, scanning electron microscopy (SEM) was used for analysis. To compare the mechanical properties between the different structures, tensile strength was measured to failure on a mechanical tester (MTS Model 1122). To investigate the groove effect on cell behavior, MTT cell viability assay (Sigma Aldrich) was performed with NIH 3T3 fibroblasts for up to 12 days. The absorbance reading from the colorimetric assay corresponds to the level of cell viability on the scaffolds.

**Results:** Representative morphology of a nonwoven fabric with round PLA fibers and multi-grooved PLA fibers is shown in Fig 2. The EastOne™ component was effectively removed by scouring in deionized water at 80±5°C. The overall diameters of the fibers were approximately 10 µm.

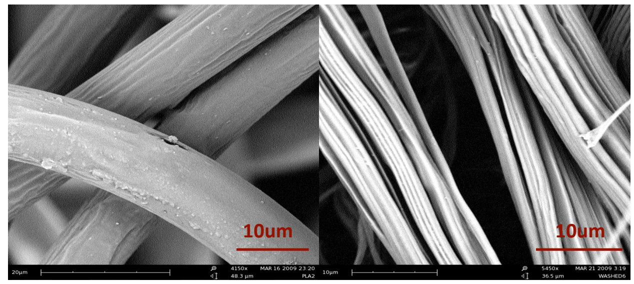


**Figure 2- Comparison of PLA fibers with round and multi-grooved cross-sections.**

To determine cytotoxicity and cell viability, the MTT assay was carried out. Assay results up to 12 days confirmed that the cells were viable on both types of scaffolds. The initial reading at Day 1 showed superior cell attachment over the multi-grooved fibers, but this difference became negligible after 3 and more days of culture. SEM analysis also confirmed positive cell attachment to both types of PLA fibers.

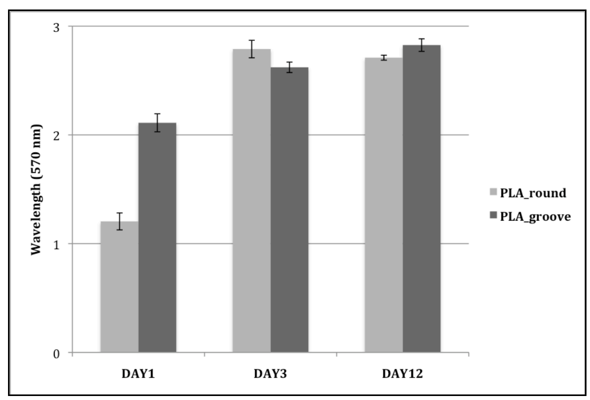


**Figure 3- MTT assay**

**Conclusions:** This study has shown that the use of PLA multi-grooved fibers provides an effective novel application for use in tissue engineering scaffolds. Different numbers and sizes of grooves were spun and evaluated to observe cell-matrix interactions. The increased surface area of the grooved fibers appears to promote the initial attachment of cells. Analysis of degradation behavior and mechanical properties is currently under investigation.

**References:**

[1] Wiesmann HP, Lammers L. *Fundamentals of Tissue Engineering and Regenerative Medicine* 2009:539-548.

[2] Vaughn E, Carman B. *Journal of Industrial Textiles* 2001;30:303.