# Fabrication of Fiber Based 3D Tissue Engineering Scaffolds

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**Statement of Purpose:** In the USA there are currently over 90,000 patients waiting for organ transplantation with annual healthcare costs exceeding $500 billion. This healthcare crisis is driving growing interest in regenerative medicine and tissue engineering research. Despite significant successes, there remain major challenges in tissue engineering such as developing a three dimensional (3D) architecture for scaffolds which will lead to an appropriate proliferation and orientation of cells. To overcome this challenge, we are proposing to harness textile knitting technologies to fabricate 3 dimensional (3D) porous bioresorbable tissue engineering (TE) scaffolds. Our goal is to determine whether these knitted spacer fabric structures will be mechanically functional, biocompatible and support the adhesion and proliferation of cells through the thickness dimension.

**Materials and Methods:** Various 3D spacer fabric prototypes using a multifilament 150 den polyester yarn (Unifi, Inc., Greensboro, NC) have been knitted with different thicknesses and porosities in the range of 85-95%. They were knitted on a double needle bed Karl Mayer DR 10 warp knitting machine. To facilitate design innovation the software ProCad WarpKnit 3D was used to model, evaluate and modify the structures before knitting. During the knitting process variables such as speed, tension, knit gauge, and yarn feed were optimized. These prototype fabrics have been evaluated in terms of their morphology by SEM as well as their compression resistance and recovery. Their *in vitro* biocompatibility and functionality have been assessed by using cell viability and proliferation assays (MTT & Alamar Blue).

**Results:** The image of an example of a simulated 3D knitted spacer fabric structure is shown in Figure 1.

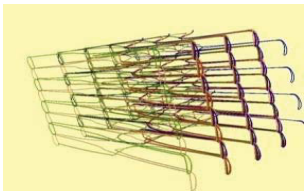
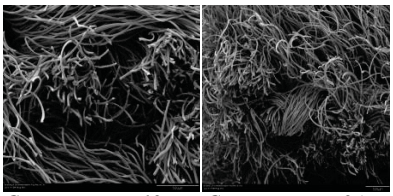


*Figure 1: Image of Simulated 3D Spacer Fabric*



*Cross section – 12 gauge structure* *Cross section – 24 gauge structure*

*Figure 2: SEM Images at 20.0KV Mag 30x*

**SEM:** The SEM images shown in Figure 2 compare the cross-sectional views of the structures of the 12 and 24 gauge prototypes.

**Compression and Recovery:** The results of the compression and recovery analysis are illustrated in Figure 3. Both 12 and 24 gauge samples have similar compression and recovery properties, in that they were compressed to 40±5% and recovered to 80±3% of the initial thickness.

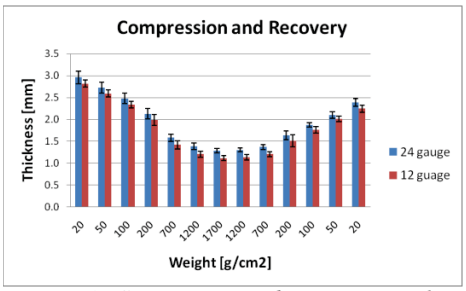



*Figure 3: Compression and Recovery Results*

**Cytocompatibility**: The biocompatibility of these scaffolds was confirmed by a preliminary MTT viability assay (Figure 4) using human dermal fibroblasts. Both prototype fabrics indicated equivalent amounts of cell growth and proliferation after 48 h.

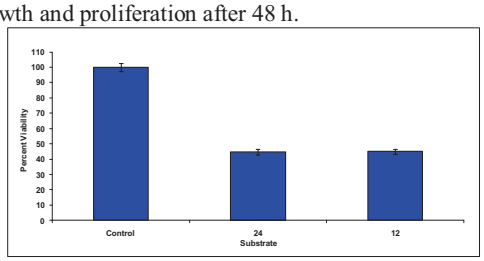



*Figure 4: MTT Viability on 3D Spacer Fabrics*

**Conclusion:** The prototype knitted spacer fabrics with 12 and 24 gauge constructions have different levels of total porosity which make them suitable for different cell lines with a range of different sizes from fibroblasts[1] (15 - 20 μm) to pancreatic islets[2] (>100 μm). From the measurement of mechanical and biological properties, it is concluded that both prototype scaffolds are biocompatible and support the adhesion and proliferation of cells. Further evaluation of the structures in terms of pore size distribution, dynamic mechanical properties and cellular response through the thickness are continuing. This will lead to the use of resorbable polymers and fibers, such as polylactic acid (PLA), as future scaffold materials.

**References**

1. S Chun, Y Huang, WJ Xie et al. Adhesive growth of pancreatic islet cells on a polyglycolic acid fibrous scaffold. Transplantation Proc. 40:1658-1663 (2008).
2. MC Demirel, E So, TM Ritty et al. Fibroblast cell attachment and growth on nanoengineered sculptured thin films. JBRM Appl Biomater 81B: 219-223 (2007).

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