DEPARTMENT OF BIOMEDICAL ENGINEERING

UAB Schools of Engineering and Medicine

Ph.D. Dissertation Defense

Department of Biomedical Engineering

Timothy Fee

"ELECTROSPUN POLYCAPROLACTONE SCAFFOLDS: MECHANICAL PROPERTIES, ALIGNMENT QUANTIFICATION, AND TOPOLOGY INDUCED GENE EXPRESSION"

12:00 pm –1:00 pm

Tuesday, March 1, 2016

Shelby – Room 817

Thesis Committee:

Dr. Joel Berry, Chair
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Producing tissue engineering scaffolds which mimic the structure and mechanical properties of the native extracellular matrix (ECM) is an important challenge in developing synthetic tissue replacements. Electrospinning is a frequently used technique to fabricate 3D nanofibrous scaffolds which match the dimensions of the fibrous elements of ECM. However, the mechanical behavior of electrospun materials is complex and challenging to predict. To aid in understanding the mechanical properties of electrospun materials, a microtensile testing platform was developed. This platform was used to quantify the mechanical properties of arrays of individual electrospun nanofibers. Additionally, this device permitted optical strain recording to visualize the true strain along the length of an electrospun fiber. To investigate the importance of fiber alignment within electrospun scaffolds, a metric of fiber alignment first needed to be defined. Using an image-based method, a metric for quantifying the alignment of fibers within an electrospun material was developed. It was found that this metric was correlated with the mechanical anisotropy of scaffolds fabricated under various conditions. Finally, the influence of fiber alignment on adherent cell behavior was examined. It was found that fibroblasts on aligned scaffolds elongate and reoriented to mirror the topological arrangement of their substrate. While fiber alignment does not significantly alter proliferation, the addition of 10% gelatin to the electrospun fibers did significantly increase cell proliferation compared to 100% polycaprolactone scaffolds. Additionally, it was found that fibroblasts on aligned scaffolds express genes related to actin production, actin polymerization, and focal adhesion assembly at higher levels than fibroblasts on randomly oriented scaffolds. These results improve the ability to understand and predict the cellular response to fiber alignment in electrospun tissue engineering scaffolds.