ENGR 491 – Rapid Production of Engineered Tubular Tissues by Rotary Jet Spinning

Our Grand Challenge

In collaboration with stem cell biologists, we will employ engineering skills toward the creation of tubular tissues such as blood vessel, trachea or ureter with microfibers. To accelerate production rates, we will employ rotary jet spinning to generate microfibers at rates two orders of magnitude faster than with conventional electrospinning without requirement of an electric field and charged solution. In parallel, we will develop a perfusion system to optimize stem culture conditions in the engineered tissues.

Project Goals

We have demonstrated that rotary jet spinning successfully produces microfiber networks of polymers accepted by the FDA for surgical implantation. Importantly, we can collect these fibers on spinning mandrels to rapidly generate tubular scaffolds that support cell culture. These scaffolds mimic the fibrillar architecture of human tissues. Prototypes for the rotary jet spinning system and bioreactor have demonstrated initial feasibility, but there is much room for optimization.

One team will focus on optimizing the rotary jet spinning system for collecting fibers onto an array of rotating spindles for rapid tubular scaffold fabrication. The second team will focus on developing a perfusion bioreactor for long-term culture of stem cells in the tubular scaffolds. Strong synergy between these teams is needed for the overall success of the project.

Key challenges:

- Design and manufacture a new rotary jet spinning system with an array of collection spindles
- Optimization of process procedures for reproducible tube fabrication
- Design and implementation of manufacturing quality control standards
- Successful culture of cells in the scaffolds for up to 3 weeks

Impact to Society

- Replacement of diseased and damaged tissues
- Reduced need for organ donation
- Novel biomanufacturing and processing methods for engineering tissues

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Faculty Mentors

Roland Kaunas (BMEN and Molecular/Cellular Medicine)
Wayne Hung (ETID and MEEN)
Tech Advisor: Carl Gregory (Molecular/Cellular Medicine and BMEN)

Desired Engineering Majors

This project incorporates polymer science, material processing, design & fabrication, process optimization, cell biology, thus we will be targeting students from biomedical, mechanical, industrial, chemical, aerospace engineering, materials science and engineering technology.