# Design, Manufacture, and Test an Electrospinning Machine

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## Background

UT Tyler sought the development of a low-cost electrospinning machine to generate medical-grade tissue scaffolds. Nanofiber scaffolds are created during the electrospinning process.

## Specifications

| | |
|---|---|
| • Voltage Control | 0 - 30 kV |
| • Infusion Flow Rate: | 0.1 - 5.0 mL/s |
| • Speed : | ≤ 300 RPM |
| • Needle-to-Collector Distance | 10 - 40 cm |
| • Collector Diameter: | 100 mm |
| • Design Multiple Collectors: | Plate, Wire, Drum |

## Journey of a Collector

The most difficult part of the project was the mechanical design of the Drum Collector. Each iteration improved on the previous design.

- What material should be used?
- Should it be hollow or solid?
- How does it spin?
- How should it be supported?
- How does the motor attach to the shaft?
- How to conduct current through a rotating drum?

***Figure 1:*** *First mechanical prototype of a rotating collector drum using PVC pipe*

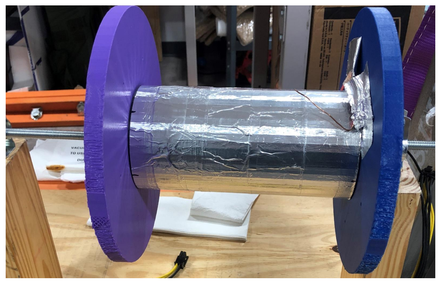

***Figure 2:*** *Custom 3D-printed interconnect allows conduction from power supply to slip ring, to collector*

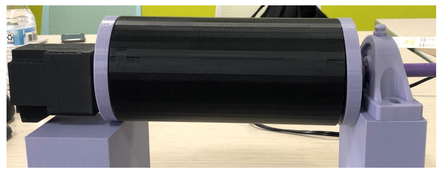

***Figure 3:*** *Many off-the-shelf parts were incorporated, and 3D printed. Shown is the speed-controlled motor, drum, interconnects, shaft, bearings and stands.*

***Figure 4:*** *Final design is printed. Wire Collector fits inside a standard 4" pipe. Together they form the Drum Collector.*

## Objective

- Design, Build, and Test an Electrospinning Machine
- Be far more flexible, modular, and cheaper than commercially available machines
- Facilitate the reliable, repeatable research into the optimal nanofiber creation
- Provide unprecedented control over every parameter
- Be controllable from LabVIEW
- Provide a simple, intuitive interface

## Abstract

Electrospinning refers to the collection of fibers, or spinning, about a cylinder by use of an electrostatic field. An Electrospinning Machine consists of four major components: a high voltage power supply, syringe pump with syringe, motor, and a conductive collector

- A polymer-filled syringe placed into a syringe pump and charged with up to 30 kV
- The pump discharges the polymer
- The motor rotates a negatively charged Wire/Drum Collector
- Nanofibers emerge from the syringe in the form of a jet stream, attracted to a negatively charged collector
- Fibers are spun into tiny scaffolds about the Wire/Drum Collector

The scaffolds are used to grow cells. The thinner fibers allow better cell adhesion. The control, reliability, and repeatability of the process is paramount to allow the University to research the optimal parameters for the best scaffolds.

## Electrospinning Machine: More Than the Sum of its Parts

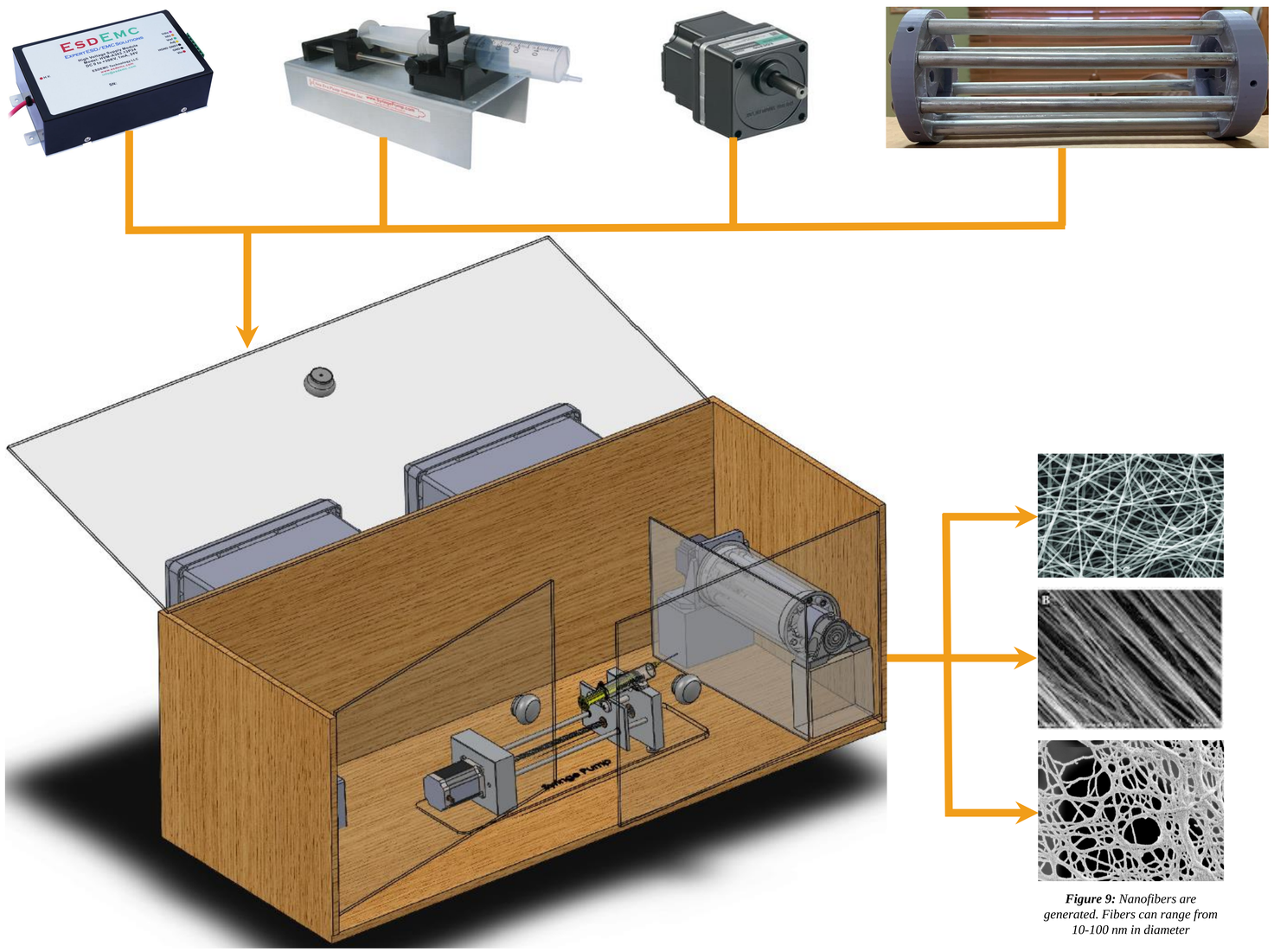


***Figure 5:*** *High Voltage Power Supply, Syringe Pump with Syringe, Motor, and Wire Collector are shown (Top). Electrospinning Machine with three collectors are shown. Doors allow easy access to the parts, while isolating the process from the environment (Left)*




***Figure 9:*** *Nanofibers are generated. Fibers can range from 10-100 nm in diameter*

## LabVIEW Automation

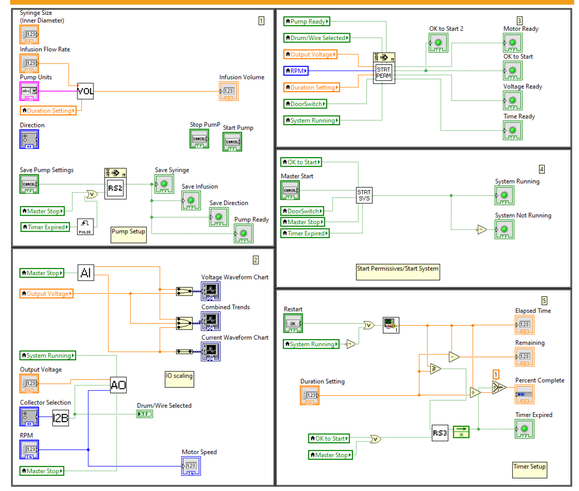

***Figure 6:*** *LabVIEW logic works behind the scenes to control the process. Complex combinational and sequential logic was developed. Boxes group the logic by function*

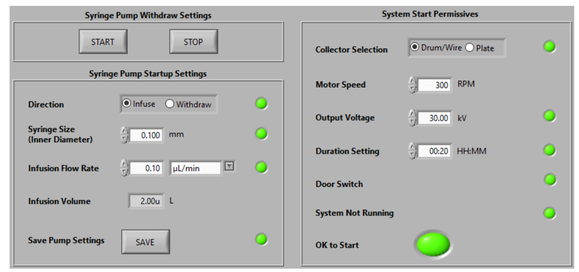


***Figure 7:*** *Custom LabVIEW interface was developed to allow a safe, flexible, and intuitive startup. The interface was design with simplicity in mind*

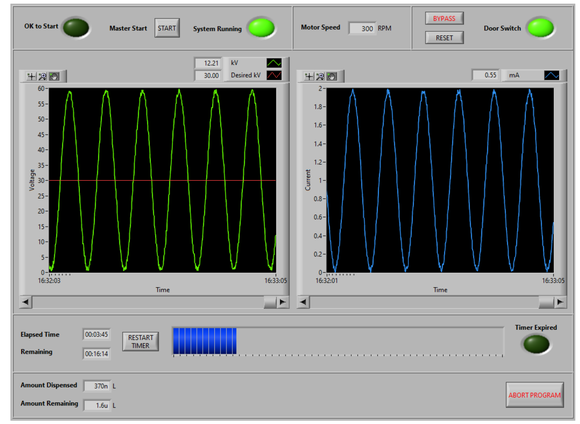


***Figure 8:*** *Interface allows real-time monitoring and control of the Electrospinning Machine. The trends can be changed in real-time*

## Conclusion

The electrospinning device creates medical-grade scaffolding. The machine is extremely flexible, allowing the choice of syringe size, polymer flow rate, collector speed and selection, voltage, and run time. It is an affordable device for educational and nanofiber research. It is less than 1/3 the cost of competing commercial products while being far more flexible and configurable. The device will be used for research by the university. Further, it aids in the learning process of scaffold generation in materials science laboratory classes.

## Acknowledgement

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