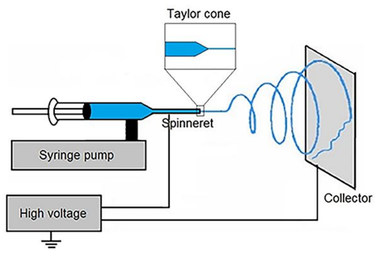
Electrospinning around the World

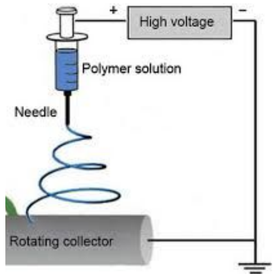
NanoQuEST

Summary

Electrospinning around the World is a collaborative research project investigating the impact of variations in equipment and solution used in the electrospinning of nanofibers. This project is in collaboration with Dr Marcus Johns, Mike Boyer and the US team from North Penn High School and a team from Benenden School. The current focus of our research is how a rotating drum collector will impact the fibers that we spin and how the age of the solution impacts the fibers.



Setup 1 - Perpendicular plate Collector



Setup 2 - Experimental Rotating Collector

Setups

One setup involves our newly developed rotating drum that we are currently testing. Using a rotating collection plate rather than a flat perpendicular plate has been proven to align the fibers in lines, making it easier to measure their thickness. We are planning to continue to develop our prototype and then investigate how the rotation speed influences the fiber formation and organisation.

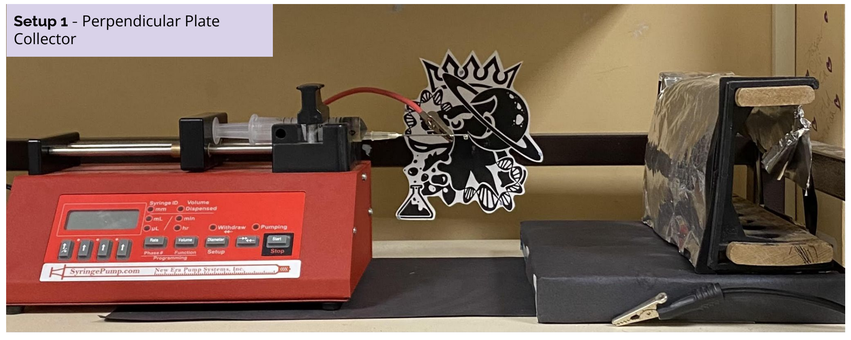
The other setup is (the original setup) with the perpendicular plate. We use this setup to test how the age of solution impacts how thin the fibers spin. We make one batch of either a phosphate or an acetate solution and spin it over the course of a school term (~6 weeks) at different intervals. Then we record how quickly it spins after each period of time from when the solution was originally made as well as looking at the fibers under a light or scanning electron microscope to see how thin it is.

Experimental Method

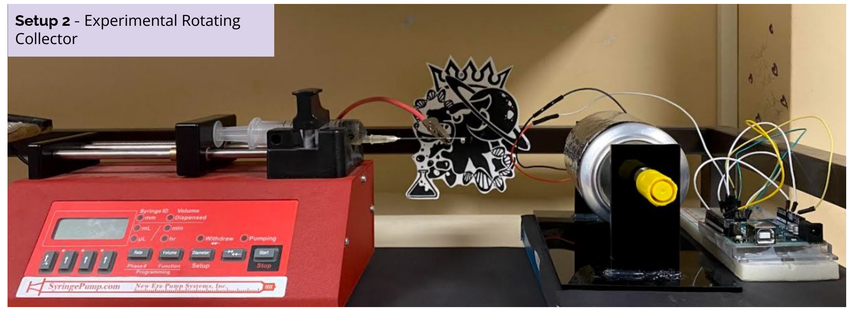
- When a sufficiently high voltage is applied to the solution, it becomes charged, electrostatic repulsion counteracts the surface tension and the droplet is stretched.
- At the critical point a stream of liquid erupts from the surface. If the molecular cohesion of the liquid is sufficiently high, the fiber will form properly and is electrically charged.
- The fiber is then elongated by electrostatic repulsion, until it is deposited on the grounded perpendicular plate collector.
- The elongation and thinning of the fiber resulting from this bending instability leads to the formation of uniform fibers in the micro and nano scales.

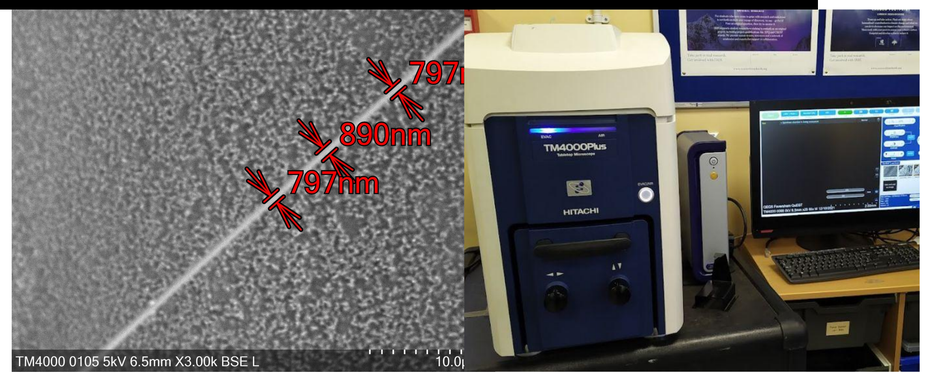
The solution used for the electrospinning process is a mixture of an ionic solution (1-ethyl-3-methylimidazolium acetate or phosphate) with DMSO and alpha-cellulose. Alpha cellulose is just one type of cellulose however in most cases beta and gamma Cellulose lack the polymer chain length to be spun into fibers so we are only using the alpha cellulose.

Setup 1 - Perpendicular Plate Collector



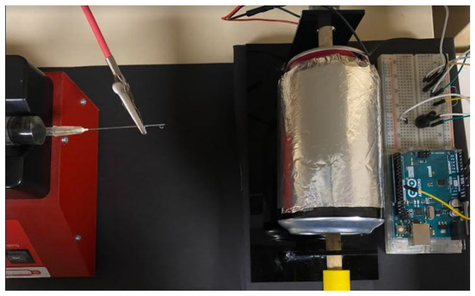
Setup 2 - Experimental Rotating Collector

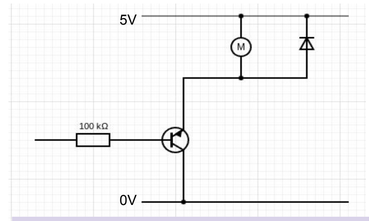




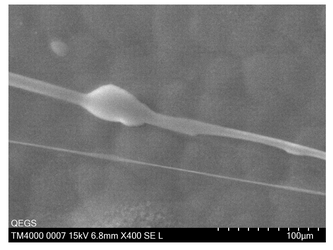
This is an SEM image of a confirmed nanofiber using the SEM at our school. The more common fibers we locate are in the micro scale therefore to find one in the nanoscale was reassuring that our process is going in the right direction for further nanofiber production.

The syringes we use have a down-turned pointed tip.





Circuit Diagram for the Motor setup running with the arduino



Solution Aging

- Testing age of solutions and its effect on frequency of spins
- Results suggest after 4 weeks they don't spin
- 1-2 weeks is optimal, however further testing will be done to confirm this result

Rotating Drum

- Successfully spun aligned fibers
- Yet to find some nanofibers with the drum, but have found microfibers
- Drum conductivity is unreliable currently and it has occasional issues with connecting to the drum

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