

Centrifuge Fiber-Spinning Setup for Production of Micro/Nano Fibers

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What is centrifugal fiber-spinning?

Centrifugal fiber spinning is a technique to produce micro/nano polymer fibers using centrifugal force.

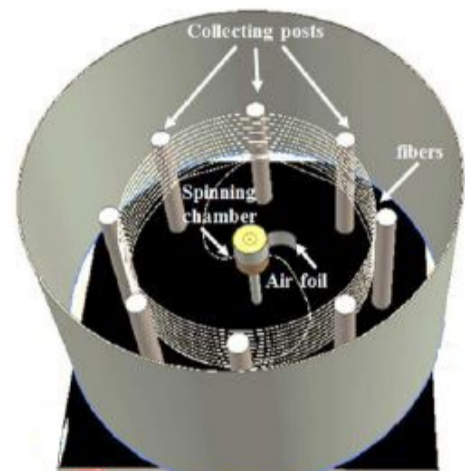


Figure 1: Schematic drawing of centrifugal jet spinning system

In case of centrifugal fiber spinning, the fluid polymer is added to a cup that is spun at high rpm. Once the centrifugal force exceeds the surface tension and viscous resistance of the fluid polymer, it gets ejected from holes on the sides of the cup. The ejected polymer solidifies into fibers, that can be collected.



Figure 2: Original setup

Aim

The current setup consists of a lab centrifuge with plastic Eppendorf pipettes with a needle protruding from them. The Eppendorf pipettes are filled with a polymer solution consisting of a polymer and a strong solvent. The setup does not allow the operator to change variables that are important for a fundamental research. These variables are:

- Collection distance,
- Rotation speed,
- Orifice diameter.

Additionally, the collection height is fixed. The existing centrifuge spins all fibers at the same height, collecting them on top of each other. This makes it difficult to separate them, which makes it hard to characterize them using a microscope. The aim is to design a sturdy and adjustable centrifuge, that is able to facilitate fundamental research on the subject of fiber spinning.

Version 1



Figure 3: Spinneret version 1



Figure 4: Cup with lid

- 3 sets of different orifice sizes
 - 0,3 mm; 0,6 mm; 1,0 mm
- 37 mm diameter of the cup
- Direct mount to motor shaft
- Continuous feed through hole in the lid
- Lid with O-ring to resist leaks from rising fluid

Version 2



Figure 5: Spinneret version 2



Figure 6: Interchangeable tips

- Interchangeable tips
 - orifice sizes 0,3 mm; 0,6 mm
- 90 mm length
- Direct mount to motor shaft
- Continuous feed through hole in the top
- Teflon tips, to alter fiber morphology

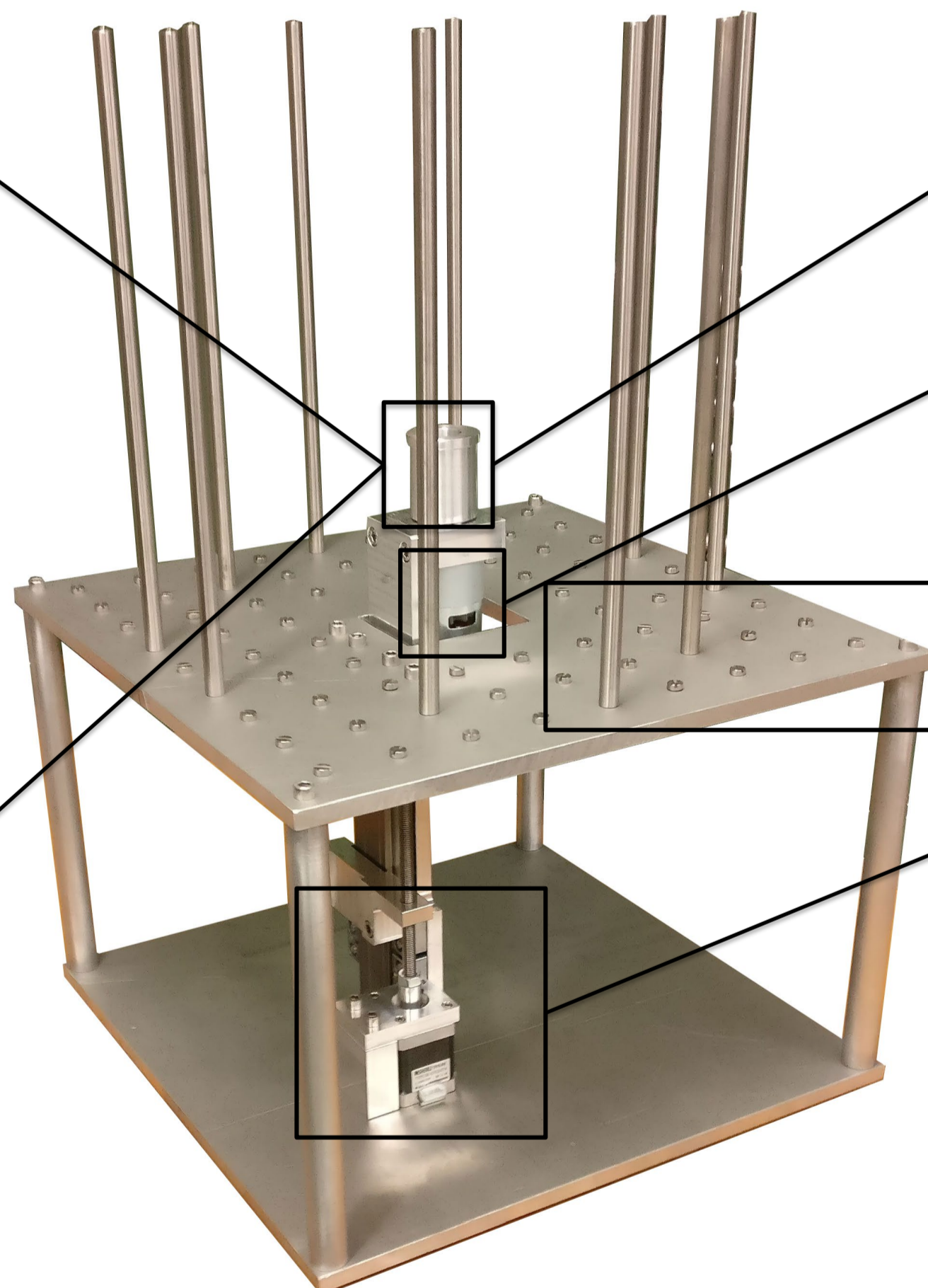


Figure 7: New setup

Requirements

Adjustable Nozzle Sizes

- Aluminum for light weight and strength
- Different nozzle sizes drilled into the spinneret

Variable Rotation Speed

- DC motor + Variable power supply
- Increasing voltage, increases rpm

Variable Collection Distance

- Alter post position to change collection distance
- Screw fitting to make repositioning easier

Lifting System

- Stepper motor
- Threaded rod
- Lifting arm
- Guide rail

Sturdy Build

- Durable assembly
- Rigid connections limit vibrations
- Guide rail as additional support

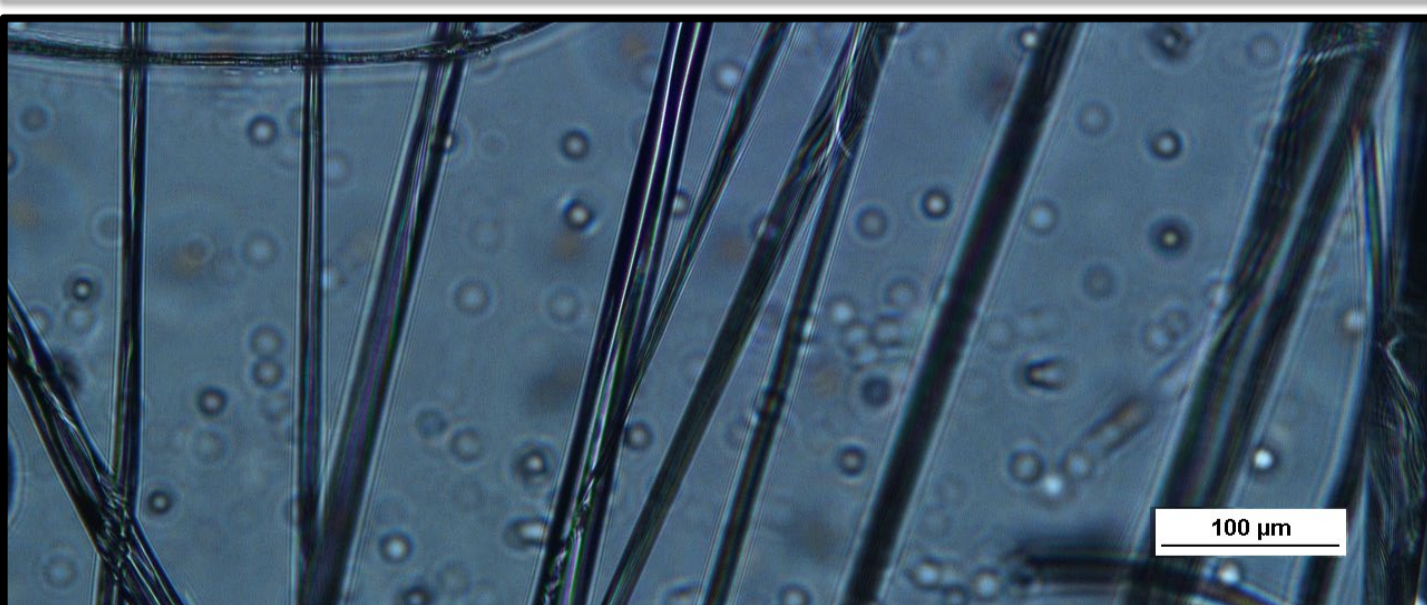
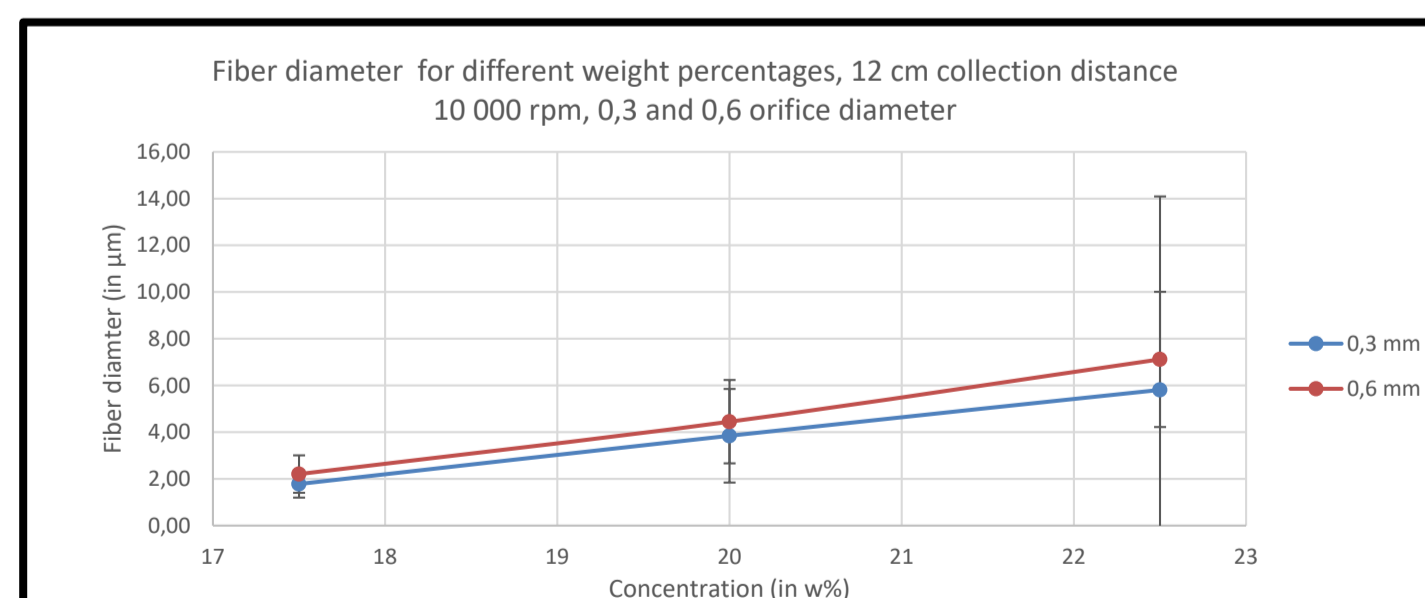
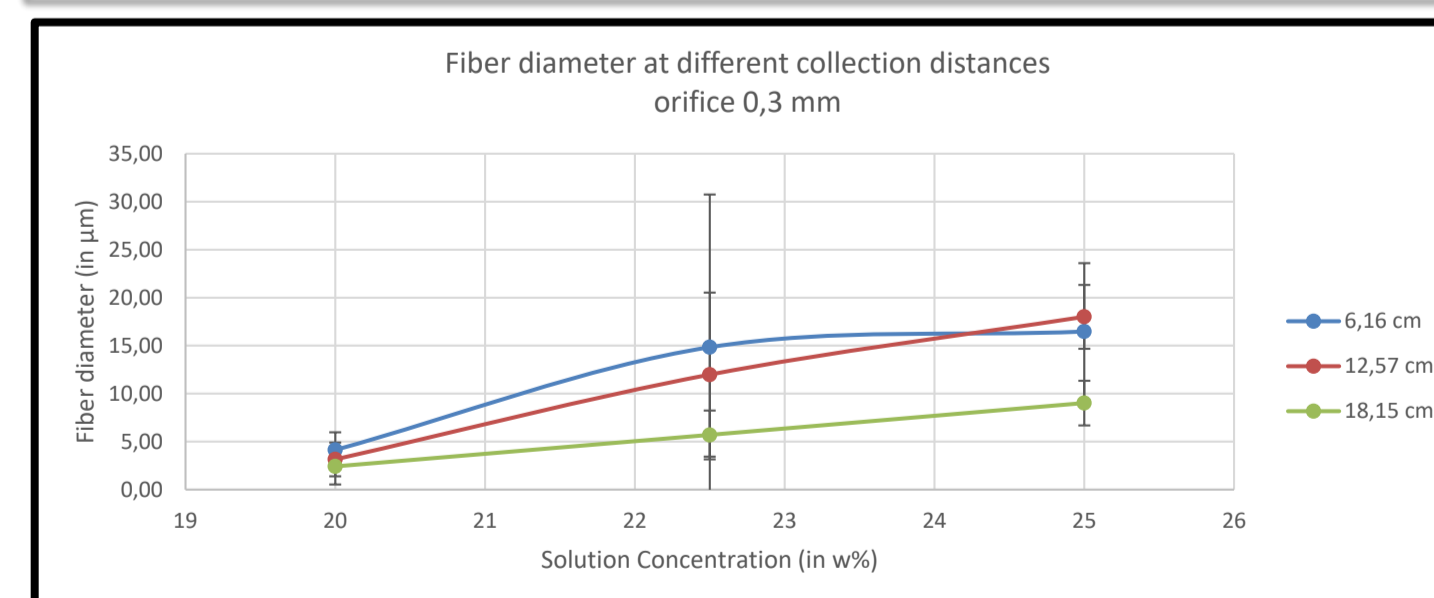


Figure 8: Microscope image of spun fibers made out of PS in THF solution



Graph 1: Effect of variable orifice diameter



Graph 2: Effect of variable collection distance

Fiber Characterization

Fiber characterization is done with a microscope and with image processing software to calculate the diameter of the fibers. A digital camera is fixed to the microscope to take pictures of the spun fibers. Image processing is performed using ImageJ's Diameter macro. The pictures are segmented to separate the fiber from the background. Fiber thickness can be calculated from those pictures. Further testing needs to be done to conduct an in-depth research on the subject of centrifugal fiber spinning.

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