Electrospun Polymer Fibers For Composite Applications

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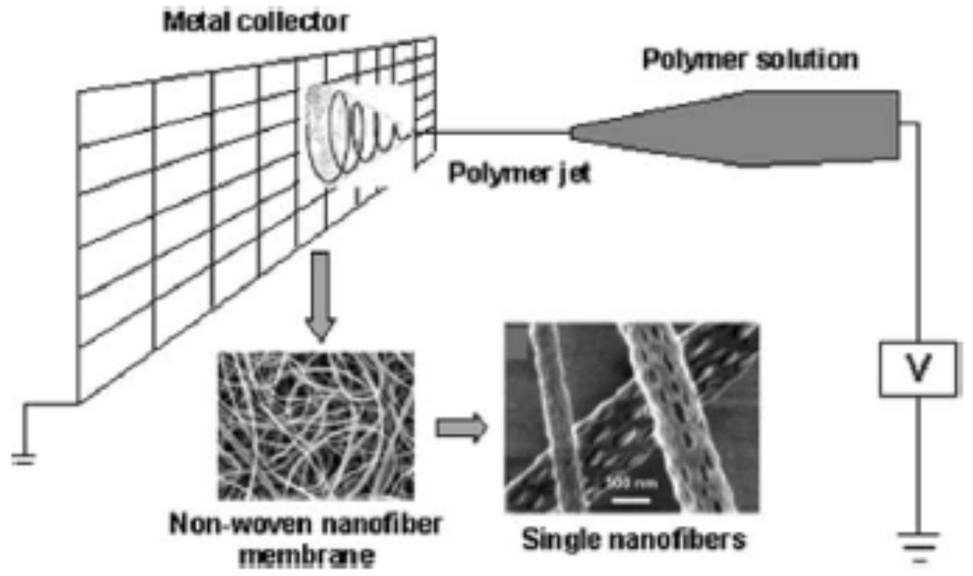
INTRODUCTION

Electrospinning is method of producing micro- and nanoscale polymer fibers through the action of external electric field imposed on polymer solution or melt.

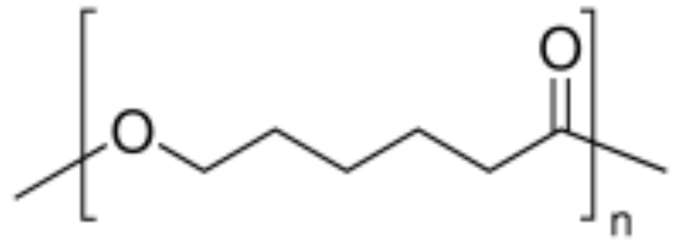


High surface area and high aspect ratio of the nanofibers are very important parameters determining unique properties of these materials.

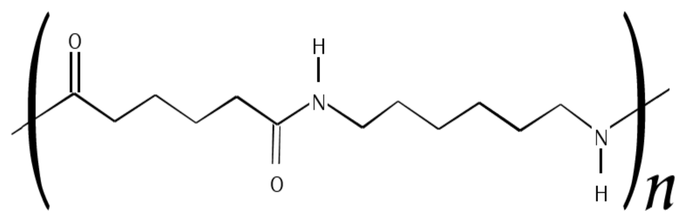
Applications for electrospun fibers:

- ✧ Biomedicine: wound dressing, tissue engineering scaffolds
- ✧ Chemical technology: catalysts, membranes/filters
- ✧ Electronics: magnetic and conductive inorganic nanofibers
- ✧ Composites: reinforcement filler (toughening component)

MATERIALS

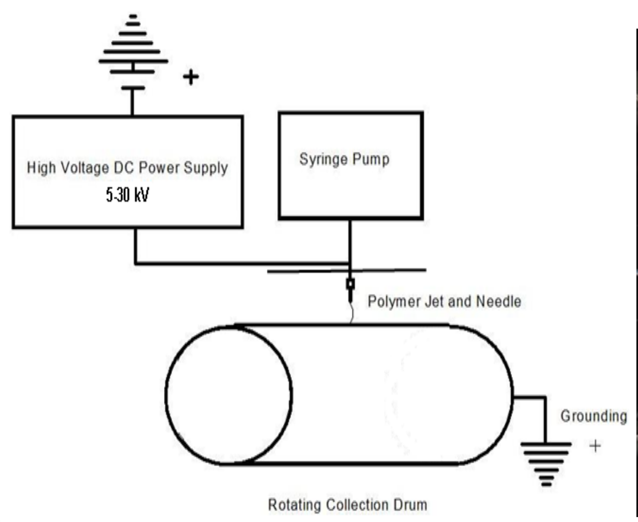


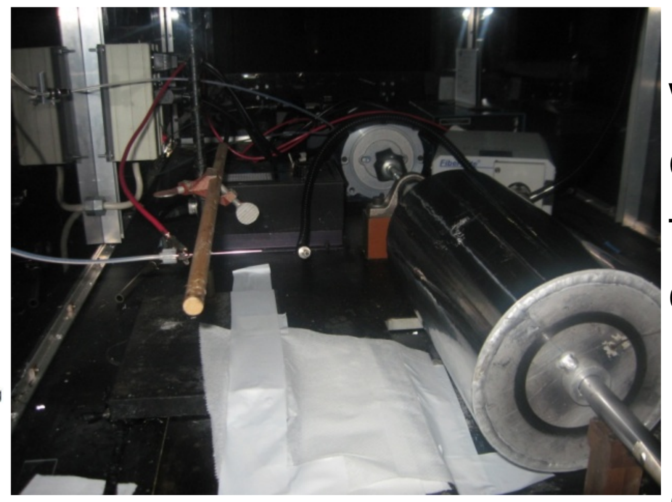
Polycaprolactone (PCL): promising polymer for biomedical applications (wound dressing, artificial organs, tissue engineering scaffolds).



Nylon 6,6: high performance polymer with very attractive mechanical properties that is of interest as toughening filler for composites.

EXPERIMENTAL SETUP

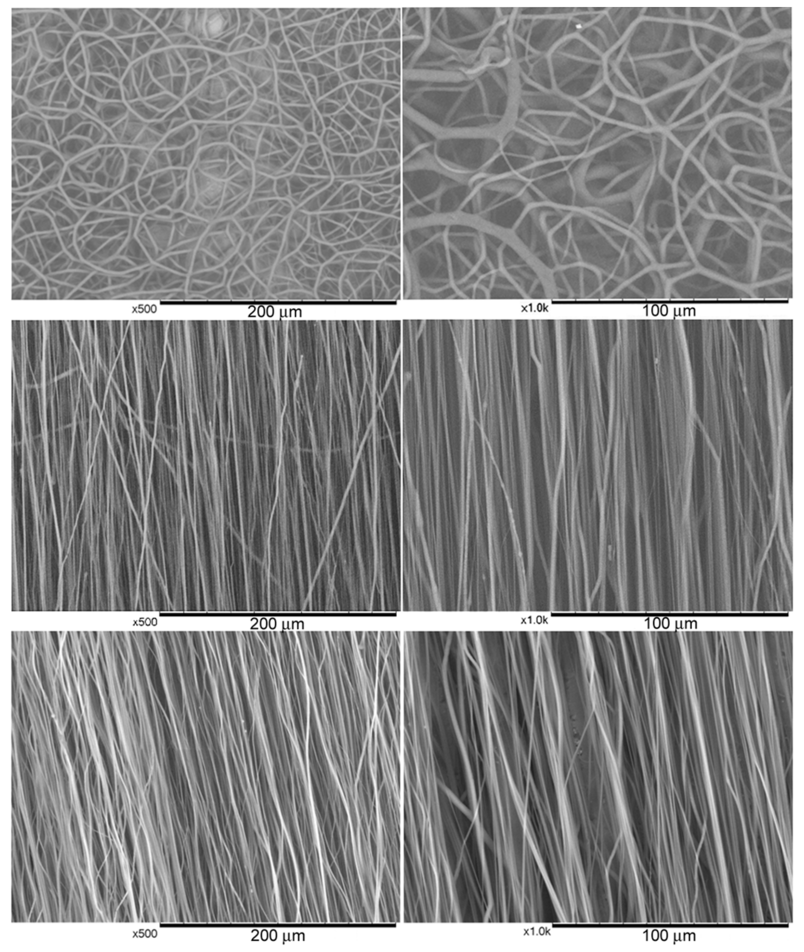




Rotating drum was used as collection target for fiber deposition. Drum velocity: 100-2000 rpm (0.7-16 m/s).

Voltage: 15-18 kV; Solution feed rate: 0.3-0.5 ml/hr

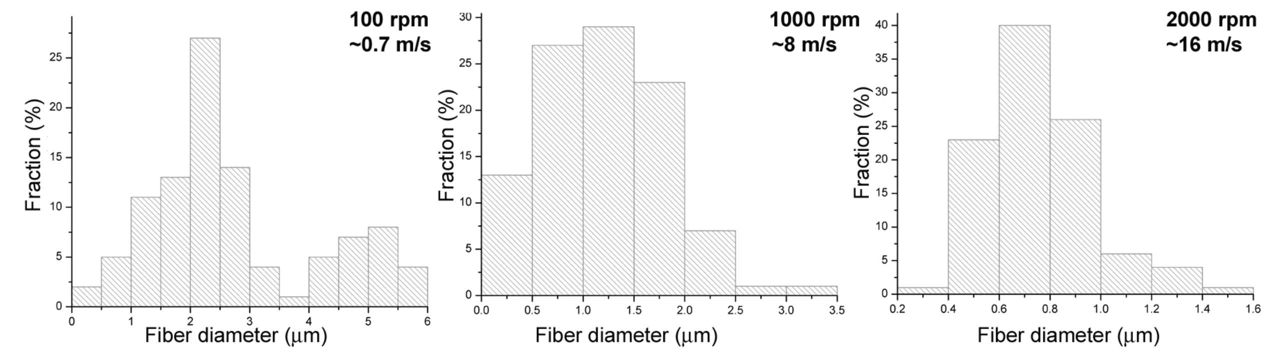
MORPHOLOGY OF PCL FIBERS



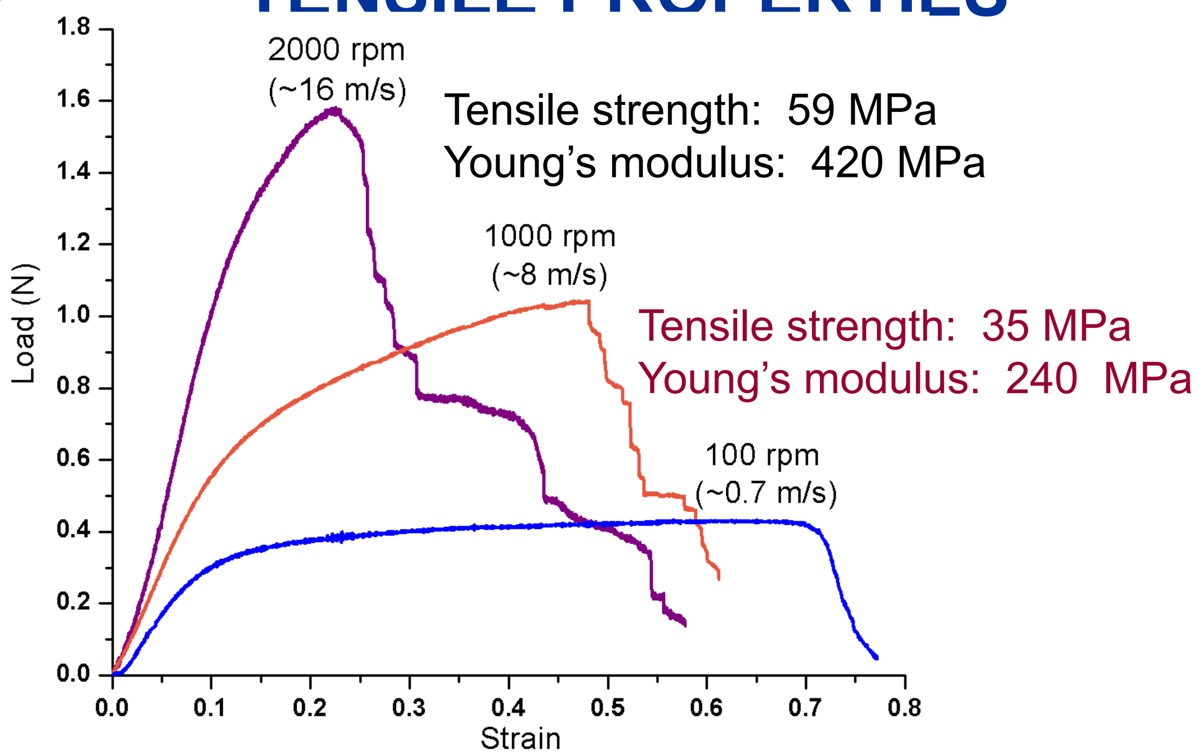
100 rpm (~0.7 m/s) — Average fiber diameter: ~2.7 μm

1000 rpm (~8 m/s) — Average fiber diameter: ~1.18 μm

2000 rpm (~16 m/s) — Average fiber diameter: ~0.75 mm



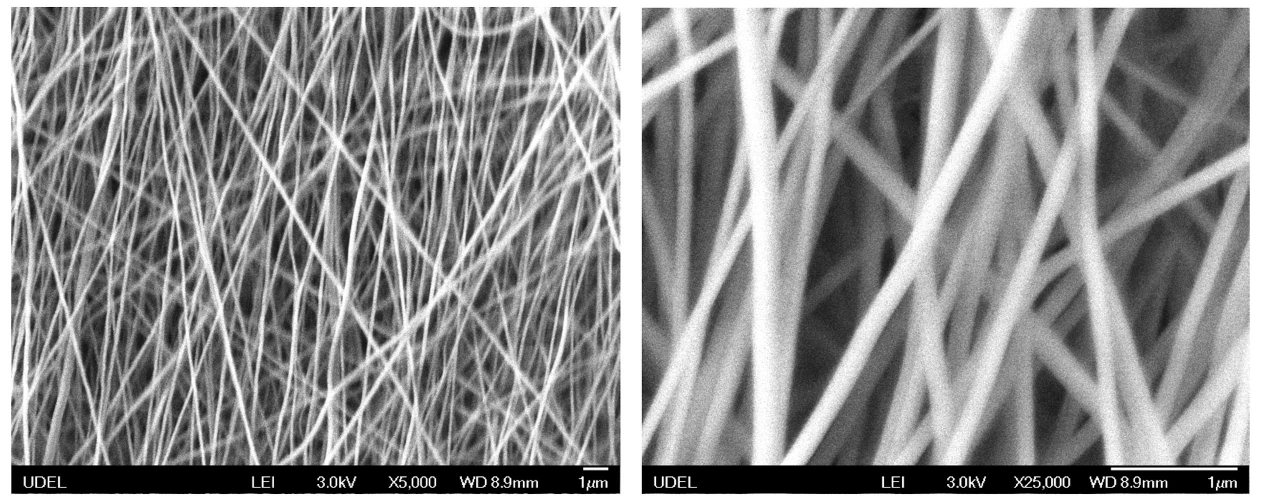
PCL FIBERS: TENSILE PROPERTIES



Both tensile modulus and tensile strength increase with a drum velocity.

Fiber mechanical properties can be tuned directly in the spinning process.

SPINNING OF NYLON 6,6 NANOFIBERS



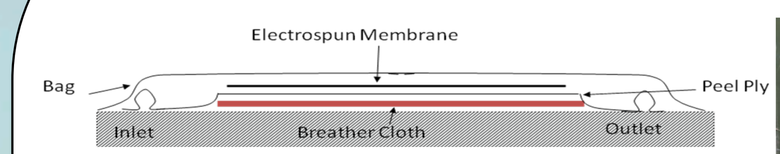
Nylon 6,6 was spun from the mixture of formic and acetic acid at 1500 rpm (~12 m/s).

Average fiber diameter: ~100 nm

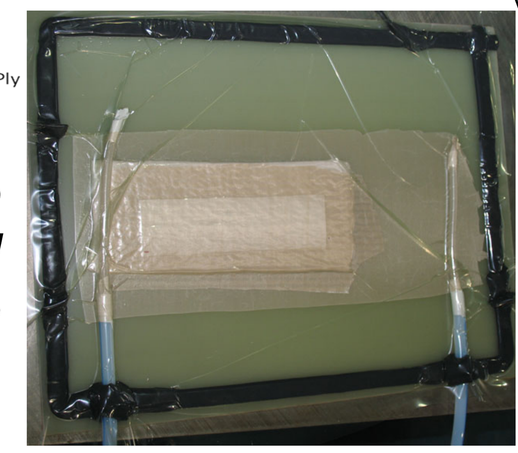
Polar solvent induces jet instability during electrospinning process lessening fiber alignment.

However, uniaxial orientation of fibers is not necessary for toughening applications in composites.

COMPOSITE FABRICATION



Scheme of VARTM procedure for fabricating epoxy-based composites filled with electrospun polymer nanofibers



The feasibility of conventional VARTM technique for the fabrication of the epoxy-based composites reinforced with electrospun fibers was experimentally verified in this work.

- ➢ Primary limitation: zero in-plane permeability of electrospun fabrics.
- ➢ Resin flow was maintained through the thickness of the electrospun fabric using special carrier layer (breather cloth).

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