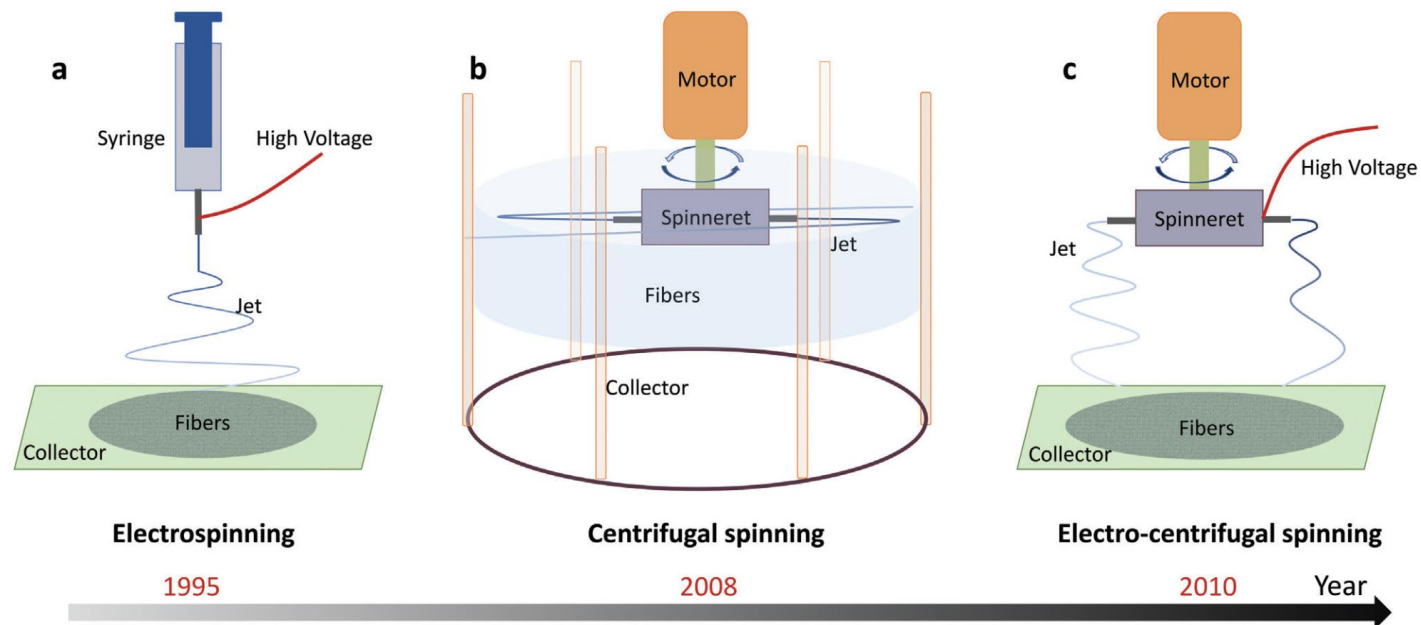


# Hybridspinning technology (FZP UJEP & NST)

Combination of centrifugal and electrostatic spinning



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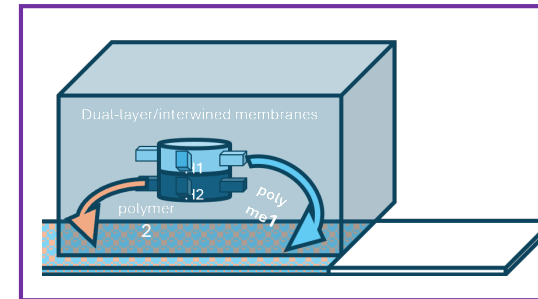
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# Hybridspinning technology (FZP UJEP & NST)

## Combination of centrifugal and electrostatic spinning

### KEY PARAMETERS

- Semi-industrial spinning compatible with the NST production line (straightforward upscaling)
- Dual-layer/interwined membranes
- Maximum spinneret rotation is 15,000 rpm
- Membrane width: 50 cm
- Substrate feed rate: up to  $0.5 \text{ m s}^{-1}$
- **Production yield:**
  - UJEP:** for 5 gsm, it is about  $0.3 \text{ m min}^{-1}$
  - NST:** for 5 gsm, it is about  $1.2\text{--}2.4 \text{ m min}^{-1}$
  - (classical electrospinning: hours for A4-like sample size)
- Flexible unit allowing many additional modifications (inert atmosphere, spray coating, NIR automated fiber detection...)

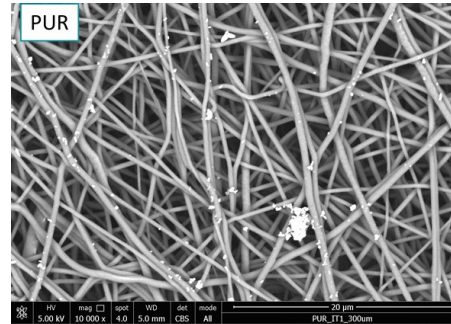


# Comparison of the two solution spinning technologies

## ELECTROSPINNING

### MEMBRANE STRUCTURE

- 2-D planar structure
- Thinner membranes



- Lower mechanical resistance
- Lower permeability
- One polymer in one membrane (or „core-shell-like/co-axial“ morphology, which is difficult to be produced on industrial scale)

### PRODUCTION COST

- NO waste production (dead volume in the filling system)
- Requires more solution to start the process
- Slow production (20× lower yield to spinning head/string)
- Easy roll-to-roll technology

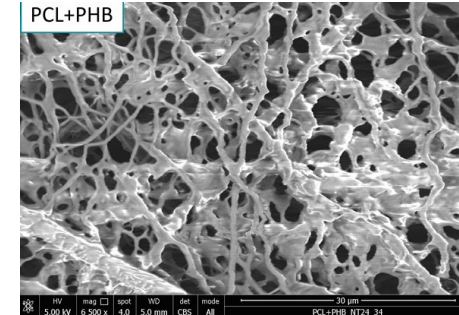
### FIBER MORPHOLOGY

Diameter ~100–400 nm

## HYBRIDSPINNING

### MEMBRANE STRUCTURE

- 3-D structures
- Thicker membranes



- Higher mechanical resistance
- Higher permeability
- Combination of up to 4 (nanoSPACE Technology) or 2 (UJEP) polymers in one membrane structure
- Water-based solutions
- Dopants are not negatively affected by the high voltage (crystallization, oxidation)

### PRODUCTION COST

- ZERO waste production (all solution processed into fibers)
- Starting with 0.5 kg of solution
- Faster production (20× higher yield to spinning head/string)
- Easy roll-to-roll technology

### FIBER MORPHOLOGY

Diameter ranging between <100–800 nm

Spinning is not limited by the conductivity of polymer or substrate, and solution viscosity