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A Review on Nano-Fiber Fabrication Methods by Near-Field Electrospinning

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INSTITUTO TECNOLÓGICO Y DE ESTUDIOS SUPERIORES DE
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Abstract

Faculty: Nanotechnology

School of Engineering and Sciences

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Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

keywords: nanotechnology, nano-fiber, near-field electrospinning, NFES

1 Summary

TABLE 1.1: Electrospun Polymer Solutions - Solution and Process Parameters

Polymer(s)	Solvent(s)	NFES Variant	Polymer Solution and Process Properties	Fiber Characterization	Ref.
Poly(ethylene oxide) (PEO)	Deionized water	Mechano electrospinning	<ul style="list-style-type: none"> • PEO Concentration: 1, 2, and 3 <i>wt%</i> • Rise in solution conductivity with the increase in PEO concentration • Solution Stirring: 24 <i>h</i> of free diffusion followed by 96 <i>h</i> of stirring at 30 <i>rpm</i> • 3 <i>mL</i> syringe • 27 gauge type 304 stainless steel needle • Solution deposition rate: lower than 1 $\mu\text{L}/h$ • needle-to-collector distance: 1 <i>mm</i> • Collector substrate: Pyrolyzed SU-8 carbon and Si • NFES process initiated by an air interference with a glass microprobe tip (1 to 3 μm tip diameter) to overcome the surface tension • Time to produce a stable continuous jet: 45 <i>min</i> • Polymer jet initiated at 400-600 <i>V</i> and dispensed at 200-400 <i>V</i> • Collector linear speed: 10-40 <i>mm/s</i> • The voltage turned on when the solution formed a full-sized droplet of 500 μm diameter at the needle tip. 	<ul style="list-style-type: none"> • Diameter: 50-425 <i>nm</i> 	[1]

TABLE 1.2: Electrospun Polymer Solutions - Solution and Process Parameters

Polymer(s)	Solvent(s)	NFES Variant	Polymer Solution and Process Properties	Fiber Characterization	Ref.
Poly[2-methoxy-5-(2-ethylhexyloxy)-1,4-phenylenevinylene] (MEH-PPV) with Poly(ethylene oxide) (PEO)	acetonitrile / toluene mixture (65 / 35); acetic acid / toluene (17 / 83); pure toluene	Mechano electrospinning	<ul style="list-style-type: none"> • Concentrations: <ul style="list-style-type: none"> – MEH-PPV solution: 10 <i>mg</i> of MEH-PPV in 2 <i>mL</i> of toluene – 500 μL of MEH-PPV solution with 250 <i>mg</i> of PEO in 3.5 <i>mL</i> of acetonitrile / toluene (65 / 35) – 500 μL of MEH-PPV solution with 250 <i>mg</i> of PEO in 3 <i>mL</i> of acetic acid / toluene (17 / 83) – The resulting MEH-PPV/PEO concentration is 1:100 • Solution Stirring: MEH-PPV solution stirred for 4 <i>h</i>; PEO solution stirred for 8 <i>h</i>; MEH-PPV/PEO solution stirred and ultrasonically agitated • Collector substrate: SiO₂/Si (oxide thickness = 800 <i>nm</i>) • needle-to-collector distance: 500 μm • μm-diameter tip Tungsten spinneret in a 26 gauge needle • Solution deposition rate: 50 $\mu\text{L}/\text{h}$ • Electrostatic voltage: around 1.3 <i>kV</i> • x-y stage velocity: 50 <i>cm/s</i> 	<ul style="list-style-type: none"> • Distance between adjacent fibers: around 100 μm • Fiber diameter: around 100 <i>nm</i> 	[2]

TABLE 1.3: Electrospun Polymer Solutions - Solution and Process Parameters

Polymer(s)	Solvent(s)	NFES Variant	Polymer Solution and Process Properties	Fiber Characterization	Ref.
Poly(ethylene oxide) (PEO)	Water	Mechano electrospinning	<ul style="list-style-type: none"> • 7 wt % PEO aqueous solution • Under room temperature at 1 <i>atm</i> • needle-to-collector distance: 500 μm • needle diameter: outer: 200 μm; inner: 100 μm • applied voltage for jet initiation: 1.5 <i>kV</i> • applied voltage for fiber deposition: 600 <i>V</i> • Mechanical drawing is applied by using a tungsten probe with 1 μm tip diameter to poke inside the meniscus. • The probe is then rapidly pulled away from the polymer droplet to activate the continuous electrospinning process • polymer jet diameter: 3 μm • polymer feed rate: 0.1 $\mu\text{L}/\text{h}$ • x-y stage velocity: 120 <i>mm/s</i> 	<ul style="list-style-type: none"> • 108 <i>m</i> yield in 15 <i>min</i> with a fiber diameter of $709 \pm 131 \text{ nm}$ • Fiber diameter: around 49-74 <i>nm</i> when applied voltage is 800 <i>V</i> 	[3]

TABLE 1.4: Electrospun Polymer Solutions - Solution and Process Parameters

Polymer(s)	Solvent(s)	NFES Variant	Polymer Solution and Process Properties	Fiber Characterization	Ref.
Poly(ϵ -Caprolactone) (PCL)	<i>Not applicable.</i>	Melt Electro-spinning Writing (MEW)	<ul style="list-style-type: none"> • Collector substrate: NCO-sP(EO-stat-PO)-coated glass slide surfaces • fibre diameters are between 5 and 30 μm 	<ul style="list-style-type: none"> • 1 • 2 	[4]

TABLE 1.5: Electrospun Polymer Solutions - Solution and Process Parameters

Polymer(s)	Solvent(s)	NFES Variant	Polymer Solution and Process Properties	Fiber Characterization	Ref.
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