
Fluidnatek® LE-100

Laboratory electrospinning/-spraying machine



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The Fluidnatek® LE-100 Laboratory electrospinning machine is the equipment of choice for customers working on advanced development projects, where advanced experimental capabilities, tighter process control and larger sample sizes are key. The Fluidnatek® LE-100 is ideal to explore and develop nanofiber and nanoparticle materials for a wide range of applications, especially those that require good control of the working conditions (relative humidity, temperature, cleanliness, sterility). Crucially for such applications, the Fluidnatek® LE-100 is compatible with our range of climate control systems that ensure optimal and reproducible processing conditions.

Specification	
Operating mode	Batch system
Volume per batch	up to 140 ml per syringe pump
Run time per batch	5 min to 24 h (or longer) Strongly dependent on the polymer solution. The controls allow the user to program the machine to automatically switch off after a set time.
Typical fiber/particle diameters	20 nm up to 10 µm.

Fluidnatek® LE-100 standard platform [LE-100BS]

The Fluidnatek® LE-100 Laboratory electrospinning machine comes as standard with the following features and can be upgraded with optional extras as shown in the next section:

Stainless steel, aluminium and glass frame and enclosures

The cabinet is chemically resistant to organic solvents, enabling proper solvent cleaning. It is designed with a focus on the creation of sterile conditions.

Special safety-encapsulated diffuse LED lighting

To enable proper visualization of the process.

Control from touch screen

The tool is controlled from a touch screen interface through which the user can interact with intuitive software, controlling all the parameters and functionalities. The software can be provided with admin and user access levels.

Ethernet remote diagnostics and software upgrading

Equipped with an Ethernet connection that will permit remote diagnosis and maintenance activities.

One HV power supply (up to 30 kV)

To polarize the emitter. Fully arc and short circuit protected.

Voltage regulation	
Line	<0.01%
Load	<0.01%
Stability	0.01% per 8 hours, 0.02% per day
Accuracy	2% of full scale
Max. output current	0.133mA.

One syringe pump

For accurate control of liquid infusion.

Syringe specification	
Minimum dead volume	to < 0.1 ml
Syringe volume	up to 140 ml
Min-max flow rates	0.1 µl/h – 6000 ml/h (depending on syringe size: e.g. from 9.5 µl/h to 1240 ml/h for a 5 ml BD plastic syringe)
Linear force	100 – 200 N

Single-phase emitter

The spinning head allows for easy removal and replacement of the capillary needle and can use a broad range of needle dimensions (OD: 0.15 – 3.2 mm; ID: 0.08 – 2.6 mm).

Flat plate collector

Horizontally oriented, flat stainless-steel plate collector with dimensions: 400 mm x 400 mm.

Regulation of emitter-collector distance

Manual Z-axis adjustment for the regulation of the distance between the spinning head and collector. Range: 0 to 300 mm.

Temperature and relative humidity display

Equipped with temperature and RH sensors within the spinning chamber that display the real-time environmental conditions on the control panel.

Special castors

Allowing easy positioning of the equipment and then secure solid placement on the floor.

Exhaust system

The equipment is provided with a ventilation fan to properly exhaust evaporated solvents. Fitted with rear port to allow connection to external ventilation via a 125 mm ID duct.

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Safety features

Fluidnatek® equipment is CE compliant, fulfilling all the corresponding EU directives (2006/42/EC, 2004/108/EC, 2006/95/EC). Supplied with a certificate of CE compliance from an independent 3rd party auditor (SGS). This means that the user is completely protected against electrical discharges, despite the high voltages used.

Dimensions [w x d x h]

Fluidnatek® LE-100	896 mm x 1240 mm x 1950 mm
Climate control unit	900 mm x 1100 mm x 1900 mm
Drying heating unit (DHU)	800 mm x 1000 mm x 1400 mm

In addition, the Fluidnatek® LE-100 Laboratory electrospinning machine can be configured with a variety of optional upgrades, which provide additional functionality and enable the system to be tailored to the requirements of your application.

Negative high voltage power supply for collector (down to -30 kV)** [LE-100NHV]

A second HV power supply (negative) for connection to the collector, enabling the generation of a maximum emitter-collector electrical voltage drop of 60kV (up to +30 kV and -30 kV for the emitter and the collector, respectively). This feature allows the accurate control of the process, provides increased potential difference, which can be important when using the multi-emitter spinning head, and improves the collection efficiency of atomized particles/fibers onto the target collector.

2nd syringe pump with coaxial spinning head** [LE-100P2]

Provides independent control of a 2nd solution flow, enabling single-phase or coaxial electrospinning / electro spraying.

See table Syringe specification.

Includes one coaxial emitter for the spinning of core-shell fibers or particles. Capillary needles can be easily replaced and interchanged, allowing the use of a broad range of dimensions (OD: 0.15 – 3.2 mm; ID: 0.08 – 2.6 mm). Other emitter geometries can be custom designed. Additionally, this 2nd syringe pump and coaxial emitter can be used to flow pure solvent through the outer capillary, whilst spinning single-phase fibers or particles through the central capillary, in order to eliminate drying of polymer solution on the emitter tip, which can sometimes occur when working with highly volatile solvents.

3rd syringe pump with triaxial spinning head** [LE-100P3]

Provides independent control of a 3rd solution flow, enabling single-phase or triaxial electrospinning / electro spraying.

See table Syringe specification.

Includes one triaxial emitter for the spinning of core-shell-shell fibers or particles. Capillary needles can be easily replaced and interchanged, allowing the use of a broad range of dimensions (OD: 0.15 – 3.2 mm; ID: 0.08 – 2.6 mm). Other emitter geometries can be custom designed. Additionally, this 3rd syringe pump and triaxial emitter can be used to flow pure solvent through the outer capillary, whilst spinning coaxial fibers or particles through the central two capillaries, in order to eliminate drying of polymer solution on the emitter tip, which can sometimes occur when working with highly volatile solvents.

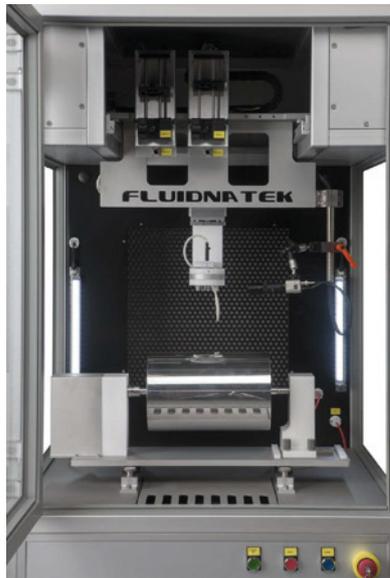
Fluidnatek® LE-100

Laboratory electrospinning/-spraying machine

Universal rotating collector platform* [LE-100RA]

Allows the easy mounting of interchangeable rotating drum, mandrel, or disc collectors up to 300 mm length. Motor provides collector rotation speed from 200 rpm up to 2.000 rpm (up to 20 m/s linear speed with 200 mm diameter drum), enabling collection of randomly oriented or circumferentially aligned fibers. Please discuss your specific requirements and Bioinicia may be able to provide a customized solution. Note: Rotating collectors provided by Bioinicia are carefully balanced for eccentricity.

Drum collector* [LE-100DRC]



Cylindrical anodized aluminium collector for mounting into the Universal Rotating Collector Platform [LE-100RA]. Standard drum size supplied: 200 mm diameter x 300 mm length. Other materials and diameters available on request. When combined with the X-Axis automated scanning emitter motion [LE-100XSM], this also allows for the fabrication of uniform coatings or sheets of electrospun fiber (up to 300 mm x 620 mm).

Note: Other materials for drums (such as stainless steel, titanium, among others) and other diameters are also available upon request.

Mandrel collector* [LE-100MC]

Anodized aluminium rod collector for mounting into the Universal Rotating Collector Platform [LE-100RA]. Allows for the fabrication of nanofiber-walled tubular structures. Multiple diameters available from 1-1.5 mm. Maximum length: 300 mm. Other materials available on request. Standard mandrel size supplied: 5 mm diameter x 300 mm length. However other diameters can be supplied also upon request.

Disk collector* [LE-100DC]

Sharp-edged anodized aluminium disk collector for mounting in to the Universal Rotating Collector Platform [LE-100RA]. For collection of aligned fiber bundles onto disk edge. Standard disk size supplied: 200 mm diameter x 1 mm width. Other materials and diameters available on request.

Roll-to-roll collection system for semi-continuous production** [LE-100R2R]

Plug and play roll-to-roll collection system for semi-continuous collection. The roller mounts can accommodate rolls with external diameters ranging from 50 mm to 100 mm. Maximum roll width: 300 mm. Minimum linear speed: 0,5 mm/s. Maximum linear speed: 10 mm/s.

X-axis automated scanning emitter motion** [LE-100XSM]

Linear automated motion of the spinning head to create wider, homogenous samples. In combination with the rotating drum collector this enables the fabrication of homogenous nano/micro-fibrous sheets or coatings up to 300 mm x 620 mm. Adjustable speed and stroke length. Maximum stroke: 300 mm. Minimum speed: 1 mm/s. Maximum speed: 100 mm/s.

X-y-axis automated linear emitter motion** [LE-100XYSM]

X-Y platform for 2-D automated emitter motion to enable the creation of larger homogenous samples. Allows independent sweeping motion of either linear axis (X or Y), or synchronization of X and Y axes to cover larger area. Adjustable stroke length. Maximum stroke: 300 mm. Minimum emitting speed: 1 mm/s. Maximum speed: 100 mm/s.

Automated regulation of emitter-collector distance (Z-Axis)** [LE-100AZ]

Automated Z-axis motion to control the emitter-collector distance from the touch-screen. Range: 0-300 mm. Accuracy: 1 mm.

Programmable 3D emitter movement** [LE-1003D]

Interpolation of the automated X, Y and Z linear axes to enable the programming of three-dimensional emitter trajectories. User-generated programs can be uploaded to the LE-100 as .csv files via Ethernet port to create patterned depositions. X, Y and Z stroke lengths: 290 mm. Accuracy: 0.1 mm. Speed: from 1 mm/s to 250 mm/s. (requires connection to PC for file uploading).

Fluidnatek® LE-100

Laboratory electrospinning/-spraying machine



Linear single-phase multi-emitter spinning head (20 emitters)* [LE-100M20L]

Stainless steel multi-emitter spinning head consisting of 20 parallel emitters in a linear array, to provide optimum deposition uniformity across the width of a drum or roll-to-roll collector. Recommended for increasing production rate when electrospinning of fibers. All emitters are supplied from the same solution feed. For use with any size of Luer lock needle (reusable or disposable), which enables extremely fast removal and replacement. Needles supplied are 22GA-1/2" (disposable stainless steel with PP hub) by default. Other sizes are available upon request.

For the deposition of two different polymers onto a drum or roll-to-roll collector to achieve a uniform two-component membrane, two linear multi-emitter heads can be supplied from individual solution feeds and connected to separate HV power supplies to allow for independent control of flow rate and applied voltage for each material. Requires second liquid feeding system [LE-100P2], and secondary spinning stage with independent HV power supply [LE-100PHV2].

Circular single-phase multi-emitter spinning head (20 emitters)* [LE-100M20N]



Multi-emitter spinning head consisting of 20 parallel emitters in a circular array, all fed from the same syringe. Recommended for increasing production rates when electro spraying of particles. For use with any size of Luer lock needle (reusable or disposable), which enables extremely fast removal and replacement. Needles supplied are 22GA-1/2" (disposable stainless steel with PP hub) by default. Other sizes are available upon request.

Circular coaxial multi-emitter spinning head (20 emitters)* [LE-100C20N]

Multi-emitter spinning head consisting of 20 parallel emitters in a circular array, all fed from the same syringe. to enable both single-phase and coaxial electrospinning or electro spraying. Emitters can be easily removed and replaced to enable a broad range of capillary needle sizes to be used (OD: 0.15 – 3.2 mm; ID: 0.08 – 2.6 mm)

Secondary spinning stage with independent HV supply** [LE-100PHV2]

Secondary spinning head with mount to allow for the spinning of a second solution to the collector from a different angle than the primary emitter. An additional HV power supply (0 to +30 kV) provides independent control of spinning voltage for the second solution.

Fluidnatek® LE-100

Laboratory electrospinning/-spraying machine

HV upgrade to bipolar (-30 kV to +30 kV)** [LE-100BHV]

Any of the HV power supplies (positive or negative) can be upgraded from single polarity to bipolar supplies, allowing the voltage to be seamlessly controlled from -30 kV to +30 kV via the touch-screen interface. This function allows for experimentation with reversed polarity electrospinning or various other non-standard configurations.

Specification	
Voltage regulation	Line <0.01%, Load <0.01%
Stability	0.01% per 8 hours, 0.02% per day
Accuracy	2% of full scale
Max. output current	0.3 mA

Solvent-gas-jacket system** [LE-100SGJ]

System to regulate a solvent-saturated gas flow around the emitter tips, to reduce the risk of tip drying, which can lead to needle blockage. This system will enable a steady and robust electrospinning/electrospraying process for solutions with volatile solvents.

The Solvent-gas-jacket system requires supply of compressed dry air (or alternative gas if preferred) as well as a coaxial spinning head when a single emitter is used. In case of use of multi-emitter spinning heads, it is required the linear multi-emitter spinning head with solvent gas jacket fitting [LE-100M20LSGJ] for solvent gas saturation function.

Gas-assisted electrospinning head** [LE-100GA]

Specially designed emitter and gas flow controller for gas-assisted Electrospinning. This combines electrostatic stretching with conventional blow spinning, to provide further control of the spinning jet and allow for increased flow rates compared with Electrospinning alone. Hot gas option for a more powerful blow spinning also available [LE-100GAHA]. Requires supply of compressed dry air or alternative gas if preferred.

In case of use of multi-emitter spinning heads, it is required the linear multi-emitter spinning head with gas-assisted electrospinning fitting [LE-100M20LGA] for gas-assisted function (blow spinning ability).

Linear multi-emitter spinning head with gas-assisted electrospinning fitting* [LE-100M20LGA]

Multi-emitter spinning head consisting of a linear array of 20 Luer lock emitters, with a external fitting to create a gas sheath around each emitter to add an aerodynamic force that assists the electrospinning process. Requires Gas-assisted electrospinning system [LE-100GA].

Linear multi-emitter spinning head with solvent gas jacket fitting* [LE-100M20LSGJ]

Multi-emitter spinning head consisting of a linear array of 20 Luer lock emitters, with a solvent gas jacket fitting that allows connection to the Solvent Gas Jacket System [LE-100SGJ] to surround each emitter with a flow of solvent-saturated gas and thereby reduce the risk of tip drying. Requires solvent gas jacket system [LE-100SGJ].

Tubeless solution dispensing system* [LE-100TS]

Modified solution feeding system to eliminate dead-volume in syringe and tubing to minimize solution waste. Particularly suited to applications requiring the incorporation of expensive or difficult to obtain active ingredients. Also recommended, in combination with the syringe heater, to avoid solution cooling when spinning solutions that require elevated temperatures.

Syringe heater for tubeless solution dispensing system** [LE-100SH]

Heating collar to regulate temperature of the spinning solution within the tubeless liquid feeding system. Controls integrated into machine touch panel so that temperature can be set and modified from outside the spinning chamber. Suited to hot solution electrospinning, but not intended for melt electrospinning. Max temperature: 120 °C. Requires tubeless solution dispensing system [LE-100TS] to avoid solution cooling within spinning head.

Taylor Cone visualization system* [LE-100C]



Modified solution feeding system to eliminate dead-volume in syringe and tubing to minimize solution waste. Particularly suited to applications requiring the incorporation of expensive or difficult to obtain active ingredients. Also recommended, in combination with the syringe heater, to avoid solution cooling when spinning solutions that require elevated temperatures.

Fluidnatek® LE-100

Laboratory electrospinning/-spraying machine



Actively regulated exhaust system** [LE-100AES]

Ventilation module to properly exhaust evaporated solvents from the experimental chamber. Pressure sensors at the inlet and exhaust monitor the air pressure differential and ensure optimum ventilation is maintained, whilst also operating a slight negative pressure within the chamber to maximize operator safety. If the ventilation is stopped for any reason, the system safely shuts down to prevent build-up of hazardous vapor. The actively regulated exhaust system is required for use with the optional air conditioning modules to maintain balanced airflow through the system.

Inlet fan filter unit (HEPA or ULPA)* [LE-100IF]

Fan unit with HEPA or ULPA filter on the air inlet eliminates the risk of chamber contamination through the air supply, to create an ultra-clean spinning environment.

Exhaust filter (HEPA or ULPA)* [LE-100EF]

HEPA or ULPA filter unit on chamber exhaust. Prevents contamination of surrounding facilities. Suitable for clean-room installation.

UV-C germicidal lamps** [LE-100GL]

UV-C germicidal lamps within the spinning chamber to further minimize contamination risk and ensure ultra-clean spinning conditions. Intended for sterilization of spinning chamber before/after processing.

Data logging and export function* [LE-100DL]



All processing parameters and spinning conditions can be automatically recorded and exported.

Multi-user level access with recipe database* [LE-100RDB]

Enables different levels of operator access, to ensure that only authorized personnel have access to modify processing parameters. Basic operator login only allows access to pre-set "recipes" of parameter set-ups, which can be saved into a database of optimized recipes associated with the processing of individual materials. This will increase standardization and simplify the workflow for repeat processing.

Programmable sequential multi-step recipe function* [LE-100PMSR]

Allows the processing parameters (e.g. voltage, distance, flow rate, drum rotation speed etc.) to be programmed and automated as a function of time. Sequential programs can be created, saved and loaded via the touch-screen interface.

Audit trail function* [LE-100ATF]

This functionality will allow the equipment to register internally (saving) all the events and actions which are taking place during its use.

Batch control function* [LE-100BCF]

This functionality makes all manufacturing batches are linked to a specific batch number which cannot be duplicated. The data-logging function (saving process parameters) will also register the batch number associated in every run.

Air conditioning: Temperature and RH control unit* [LE-100AC]

External system that introduces a conditioned air stream into the cabinet. The temperature of the air can be controlled from 18 °C to 45 °C ($\pm 1^\circ\text{C}$). Relative humidity can be controlled from 10% to 80% ($\pm 3\%$) – bounded to the AC capacity that is from 5 (minimum) to 15 (maximum) g/kg of absolute humidity. For example, at 25 °C, the achievable RH range will be 30%-70%.

Fluidnatek® LE-100 Laboratory electrospinning/-spraying machine



Importantly, this climate control system conditions the air before it enters the spinning chamber and works together with the actively regulated exhaust system to provide high air exchange rates to ensure the spinning environment remains stable during production with no build-up of solvent vapours. The air passes through a HEPA filter before entering the spinning chamber. This HEPA filter can be easily replaced – typically in a standard lab, the filter will need replacing after 3 to 5 years, in clean-room facilities it will last for at least 10 years without the need for replacement. This air conditioning system is self-contained and can be purchased separately from the LE-100 electrospinning machine and easily installed at the customer facility. Room conditions from 20 °C - 25 °C and from 5 to 9 g/kg absolute humidity. This system requires a supply of demineralized water (TDS <30 ppm, EC <47µS/cm). Where this is not already available, Bioinicia recommends the installation of an in-line reverse osmosis water purifier and can assist you further if needed. Note: an ion-exchange water softener should not be used without further purification.

Dimensions climate control unit: 900 mm width x 1100 mm depth x 1900 mm height

Voltage for the air conditioning unit: 480Vacc** [LE-100ACAD]

Modification on the air conditioning unit to work under 480 V, 60 Hz, 15 A, 3-phase + N + PE. Voltage conditions mostly required in USA.

Drying-heating control unit (DHU)** [LE100DHU]

External self-contained system that introduces a conditioned air stream into the spinning cabinet. Fresh air is taken from the room and pushed through a drying unit to reduce the moisture content to the desired point. Downstream, the dried air flows through an electric heater that increases the temperature before it enters into the cabinet. The air is continuously exhausted from the cabinet to avoid the solvent accumulation into the chamber, preserving the processing conditions and therefore ensuring proper and stable performance of the process.

Performance*	
Temperature	up to 45 °C.
Relative humidity	from room RH to 25% (@25 °C); down to 10% (@45 °C).

* This performance is bounded to room conditions in the range of 20 °C to 25° C and 40%-60% RH (regular laboratory conditions).

Facility requirements	
Compressed dry air	888 l/min @ 7 bar (dew point @ 7 bar < 7 °C)
Power	1 phase, 10 A @ 220 V/50 Hz and 60 Hz.
Dimensions drying heating unit (DHU)	800 x 1000mm x 1400 mm [w x d x h]

Machine qualification (for ISO or GMP processes)* [LE-100GMP]

The Fluidnatek® LE-100 can be provided with qualification documentation for ISO or GMP validation compliance. Alternatively, Bioinicia can provide full IQ/OQ validation on site, or FAT/SAT service. Please enquire if this is of interest to you.

* The LE-100 unit can be user-upgraded anytime with these PLUG & PLAY accessories. May require SW upgrade from the manufacturer.

** The LE-100 unit can be manufacturer-upgraded anytime with these accessories. Incurs additional on-site engineer installation charge.

