FLUIDNATEK® LE-50

BENCH-TOP LABORATORY eSTRETCHING MACHINE

TECHNICAL DESCRIPTION

by Bioinicia
Innovative Polymer Applications

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Technical description of the equipment

The **FLUIDNATEK® LE-50 Bench-top Laboratory eStretching Machine** is ideal for proof-of-concept and feasibility studies of new materials and formulations. Built to fit into small lab spaces, its ergonomic design and ease of use allows for an efficient workflow. Its wide range of capabilities and exceptional reliability allows the customers to prototype and optimize their concepts efficiently and reproducibly. This machine is suitable for the electrospinning of fibers and the electrospraying of particles. Importantly it is compatible with an optional AC unit for the control of temperature and relative humidity.

1. Fluidnatek® LE-50: standard platform [LE50BS]

The **FLUIDNATEK® LE-50 Bench-top Laboratory eStretching Machine** comes as standard with the following features and can be upgraded with optional extras as described in the next section

a) Stainless steel, aluminum 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. Front door, top ceiling and rear panel are made of transparent glass to enable process visualization. The cabinet is air tight and thermally insulated to enable quick conditioning of the chamber (for T & RH conditioning the acquisition of the climate conditioning is required).

b) Special safety-encapsulated diffuse LED lighting: To enable proper visualization of the process.

c) 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.

d) Primary HV power supply (adjustable from 0kV to 30kV): 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.

e) Non-adjustable HV power supply (-2kV). This second HV power supply connected to the collector improves the collection efficiency of atomized particles/fibers. 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: 0.75mA.

f) One syringe pump: For accurate control of liquid infusion. 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 1,240 mL/h for a 5 mL BD plastic syringe). Linear force: 100-200N**.**

g) 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).

h) Flat plate collector: Designed to allow easy tool-free removal from the spinning chamber, the plate collector stand can be oriented vertically or horizontally. Includes an exchangeable flat stainless-steel plate collector with dimensions: 200 mm x 200 mm.

i) Regulation of emitter-collector distance: Manual regulation of the distance between spinning head and collector. Range: 0-290 mm.

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

k) Passive 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 40mm ID hose.

l) Sealed cable pass-through: Tubing, power and/or control wires can be easily wired out from the chamber to enable maximum flexibility to improve the experimental set-up by the installation of additional accessories, systems or apparatus inside the experimental chamber (*Bioinicia is not responsible for damages caused by accessories or parts not provided by Bioinicia*).

m) Ethernet remote diagnostics and software upgrading: Equipped with an Ethernet connection that will permit remote diagnosis and maintenance activities.

n) Safety features: CE compliant, fulfilling all the corresponding EU Directives (2006/42/EC, 2004/108/EC, 2006/95/EC). Verified by independent 3rd Party.

Dimensions:

- Outer dimensions (external): 850mm width x 570mm depth x 850mm height.
- Experimental chamber (internal): 685mm width x 510mm depth x 617mm height.
- AC Unit: 1200mm width x 700mm depth x 900mm height. *On castors, to act as a table onto which the LE-50 can be placed.*
- Drying-Heating Control Unit (DHU): 400mm x 600mm x 750mm (width x depth x height).

Weights (approximate):

- LE-50: 90kg
- DHU: 30kg
- AC unit: 200kg

In addition, the **FLUIDNATEK® LE-50 Bench-top Laboratory eStretching 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.

2. Second syringe pump with upgrade to coaxial spinning head* [LE50P2]

Provides independent control of a 2nd solution flow, enabling single-phase or co-axial electrospinning / electrospraying. Minimum dead volume (down to < 0.1 mL). Syringe volume: up to 140 mL. Min-max flow rates: 0.1 – 1000 mL/h. Linear force: 100-200 N. The coaxial emitter is used for spinning of core-shell fibers or particles and can also be used to prevent tip blockages when spinning solutions of highly volatile solvents by flowing liquid solvent through the outer needle, to keep the tip wet – a technique used by Bioinicia and found to be more effective than solvent vapour pump. 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.

3. Universal rotating collector platform** [LE50RA]

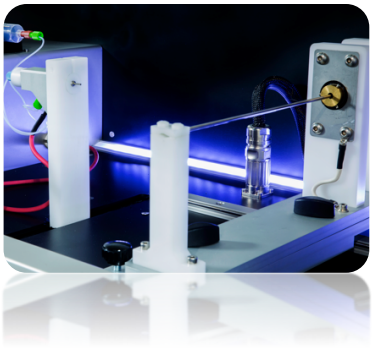
Allows the easy mounting of interchangeable rotating drum, mandrel, or disc collectors up to 200mm length. Rotation speed from 100rpm up to 2000rpm (up to approx. 10m/s linear speed with 100mm diameter drum), enabling collection of randomly aligned or circumferentially aligned fibers.

4. Drum collector* [LE50DRC]

Cylindrical anodized aluminum collector for mounting into the universal rotating collector platform (Item 3). Standard drum size supplied: 100mm diameter x 200mm length. Other diameters available on request. When combined with the Scanning emitter motion (Item 7), this also allows for the fabrication of uniform coatings or sheets of electrospun fiber (up to 200 mm x 310 mm).

5. Mandrel Collector* [LE50MC]

Anodized aluminum rod collector for mounting into the universal rotating collector platform (Item 3). Allows for the fabrication of nanofiber-walled tubular structures. Multiple diameters available from 1mm-15mm. Maximum length: 200mm. Stainless steel mandrel is also available upon request.



6. Disk collector* [LE50DC]

Sharp-edged anodized aluminum disc collector for mounting in to the universal rotating collector platform (Item 3). For collection of aligned fiber bundles. Maximum diameter:

100mm. Stainless steel disk also available upon request

7. Scanning emitter motion stand* [LE50SM]

Linear automated motion of the spinning head to create wider, homogeneous samples. In combination with the rotating drum collector this enables the fabrication of homogenous nano/micro-fibrous sheets or coatings up to 200mm x 310mm. Adjustable stroke length and speed: 0-200 mm, 0-100mm/s. The stage can be placed vertical or horizontal. Two stands can be implemented inside the chamber to enable the deposition of two materials simultaneously.

8. Negative high voltage power supply for collector upgrade (adjustable from 0 to -10kV)** [LE50NHV]

Upgrade of the negative HV power supply for the collector to an adjustable -10kV HV power supply, enabling the generation of a maximum emitter-collector electrical voltage drop of 40kV (up to +30 kV and -10kV 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. 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: 0.4mA.

9. Secondary scanning emitter motion stand with independent HV supply (adjustable from 0kV to 30kV)** [LE50PHV2]

Additional scanning emitter motion stand with a second positive HV power supply to enable the spinning of two solutions simultaneously (horizontally and vertically). 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.

10. Actively regulated exhaust system** [LE50AES]

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.

11. Air Conditioning: Temperature and RH control unit* [LE50AC]

External system that introduces a conditioned air stream into the cabinet. The temperature of the air can be controlled from **20°C to 45°C** (± 1°C). Relative humidity can be controlled from

10% to 80% (± 5%), depending on temperature. For example at 25ºC, the achievable RH range will be 30%-80% (more information can be provided on request). 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 3-5 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-50 electrospinning machine and easily installed at the customer facility. Room conditions from 20ºC-25ºC and from 35%-75% RH. The actively regulated exhaust system (Item 10) is required for use with this optional air conditioning unit, to maintain balanced airflow through the system. *Requires a supply of demineralized water.*

12. Drying-Heating control unit** [LE50DHU]

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. *Requires supply of compressed dry air: 375 l/min @ 7 bar, dew point @ 7 bar < 7ºC*

Specs*:

- Temperature: Room temperature up to 45ºC +/- 1ºC.
- Relative humidity: Room humidity down to 25% (@25ºC); down to 10% (@45ºC) +/- 5%.
- Air flow: regulated from 10-25 m3/h.

* This specs are bound to room conditions in the range of 20ºC-25ºC and 45%-65% RH (regular laboratory conditions).

13. Gas-assisted electrospinning head (single emitter)** [LE50GA]

Specially designed emitter and gas flow controller for gas-assisted eStretching. This combines electrostatic stretching with conventional blow spinning, to provide further control of the spinning jet and allow for increased flow rates compared with eStretching alone. *Requires supply of compressed dry air or alternative gas if preferred.*

14. Solvent-gas-jacket* [LE50SGJ]

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. *Requires supply of compressed dry air or alternative gas if preferred.*

15. Single-phase parallel multi-emitter spinning head (5 emitters)* [LE50M5N]

Multi-emitter spinning head consisting of 5 parallel emitters, all fed from the same syringe. For increased production rates. Can be used with single-phase emitters (OD: 0.15 – 3.2 mm; ID: 0.08 – 2.6 mm).

16. Single-phase/coaxial parallel multi-emitter spinning head (5 emitters)* [LE50C5N]

Multi-emitter spinning head consisting of 5 parallel emitters, all fed from the same syringe. For increased production rates. Can be used with single-phase or co-axial emitters (OD: 0.15 – 3.2 mm; ID: 0.08 – 2.6 mm).

17. Tubeless solution dispensing system* [LE50TS]

Modified solution feeding system to eliminate dead-volume in syringe and tubing to minimize solution wastage. 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.

18. Syringe heater for tubeless solution dispensing system** [LE50SH]

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: 120ºC. *Requires tubeless solution dispensing system (item 17) to avoid solution cooling within spinning head.*

19. Taylor Cone visualization system* [LE50C]

Analog connected camera with lens to allow close monitoring of the Taylor Cone and spinning jet. Especially recommended for use with the coaxial set-up to assist with optimisation of the spinning parameters.

20. Data logging and export function* [LE50DL]

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

21. Multi-user level access with recipe database* [LE50RDB]

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.

22. Programmable sequential multi-step recipe function* [LE50PSMR]

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 programmes can be created, saved and loaded via the touch-screen interface.

***** The LE-50 unit can be user-upgraded anytime with these PLUG & PLAY accessories.

****** The LE-50 unit can be manufacturer-upgraded anytime with these accessories. (Requires either return shipping back to manufacture or incurs additional on-site engineer installation charge).