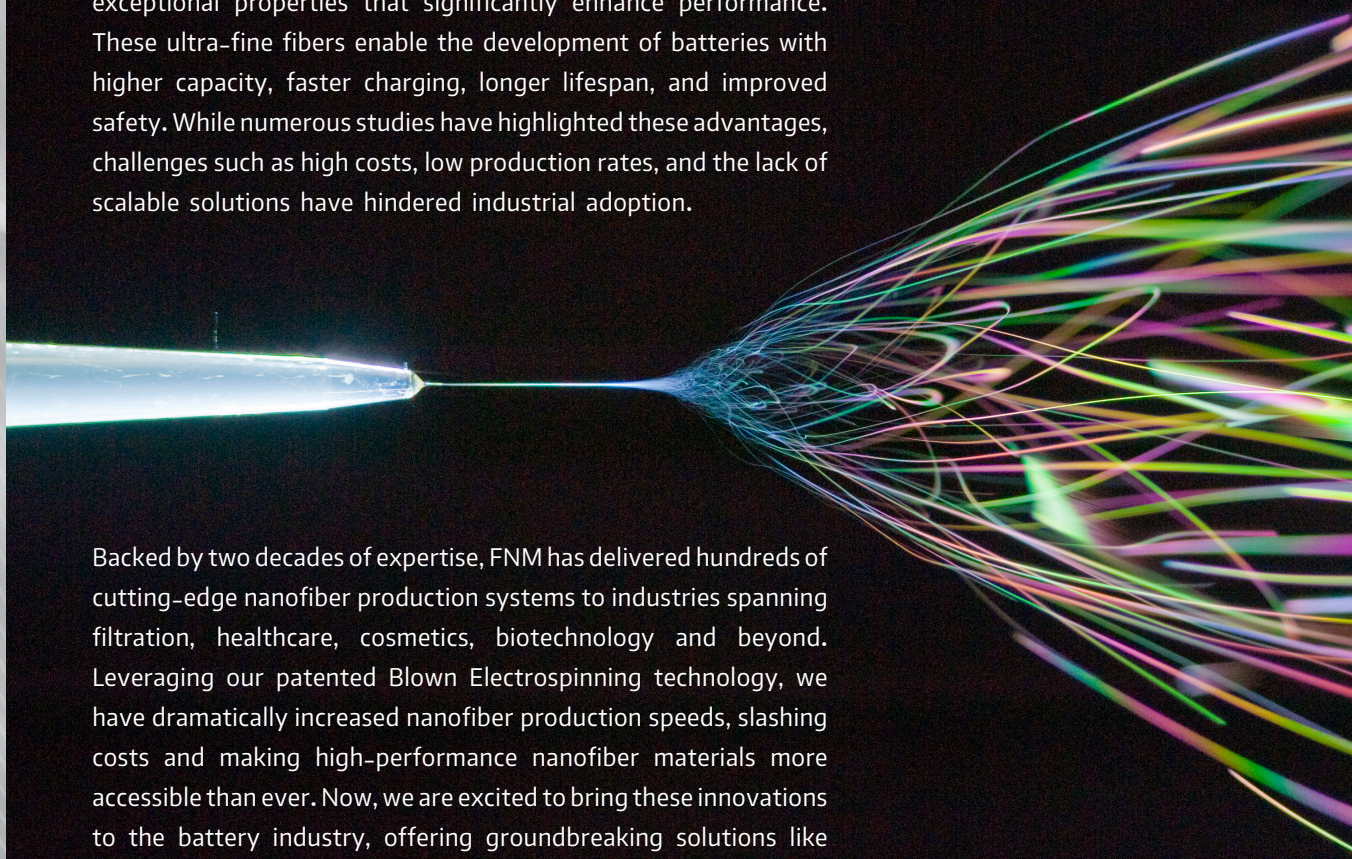
Fanavaran Nano-Meghyas

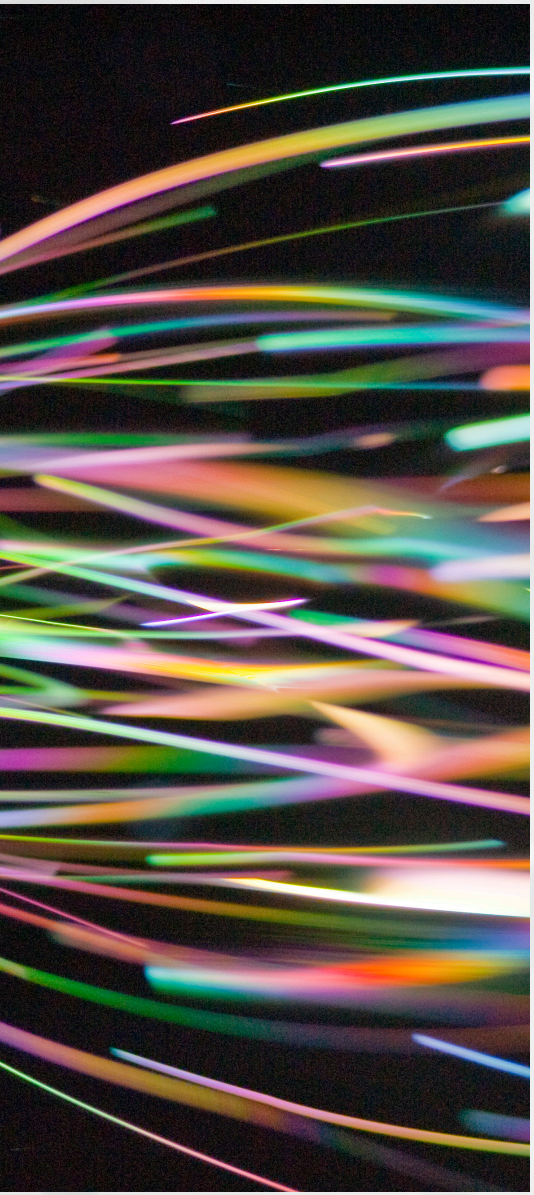
Advancing Battery Technologies with Nanofiber Innovation

A Trusted Provider of Specialized Electrospinning Machines for Battery Material R&D and Production

Nanofibers are opening up new opportunities in the field of energy storage, particularly in lithium battery technology, by offering exceptional properties that significantly enhance performance. These ultra-fine fibers enable the development of batteries with higher capacity, faster charging, longer lifespan, and improved safety. While numerous studies have highlighted these advantages, challenges such as high costs, low production rates, and the lack of scalable solutions have hindered industrial adoption.

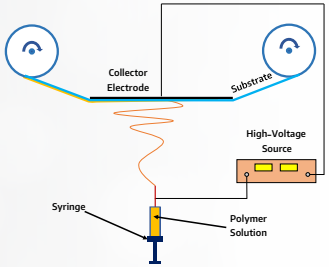


Backed by two decades of expertise, FNM has delivered hundreds of cutting-edge nanofiber production systems to industries spanning filtration, healthcare, cosmetics, biotechnology and beyond. Leveraging our patented Blown Electrospinning technology, we have dramatically increased nanofiber production speeds, slashing costs and making high-performance nanofiber materials more accessible than ever. Now, we are excited to bring these innovations to the battery industry, offering groundbreaking solutions like nanofiber-based separators with proven benefits.

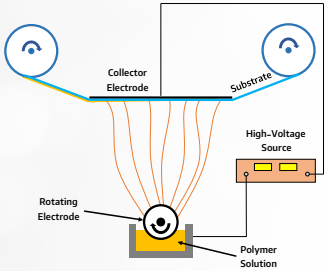


Electrospinning Techniques

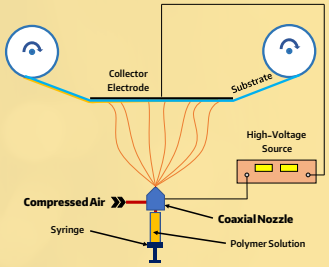
Needle-base Electrospinning



Needle-less Electrospinning



Blown Electrospinning



PATENTED

Up to 20 X Higher Production Rate

LAB

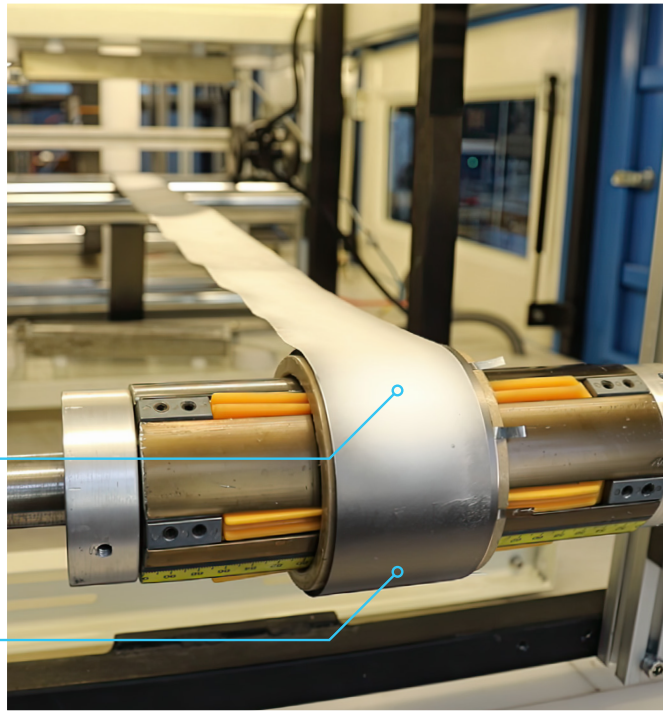
Pilot

Industrial

Scale	Lab	Pilot	Industrial
Model	NSF-02-L	NSF-08-P	NSF-40-I
Number of Nozzles	2	8-16	>40
Battery Format Compatibility	Coin/Small Pouch	Pouch/Cylindrical/ Prismatic	Pouch/Cylindrical/ Prismatic
Blowing Nozzle Technology	Yes	Yes	Yes
Exclusive Design for Battery Material Development	Yes	Yes	Yes
Compatible with Conductive (Anode, Cathode, Metal Foils) and non-Conductive (Solid electrolyte, Separator) Substrates	Yes	Yes	Yes
Roll to Roll	No	Yes	Yes
Double Side Coating	No	Yes	Yes
Temperature and Humidity Control unit	Optional	Optional	Optional
FNM Separator Technology Transfer Inclusion	No	No	Yes

FNM Nanofiber-Based Separator

In lithium batteries, separators prevent short circuits by maintaining a safe distance between anodes and cathodes while facilitating efficient ion transfer. However, conventional separators face critical limitations, such as poor wettability, insufficient thermal stability, difficulty in winding/stacking process, and challenges in achieving ultra-thin designs.

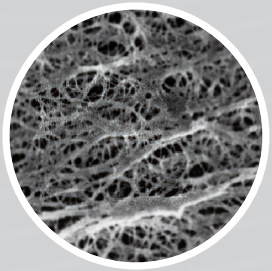


After years of dedicated research, we developed an advanced nanofiber-based separator offering the following unmatched advantages:

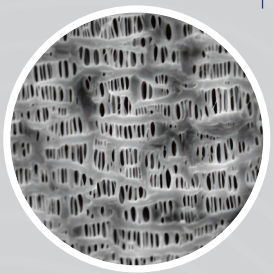
Nanofiber Technology:

Nanofibers have unique and surprising properties that have led to their growing popularity. The use of nanofibers as battery separators has been researched for many years. High and controllable porosity, nanometer-sized pores, variety of polymer materials and additives, wide range of morphologies and high tortuosity are among the reasons for the popularity of nanofibers in battery separators.

Conventional Separators

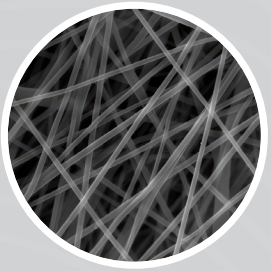


Wet Process



Dry Process

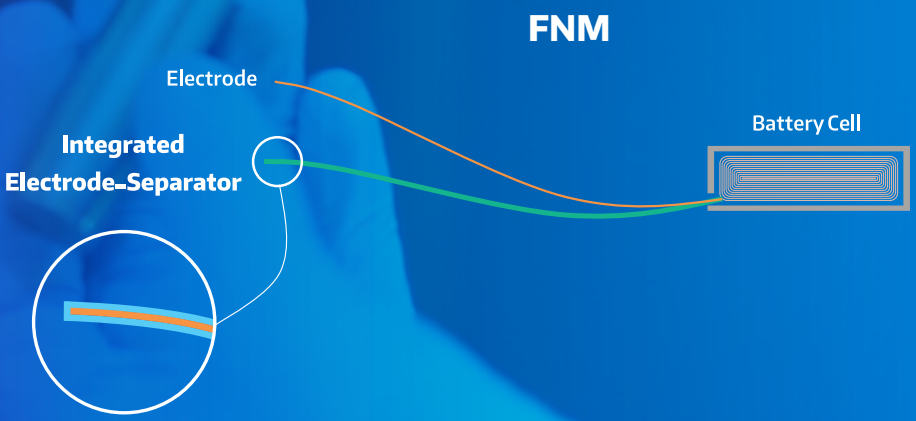
FNM Separator



Nanofiber Technology

Integration with Electrode:

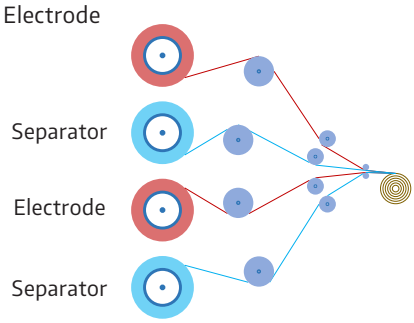
Directly coated onto the electrode, our separator eliminates assembly complexities, creating a unified electrode-separator architecture.



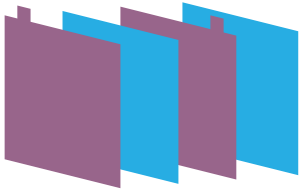
Easier, Faster, Cheaper, More Efficient Cell Assembly:

The integration of electrodes and separators creates a separator-free architecture, streamlining the cell assembly process (winding/stacking/lamination) to make it significantly easier, faster, and more cost-effective. In addition, this advantage increases the yield of the process and reduces the production scrap rate.

Conventional

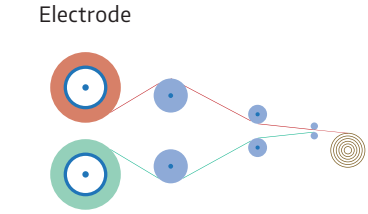


Dealing with 4 Layers

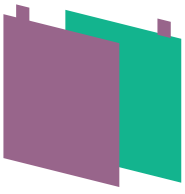


Dealing with 4 Layers

FNM



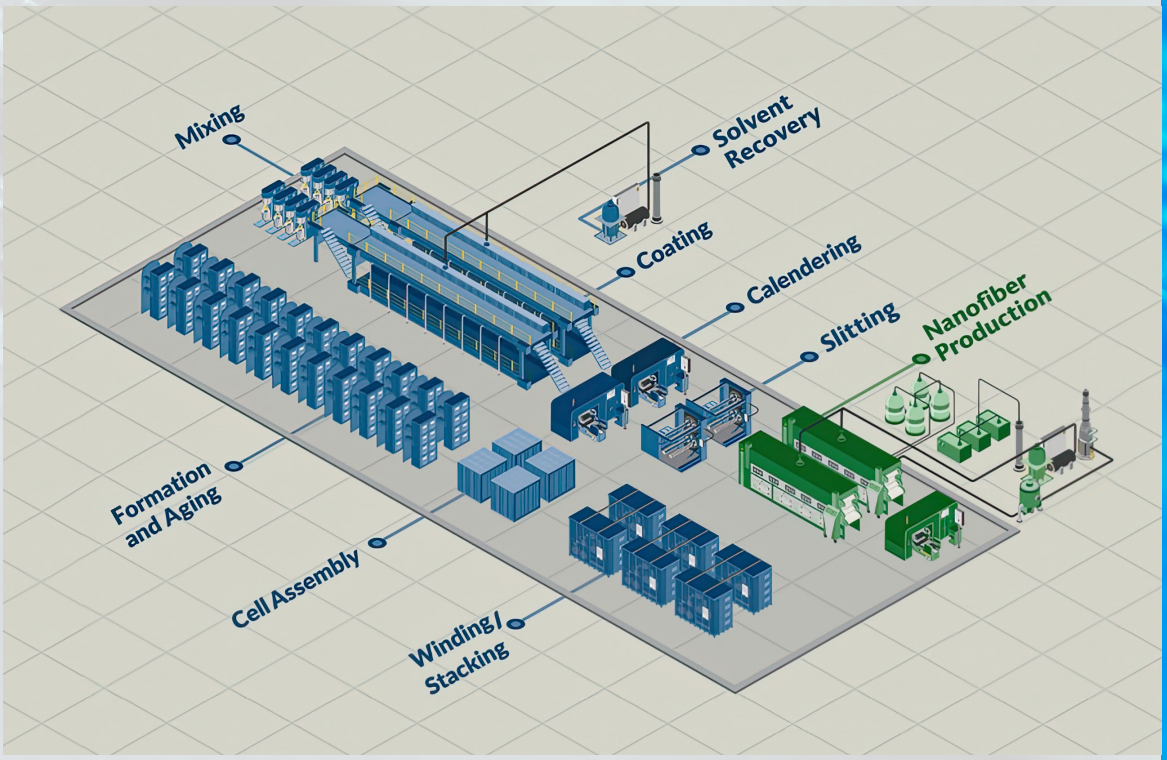
Dealing with 2 Layers



Dealing with 2 Layers

Vertical Integration for Cell Manufacturers:

Eliminate the need to procure separators externally. Produce custom separators on-site, tailored to specific design and performance needs.



Superior Thermal Stability:

Stable to temperatures exceeding 200°C, making it ideal for safety-critical applications like electric vehicles and also high temperature applications.

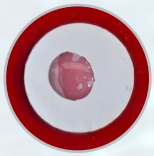
Excellent Electrolyte Wettability:

The wettability of FNM separator is far superior to other common commercial separators in terms of both electrolyte uptake capacity (by weight) and electrolyte absorption rate.

FNM

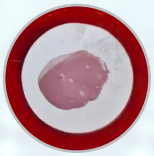
%181

One Side Ceramic Coated



%82

Double Side Ceramic Coated



%93

Faster Drying, Reduced Moisture Contamination:

High thermal stability enables quicker drying at elevated temperatures, minimizing contamination risks.

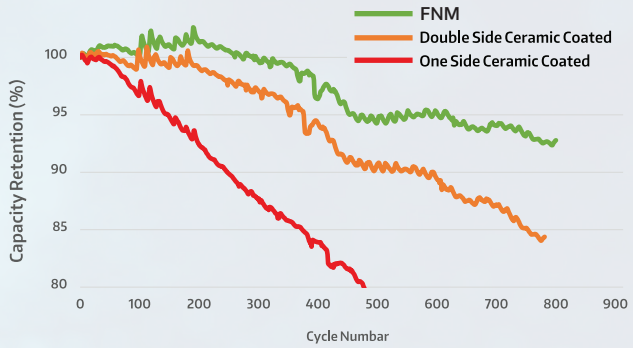
Competitive Cost:

Scaled production models project cost competitiveness with conventional separators while delivering superior performance.

Battery Performance Test Results

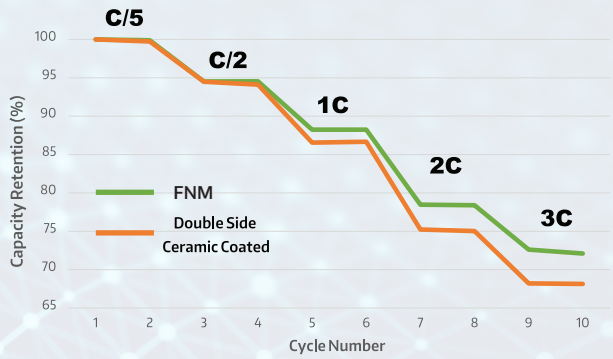
Below are test results comparing the performance of the FNM separator to that of a conventional separator.

Cyclic Life Test:



- Single Layer Pouch Cell
- Cathode: NCM-523
- Anode: Graphite

C-Rate Test:



- Single Layer Pouch Cell
- Cathode: NCM-523
- Anode: Graphite

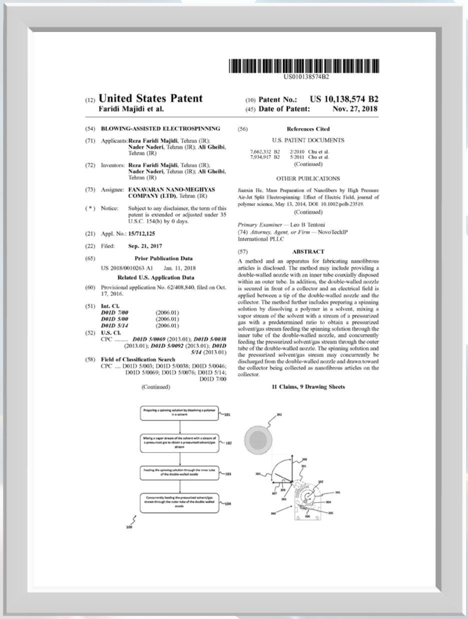
R&D Services

Our expertise in electrospinning and advanced battery technologies empowers us to offer comprehensive R&D services. From basic research to experimental development, we collaborate with clients to produce impactful outputs like patents, PCTs, and scientific publications. With state-of-the-art facilities for nanofiber production, coin and pouch batteries, and material synthesis, we provide cost-effective, accelerated R&D support tailored to your needs.

About FNM

FNM is a leading designer and manufacturer of high-quality, custom-built electrospinning machines, dedicated to advancing nanofiber technology for research and industrial applications. Our cutting-edge electrospinning systems are designed to meet the needs of scientists and engineers working in nanotechnology, biomaterials, and new energy. With a strong focus on precision, reliability, and user-friendliness, we offer highly customizable solutions, including Lab-Scale, Pilot, and Industrial electrospinning machines, as well as essential accessories like High Voltage Power Supplies, Syringe Pumps, and Collectors. Our technology empowers engineers and researchers to fabricate nanofibers with exceptional control over parameters, ensuring high-performance results in various fields, from filtration and medical applications to energy storage and textiles.

As we expand our presence in the global market, FNM remains committed to innovation and customer satisfaction. Our team, with two decades of experience, provides excellent technical support, comprehensive training, and tailored solutions to help customers achieve groundbreaking results. With a strong foundation in research-driven development, we strive to build lasting partnerships and support the growing demand for high-performance electrospinning technology.



US010138574B2

(12) **United States Patent**
Faridi Majidi et al.

(10) **Patent No.: US 10,138,574 B2**
(45) **Date of Patent: Nov. 27, 2018**

(54) **BLOWING-ASSISTED ELECTROSPINNING**

(71) Applicants: **Reza Faridi Majidi**, Tehran (IR); **Nader Naderi**, Tehran (IR); **Ali Gheibi**, Tehran (IR)

(72) Inventors: **Reza Faridi Majidi**, Tehran (IR); **Nader Naderi**, Tehran (IR); **Ali Gheibi**, Tehran (IR)

(73) Assignee: **FANAVARAN NANO-MEGHYAS COMPANY (LTD)**, Tehran (IR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/712,125**

(22) Filed: **Sep. 21, 2017**

(65) **Prior Publication Data**
US 2018/0010263 A1 Jan. 11, 2018

Related U.S. Application Data
(60) Provisional application No. 62/408,840, filed on Oct. 17, 2016.

(51) **Int. Cl.**
D01D 7/00 (2006.01)
D01D 5/00 (2006.01)
D01D 5/14 (2006.01)

(52) **U.S. Cl.**
CPC ***D01D 5/0069*** (2013.01); ***D01D 5/0038*** (2013.01); ***D01D 5/0092*** (2013.01); ***D01D 5/14*** (2013.01)

(58) **Field of Classification Search**
CPC D01D 5/003; D01D 5/0038; D01D 5/0046; D01D 5/0069; D01D 5/0076; D01D 5/14; D01D 7/00
(Continued)

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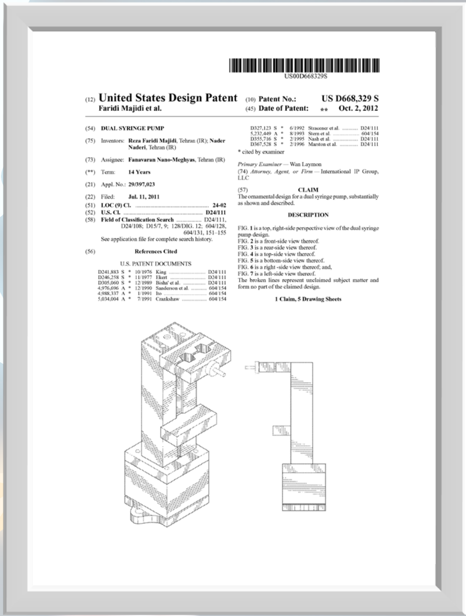
(57) **ABSTRACT**

A method and an apparatus for fabricating nanofibrous articles is disclosed. The method may include providing a double-walled nozzle with an inner tube coaxially disposed within an outer tube. In addition, the double-walled nozzle is secured in front of a collector and an electrical field is applied between a tip of the double-walled nozzle and the collector. The method further includes preparing a spinning solution by dissolving a polymer in a solvent, mixing a vapor stream of the solvent with a stream of a pressurized gas with a predetermined ratio to obtain a pressurized solvent/gas stream feeding the spinning solution through the inner tube of the double-walled nozzle, and concurrently feeding the pressurized solvent/gas stream through the outer tube of the double-walled nozzle. The spinning solution and the pressurized solvent/gas stream may concurrently be discharged from the double-walled nozzle and drawn toward the collector being collected as nanofibrous articles on the collector.

11 Claims, 9 Drawing Sheets

Preparing a spinning solution by dissolving a polymer in a solvent — 101
Mixing a vapor stream of the solvent with a stream of a pressurized gas to obtain a pressurized solvent/gas stream — 102
Feeding the spinning solution through the inner tube of the double-walled nozzle — 103
Concurrently feeding the pressurized solvent/gas stream through the outer tube of the double-walled nozzle — 104



US00D668329S

(12) **United States Design Patent**
Faridi Majidi et al.

(10) **Patent No.: US D668,329 S**
(45) **Date of Patent: ** Oct. 2, 2012**

(54) **DUAL SYRINGE PUMP**

(75) Inventors: **Reza Faridi Majidi**, Tehran (IR); **Nader Naderi**, Tehran (IR)

(73) Assignee: **Fanavaran Nano-Meghyas**, Tehran (IR)

(**) Term: **14 Years**

(21) Appl. No.: **29/397,023**

(22) Filed: **Jul. 11, 2011**

(51) **LOC (9) Cl.** **24-02**
(52) **U.S. Cl.** **D24/111**
(58) **Field of Classification Search** D24/111, D24/108; D15/7, 9; 128/DIG. 12; 604/128, 604/131, 151–155
See application file for complete search history.

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Primary Examiner — Wan Laymon
(74) *Attorney, Agent, or Firm* — International IP Group, LLC

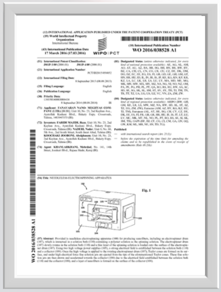
(57) **CLAIM**

The ornamental design for a dual syringe pump, substantially as shown and described.

DESCRIPTION

FIG. **1** is a top, right-side perspective view of the dual syringe pump design.
FIG. **2** is a front-side view thereof.
FIG. **3** is a rear-side view thereof.
FIG. **4** is a top-side view thereof.
FIG. **5** is a bottom-side view thereof.
FIG. **6** is a right -side view thereof; and,
FIG. **7** is a left-side view thereof.
The broken lines represent unclaimed subject matter and form no part of the claimed design.

1 Claim, 5 Drawing Sheets



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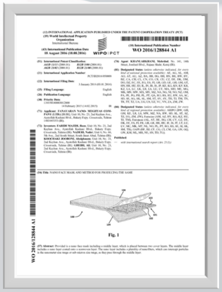

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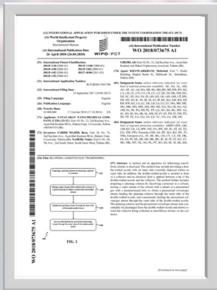

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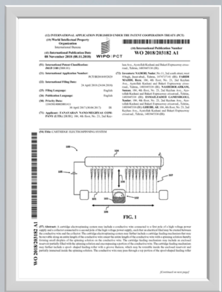

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