



# 以纳米纤维创新推 动电池技术升级

专业电纺设备的值得信赖供应  
商，用于电池材料的研发和生产

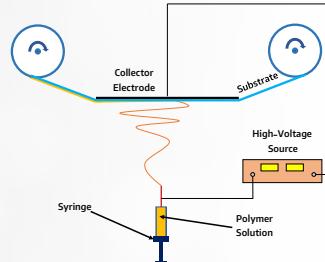
纳米纤维正为能源存储领域——尤其是锂电池技术——开辟全新机遇，其卓越性能显著提升了电池整体性能。这些超细纤维可实现电池容量提升、充电速率加快、使用寿命延长以及安全性增强。尽管大量研究已证实其优势，但高成本、低生产率及缺乏可扩展解决方案的问题仍然阻碍了其工业应用。

依托二十余年的行业经验，FNM已向过滤、医疗、化妆品、生物科技等众多领域交付了数百套领先的纳米纤维生产系统。凭借我们专利的吹制静电纺丝技术，我们大幅提升了纳米纤维的生产速度，显著降低了生产成本，使高性能纳米纤维材料比以往更加普及。如今，我们满怀激情地将这一创新成果应用于电池行业，推出例如基于纳米纤维技术的隔膜等具有突破性优势的前沿方案。

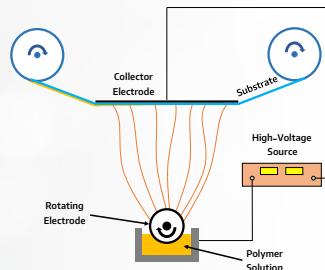


## 电纺技术

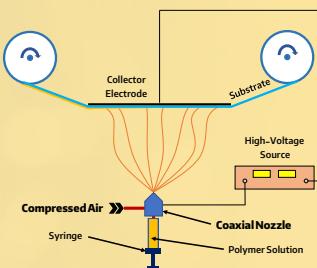
### 针式电纺



### 无针电纺



### 喷吹式电纺



➤ 生产速度可以提高多达20倍。



实验室型



中试型



工业型



规模	实验室型	中试型	工业型
型号	NSF-02-L	NSF-08-P	NSF-40-I
喷嘴数量	2	8-16	>40
电池格式兼容性	纽扣/小型软包电池	软包/圆柱/方形电池	软包/圆柱/方形电池
吹制喷嘴技术	是	是	是
专为电池材料开发设计	是	是	是
兼容导电（负极、正极、金属箔）与非导电（固态电解质、隔膜）基材	是	是	是
卷对卷	否	是	是
双面涂覆	否	是	是
温湿度控制单元	可选	可选	可选
包含 FNM 隔膜技术转移	否	否	是



## FNM纳米纤维隔膜

在锂电池中，隔膜主要作用是通过维持负极与正极间的安全间隔、防止短路，同时促进高效离子传输。然而，传统隔膜存在润湿性不足、热稳定性较差、在绕卷/叠合工艺中难以处理以及实现超薄化设计受限等关键问题。

涂覆于电池电极的 FNM 隔膜

电池电极

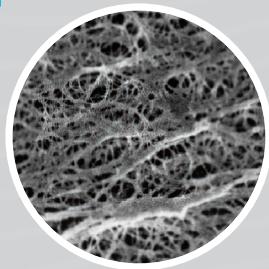


经过多年的专注研发，我们成功开发出一款先进的基于纳米纤维的隔膜，具有以下无与伦比的优势：

## 纳米纤维技术

纳米纤维凭借其独特优异的物理化学特性，在电池隔膜领域的应用已成为研究热点。高且可调控的孔隙率、纳米级孔径、丰富的聚合物和添加剂选择、多样的形态以及高曲折性，均为其广泛应用提供了坚实基础。

传统隔膜

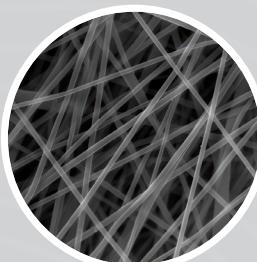


湿法隔膜



干法隔膜

FNM 隔膜



▶ 纳米纤维技术



## 与电极一体化：

本隔膜可直接涂覆在电极上，从而简化组装过程，构建  
统一的电极 - 隔膜一体化结构



## 传统



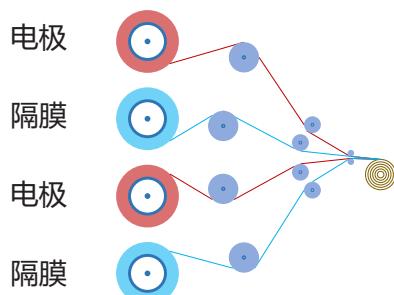
## FNM



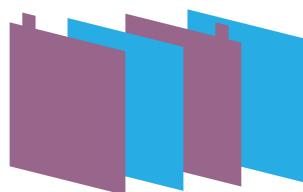
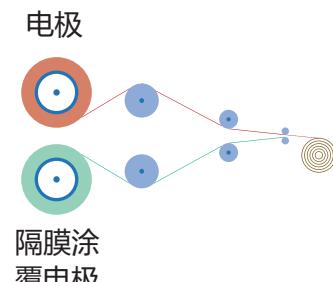
## 简化且高效的电池组装工艺：

通过实现电极与隔膜的一体化设计，组装工艺（绕卷、叠合、层压）变得显著更简单、迅速且经济，有效提升了生产良率并降低了废品率。

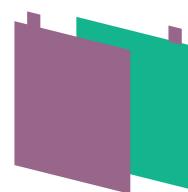
传统



FNM



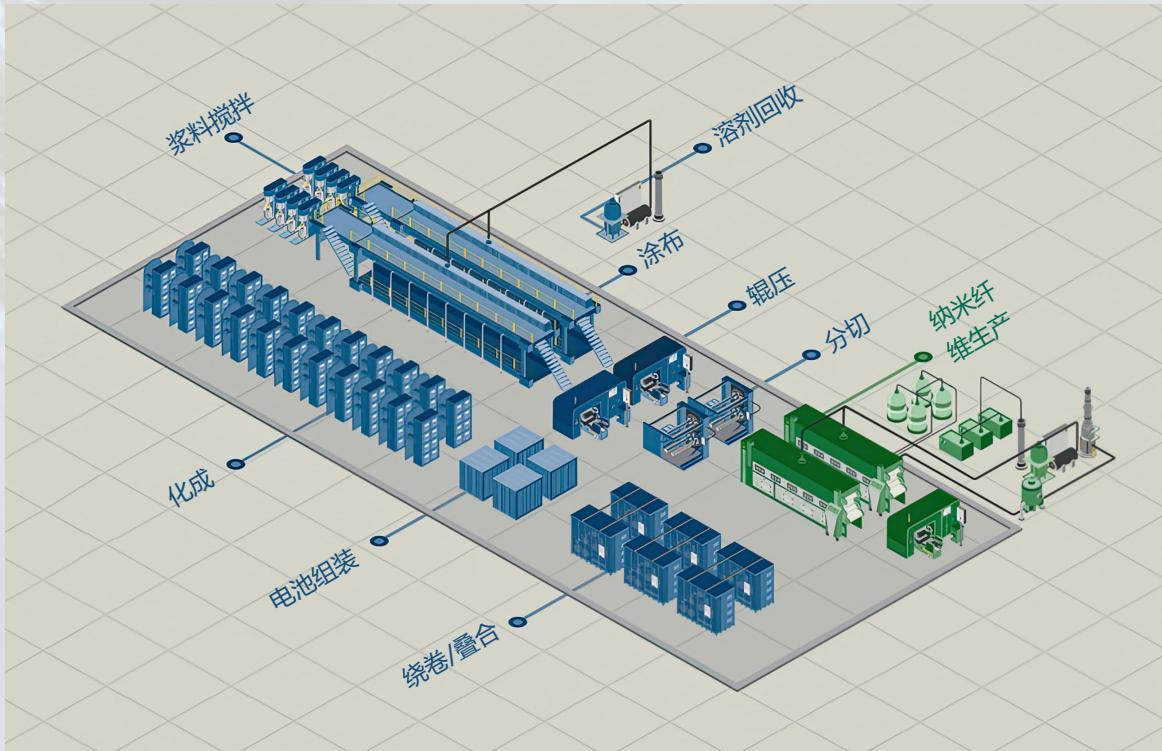
处理 4 层结构



处理 2 层结构

## 为电池制造商提供垂直整合解决方案：

企业无需依赖外部隔膜采购，即可在工厂现场定制符合特定设计和性能要求的专用隔膜。



## 卓越的热稳定性：

隔膜能在超过<sup>°</sup>200C的高温环境下保持稳定，特别适合电动车等对安全性要求苛刻及高温作业场景。



## 卓越的电解液润湿性

FNM 隔膜的润湿性在电解液吸收能力（重量比）和电解液吸收速率方面远优于其他常见的商业隔膜。



## 快速干燥和降低湿度污染风险：

优异的热稳定性能使得隔膜在高温条件下快速干燥，从而有效减少生产过程中的湿度污染风险。

## 具有竞争力的成本优势：

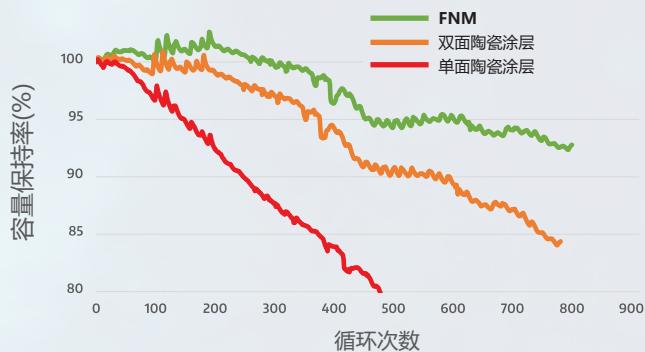
规模化生产方案使得隔膜在成本上能与传统产品抗衡，同时在性能上实现了显著提升。





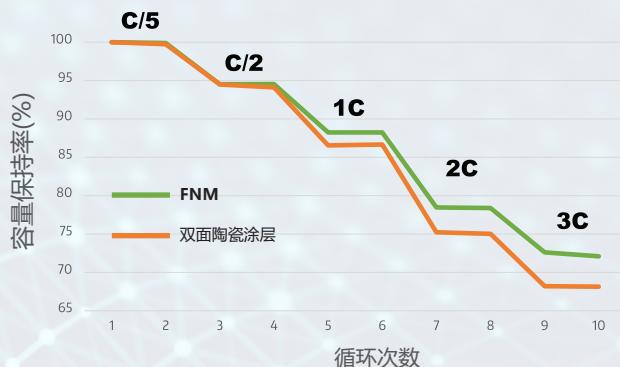
## 电池性能测试结果

### 循环寿命测试



- 单层软包电池
- 正极: NCM-523
- 阳极: 石墨

### 倍率性能(C-Rate)



- 单层软包电池
- 正极: NCM-523
- 阳极: 石墨



## 全面的研发服务

凭借在静电纺丝与先进电池技术方面的丰富经验，我们提供从基础研究到实验开发的全链条研发服务，与客户协同创新，产出专利、PCT申请及高水平科研成果。我们的尖端生产设施同时支持纳米纤维、纽扣电池、软包电池及材料合成等多领域的研发工作，确保研发过程高效且具成本效益。



## 关于FNM

FNM是一家领先的高品质定制静电纺丝设备设计与制造企业，致力于推动纳米纤维技术在科研与工业领域的普及与应用。我们的前沿静电纺丝系统专为纳米技术、生物材料和新能源领域的科学家与工程师设计，以精准、可靠与用户友好为核心，提供涵盖实验室、中试和工业级的设备以及诸如高压电源、注射泵、收集器等关键配件。我们的技术使工程师与研究人员能够对纳米纤维生产过程中的各项参数实施精细调控，确保在过滤、医疗、能源存储、纺织等多个领域取得卓越性能表现。



专利

<p><b>(12) United States Patent</b> Farid Majid et al.</p> <p><b>(16) Patent No.:</b> US 10,138,574 B2 <b>(17) Date of Patent:</b> Nov. 27, 2018</p> <p><b>(54) BLOWING-ASSISTED ELECTROSPINNING</b></p> <p>(71) Applicant: Reza Farid Majid, Tehran (IR); Farid Majid, Tehran (IR); Shahrokh Ghiasi, Tehran (IR)</p> <p>(72) Inventor: Reza Farid Majid, Tehran (IR); Shahrokh Ghiasi, Tehran (IR); Ali Ghiasi, Tehran (IR); Nader Saderi, Tehran (IR); Ali Ghiasi, Tehran (IR)</p> <p>(73) Assignee: NANO-MEGHNA COMPANY (LEED), Tehran (IR)</p> <p>(* ) Notice: Subject to any disclaimer, the term of this patent is 20 years from the filing date.</p> <p>(21) Appl. No.: 16/712,125 (22) Filed: Sep. 21, 2017</p> <p><b>(65) Prior Publication Data</b> US 2018/0100101 A1 Jun. 11, 2018 <b>(66) Related U.S. Application Data</b> Priority granted application No.: 15/480,880 filed on Oct. 17, 2016.</p> <p><b>(31) Int'l Cl.:</b> D03D 150 (2006.01) D03D 151 (2006.01) D03D 152 (2006.01) C08F 2/00 (2006.01) (52) U.S. Cl.: D03D 150/00 (2018.01) D03D 150/02 (2018.01) D03D 150/04 (2018.01) D03D 150/06 (2018.01) D03D 150/08 (2018.01) D03D 150/10 (2018.01) D03D 150/12 (2018.01) D03D 150/14 (2018.01) D03D 150/16 (2018.01) D03D 150/18 (2018.01) D03D 150/20 (2018.01) D03D 150/22 (2018.01) D03D 150/24 (2018.01) D03D 150/26 (2018.01) D03D 150/28 (2018.01) D03D 150/30 (2018.01) D03D 150/32 (2018.01) D03D 150/34 (2018.01) D03D 150/36 (2018.01) D03D 150/38 (2018.01) D03D 150/40 (2018.01) D03D 150/42 (2018.01) D03D 150/44 (2018.01) D03D 150/46 (2018.01) D03D 150/48 (2018.01) D03D 150/50 (2018.01) D03D 150/52 (2018.01) D03D 150/54 (2018.01) D03D 150/56 (2018.01) D03D 150/58 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electrospinning: 1. Spinning solution is loaded into a syringe. 2. The syringe is inserted into a nozzle. 3. Air is blown through the nozzle to form a fiber. 4. The fiber is collected onto a substrate.</p> <p style="text-align: center;">Diagram illustrating the blowing-assisted electrospinning setup: A cylindrical container labeled "Spinning solution" is connected to a syringe. The syringe is inserted into a nozzle. Air is being blown through the nozzle, creating a fiber. The fiber is collected onto a substrate.</p> </p>	<p><b>(12) Claims, 9 Drawing Sheets</b></p> <p><b>(16) Patent No.:</b> US 10,138,574 B2 <b>(17) Date of Patent:</b> Oct. 2, 2018</p> <p><b>(54) DUAL-SYRINGE PUMP</b></p> <p>(71) Inventor: Reza Farid Majid, Tehran (IR); Nader Saderi, Tehran (IR); Shahrokh Ghiasi, Tehran (IR); Ali Ghiasi, Tehran (IR)</p> <p>(73) Assignee: NANO-MEGHNA COMPANY (LEED), Tehran (IR)</p> <p>(* ) Term: 14 Years</p> <p>(21) Appl. No.: 2019/007,023 (22) Filed: Jul. 11, 2</p>
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The image displays four separate patent application documents arranged horizontally. Each document is a scanned page with a white background. The first three documents (X1, V1, A1) show a similar diagram at the bottom: a rectangular box labeled 'CPU' with a fan-like symbol to its right, connected by arrows to various components like 'VDD' and 'GND'. The fourth document (A1) shows a more complex schematic diagram with multiple components and connections. Each document includes a standard patent header with fields for inventors, assignees, and priority dates.



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