فناوران نانو مقیاس

ریاست جمهوری
معاونت علمی و فناوری
ستاد ویژه توسعه فناوری نانو

وبینار نانو تریبون صنعت

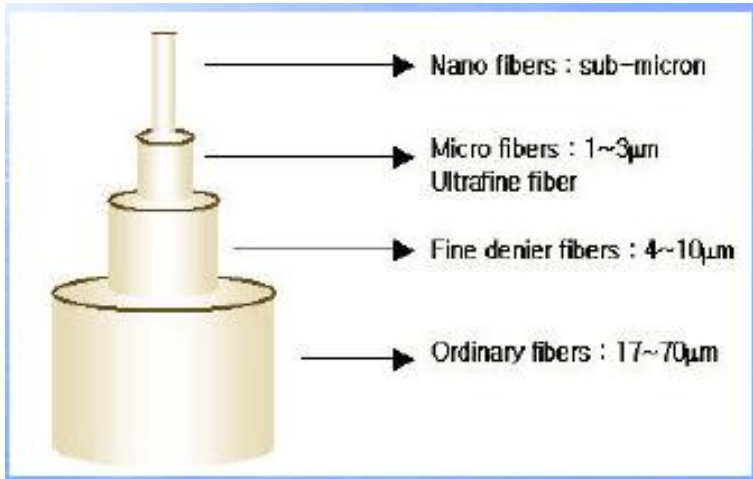
ماسک های تنفسی نانو

نادر نادری

مدیر عامل شرکت فناوران نانو مقیاس

پنجشنبه ۲۹ آبان ماه ۱۳۹۹

Nanofibers



Fibres diameter comparison

SEM of nanofibres and human hair

4.34 nanofibre

nano-object with two similar external dimensions in the nanoscale and the third dimension significantly larger

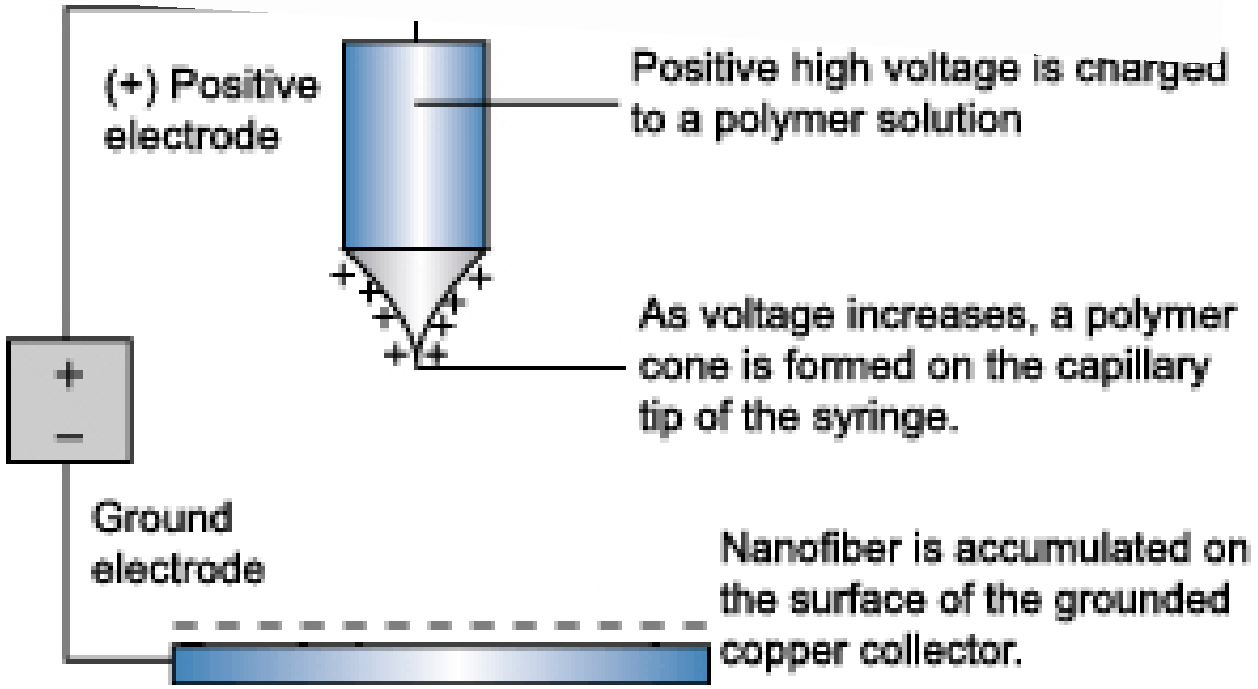
NOTE 1 A nanofibre can be flexible or rigid.

NOTE 2 The two similar external dimensions are considered to differ in size by less than three times and the significantly larger external dimension is considered to differ from the other two by more than three times.

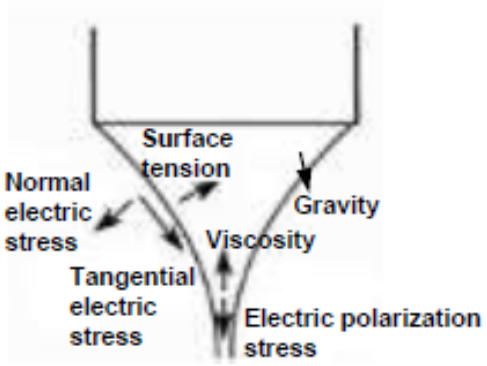
NOTE 3 The largest external dimension is not necessarily in the nanoscale.

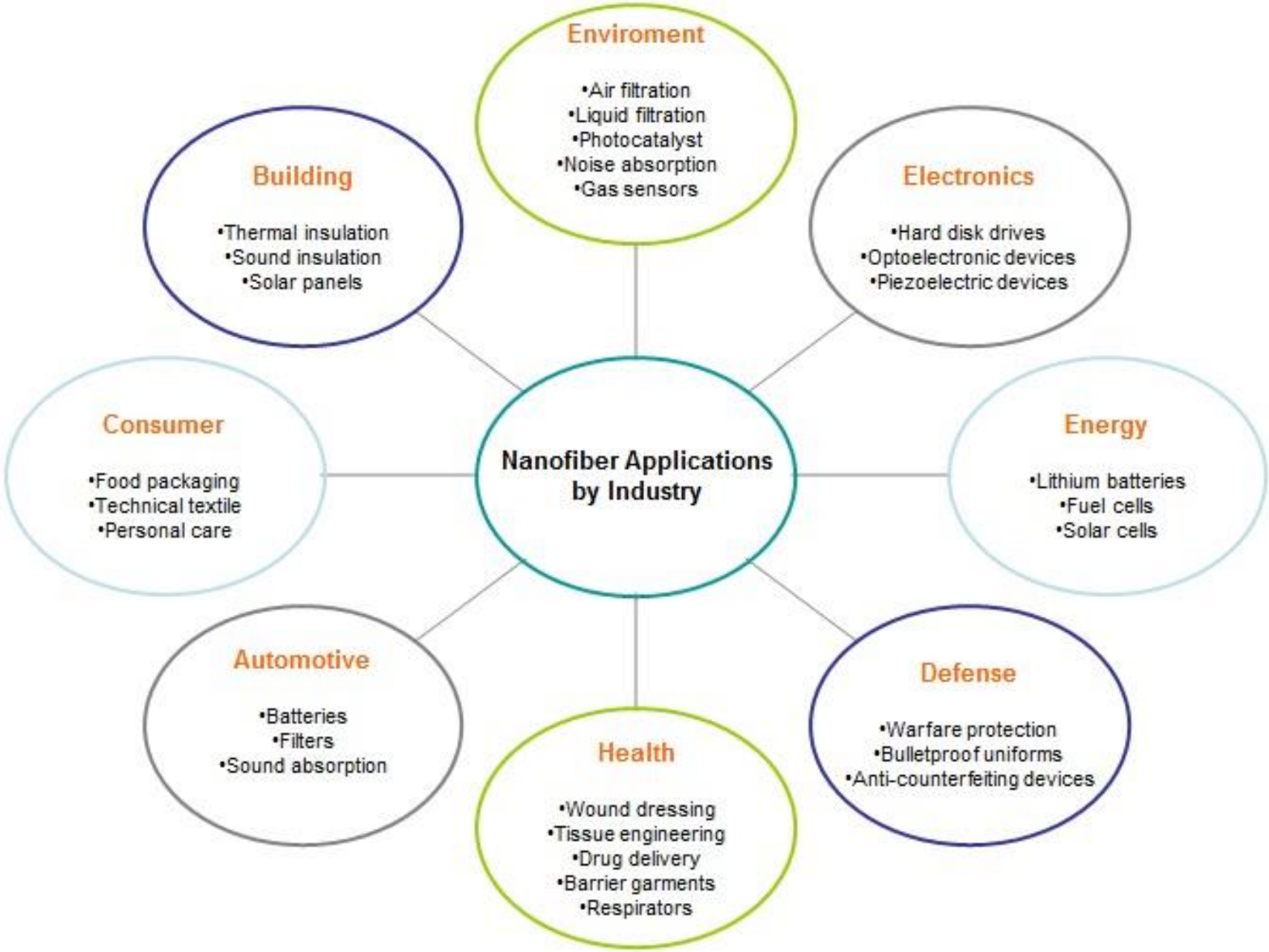
[ISO TS 27687:2008, definition 4.3]

Electrospinning



The velocity of the jet can reach values of a few m/s, and strain rates are up to 10^7 s^{-1}.




Nanofiber Applications by Industry
Enviroment
•Air filtration
•Liquid filtration
•Photocatalyst
•Noise absorption
•Gas sensors
Building
•Thermal insulation
•Sound insulation
•Solar panels
Electronics
•Hard disk drives
•Optoelectronic devices
•Piezoelectric devices
Consumer
•Food packaging
•Technical textile
•Personal care
Energy
•Lithium batteries
•Fuel cells
•Solar cells
Automotive
•Batteries
•Filters
•Sound absorption
Defense
•Warfare protection
•Bulletproof uniforms
•Anti-counterfeiting devices
Health
•Wound dressing
•Tissue engineering
•Drug delivery
•Barrier garments
•Respirators

About us

Fanavaran Nano-Meghyas (FNM Co. Ltd.;) was founded in 2004, is a knowledge based company and its goals are the development of nanofibers technology and its applications. FNM's products and services are design and production of electrospinning machines in lab, pilot and industrial scales as well as melt, force and blown electrospinning systems, with various accessories (High Voltage power supplies, Syringe Pumps and collectors), with focus on producing of respiratory face mask, power plant and automotive air and oil filters, window screen, vacuum cleaner bags, cosmetic face masks, wound dressing and etc. based on electrospun nanofibers.

Name of Company:	Fanavaran Nano-Meghyas (Fnm co. Ltd.)
E-mail:	fnm.ir.co@gmail.com, info@fnm.ir
Office:	Unit 10, No. 23, 2nd Keyhan Ave., Ayatollah Kashani St., Tehran, Iran,
Factory:	West 4th Street, Golgoon Industrial zone, 5th km Shahriar Road, Karaj old Road. Iran
Nanofiber Innovation Center	No. 8; Hamedan Ave. North Kargar Street; Tehran; Iran
Tel.:	+98 (21) 65612497
ICANANO	ICAN; NANO site; Sh. Ehsani Rad ST., Engelab St., Parsa Sq., Ahmadabad Mostoufi Rd., Azadegan Highway, Tehran, Iran

Awards, Verification and Standards

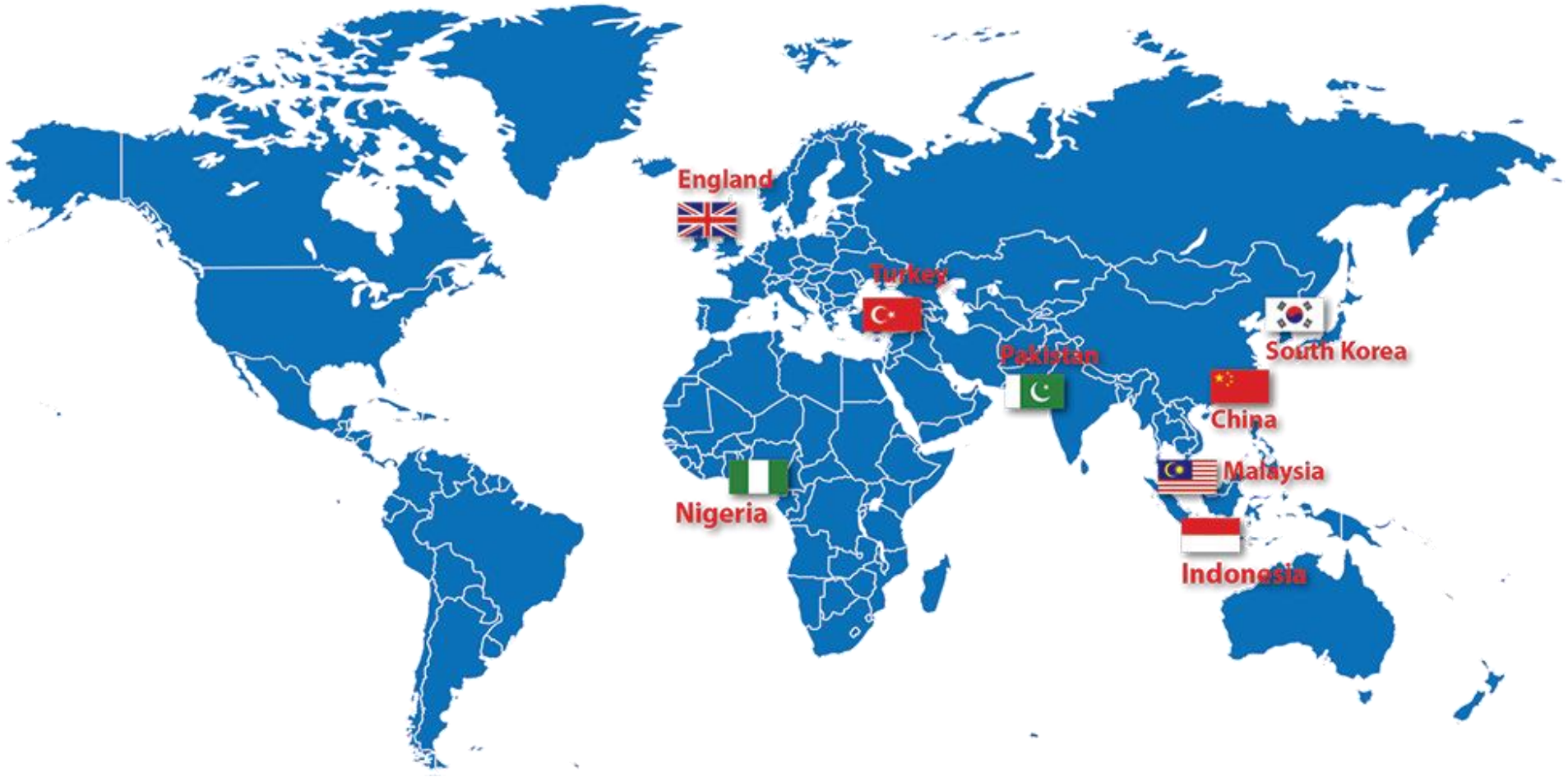
- **Ranked eighth in International Nanotechnology Festival-Tehran (2009).**
- **Award for research project at the Festival of Science to Practice (December 2010)**
- **Third laureate R&D 25th Khwarazmi international Award, 5th Feb 2012 Tehran, Iran.**
- **Academy of science award in developing countries (TWAS); UNESCO, 2012**
- **Second rank in Technology at 6th National Nano-Awards Festival, October, 2011, Tehran, Iran.**
- **First laureate nano products award at 11th National Nano-Awards Festival, October, 2016, Tehran, Iran.**
- **Award for high tech export at 12th National Nano-Awards Festival, October, 2017, Tehran, Iran.**
- **Award for high tech export at 13th National Nano-Awards Festival, November, 2018, Tehran, Iran.**
- **5 International and 12 Iranian Patents**

QUALITY ASSURANCE MANGEMENT ISO 9001 ENVIRONMENTAL MANAGEMENT ISO 14001 OCCUPATIONAL HEALTH & SAFETY OHSAS 18001 CUSTOMER SATISFACTION ISO 10002

ISO ISO 13485

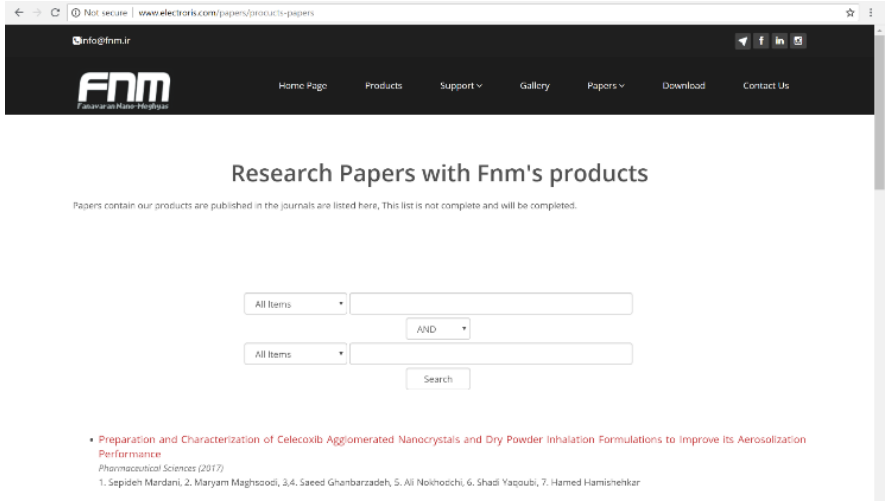
CE گواهینامه نانومقیاس

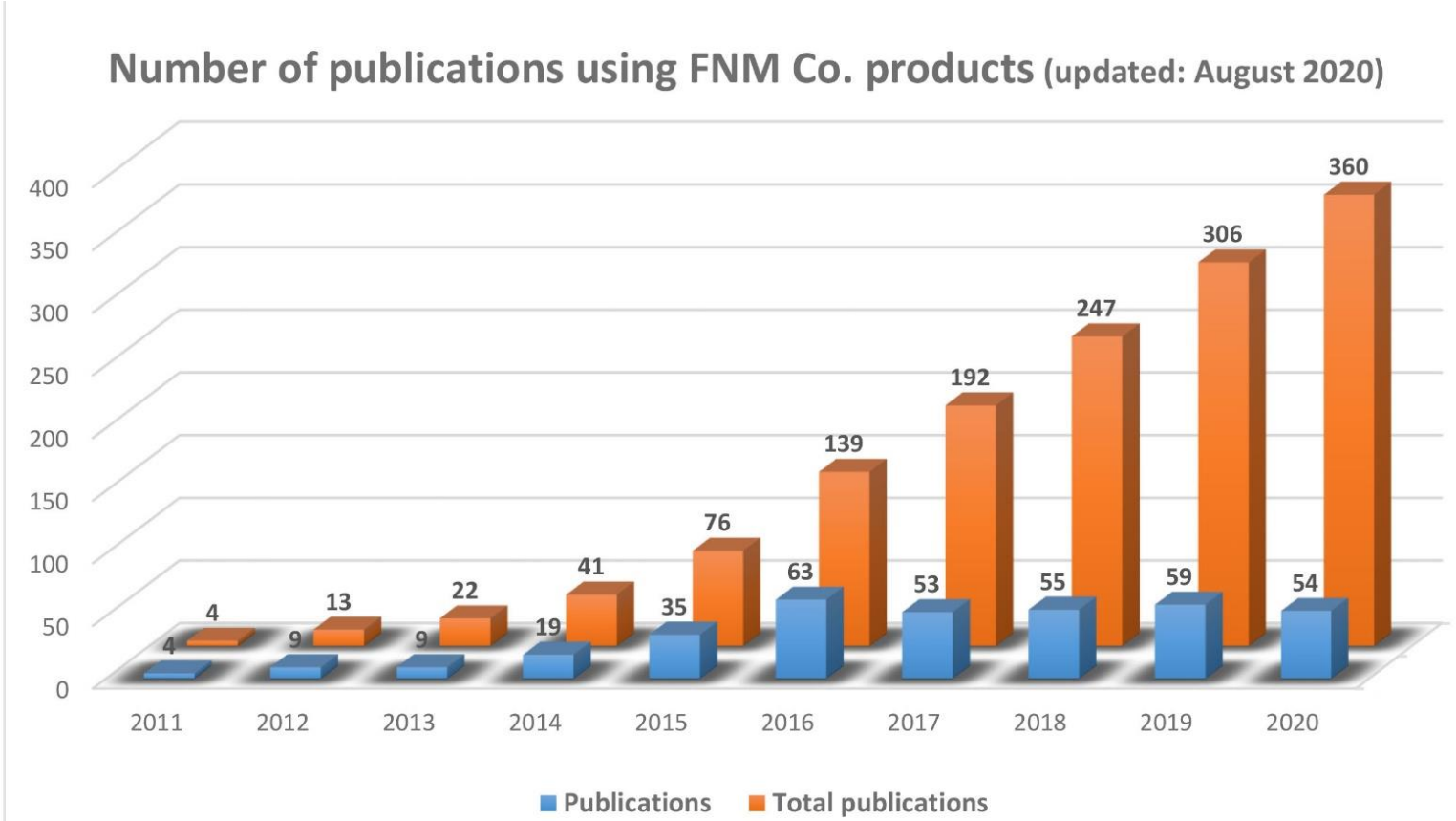
Today there are 8 overseas offices/sale representative, in Shanghai (China), Suzhou (China), Kuala-Lumpur (Malaysia), Jakarta (Indonesia), London (United Kingdom), Istanbul (Turkey), and Islamabad (Pakistan).



Citations to our Products in Research Papers

More than 250 published research papers (updated 2018).
Citations are available on our website
(http://en.fnm.ir/papers/products-papers**)**





Company Facilities

Analysis Equipment

- Scanning Electron Microscopy (SEM)

- FNM Filter Test machine

FNM Filter/Mask Test Machine

دستگاه تست فیلتر

Specifications

		FT150EA	FT200PO	FT200PS
Test Modes	Pressure drop test	✓	✓	✓
	Air permeability test	✓	✓	✓
	Filtration Efficiency Test	Atmospheric	Oil Particles	Oil and Salt Particles
	Bubble Point	×	Optional	Optional
Standards	BS EN 149	✓	✓	✓
	BS EN 779	✓	✓	✓
	ISO 16890	✓	✓	✓
	ISO 16900-3	✓	✓	✓
	ISO 11155-1	✓	✓	✓
	ISO 5011	✓	✓	✓
Control	PLC	✓	✓	✓
	HMI	7"	7"	7"
	Ambient Temp.	×	✓	✓
Air flow	Flow	10 - 150 l/min	10 - 200 l/min	10 - 200 l/min
	Digital control	✓	✓	✓
Media Holder	Area	100 cm^2	20, 50 and 100 cm^2	20, 50 and 100 cm^2
Sensors	Temperature	✓	✓	✓
	Relative Humidity	✓	✓	✓
	Digital Tank Pressure Control	×	✓	✓
	Tank Pressure	1 – 8 bar	1 – 8 bar	1 – 8 bar
Pressure Drop	Pressure Drop	0 – 1200 Pa	0 – 1200 Pa	0 – 1200 Pa
	Digital control	✓	✓	✓
Air Dryer	Air Line Trap	✓	✓	✓
	Dryer System	×	✓	✓
Particle Counter	Laser Particle Counter	1	2	2
	Channels	six-channel	six-channel	six-channel
	Channel Sizes	0.3, 0.5, 1, 2.5, 5, 10 µm	0.3, 0.5, 1, 2.5, 5, 10 µm	0.3, 0.5, 1, 2.5, 5, 10 µm
	Flow rate	2.8 L/min	2.8 L/min	2.8 L/min
Aerosol Generator (Oil)	Generator	×	✓	✓
Aerosol Generator (Salt)	Generator	×	×	✓
	Neutralizer	×	×	✓
Aerosol Dilutor	Particle Dilution	×	100:1	100:1
	Type of Aerosol Challenge	×	PSL, PAO, DOP	PSL, PAO, DOP, NaCl
Printer		Optional	Optional	✓
Respiratory Face Mask Holder		Optional	Optional	Optional
Power		Single phase, 220 V, AC	Single phase, 220 V, AC	Single phase, 220 V, AC
Weight (kg)		About 170 kg		
Size, (Length, Width, Height)		94 cm, 92 cm, 163 cm		

BS EN 149:2001 +A1:2009

FNM Co

DATE: 13 February, 2020
NO.: 98112482

Respiratory Face Mask
Filtration performance test results

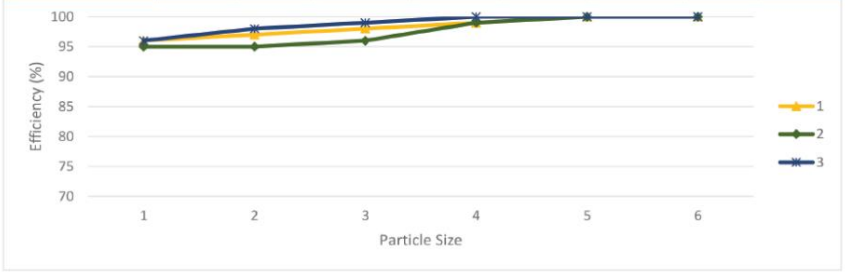
Requested by: Zist Abzar Pajoohan Co.

Test Conditions

- Test apparatus: FNM Filter Test
- Test aerosol: Oil
- Air flow rate for efficiency test: 32 l/min
- Sample name: **FFP2 - Rima**
- Particles tested size: 0.3, 0.5, 1.0, 2.5, 5.0 and 10.0 µm

Filtration performance of respiratory face mask

Performance results (According to BS EN 149)								
NO.	Efficiency (%)						Pressure Drop (Pa) @ (l/min)	
	0.3 µm	0.5 µm	1.0 µm	2.5 µm	5.0 µm	10.0 µm	30	95
1	96	97	98	99	100	100	52	187
2	95	95	96	99	100	100	51	185
3	96	98	99	100	100	100	52	187



FNM Co

DATE: 13 February, 2020
NO.: 9811241

Respiratory Face Mask
Filtration performance test results

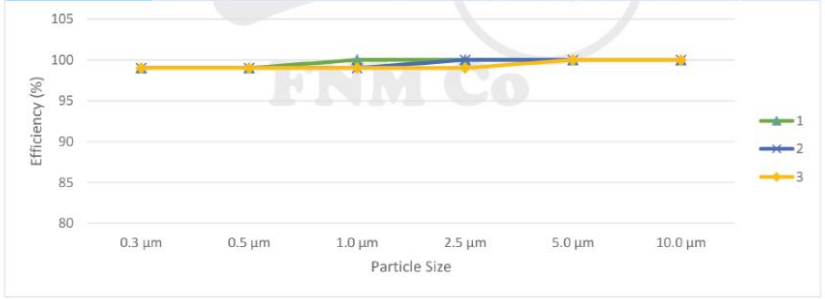
Requested by: Zist Abzar Pajoohan Co.

Test Conditions

- Test apparatus: FNM Filter Test
- Test aerosol: Oil
- Air flow rate for efficiency test: 32 l/min
- Sample name: **FFP3 - Rima**
- Particles tested size: 0.3, 0.5, 1.0, 2.5, 5.0 and 10.0 µm

Filtration performance of respiratory face mask

Performance results (According to BS EN 149)								
NO.	Efficiency (%)						Pressure Drop (Pa) @ (l/min)	
	0.3 µm	0.5 µm	1.0 µm	2.5 µm	5.0 µm	10.0 µm	30	95
1	99	99	100	100	100	100	63	231
2	99	99	99	100	100	100	64	228
3	99	99	99	99	100	100	63	230



Industrialization Center for Applied Nanotechnology (ICAN)

Nanofiber Platform

http://icanano.ir/

New Standard in ISO

Nanotechnologies –Air filter media containing polymeric nanofibres; Specification of characteristics and measurement methods

1- **Potential New Work Item Proposal:** WG4 Interim meeting in Korea, June 2015
2- **Circulation of NWIP:** 2015, June, 30
3-**Resulat of Ballot (approved):** 2015, Sept., 24
4-**Interim Meeting:** May 2016 Kyoto
5-**Interim Meeting:** November 2016 Singapore
6-**web meeting:** May 2017
7-**Interim Meeting:** November 2017 Seoul
8-**web meeting:** Feb. 2018 (resolve the USA comments)
9-**web meeting:** July 2018 (resolve the USA comments)
10-**Interim Meeting:** November 2018 Malaysia
11- **new version was circulated for DTS:** Fab. 2019
12-**Resulat of DTS Ballot**: approved 2019, April, 16
13- **Meeting Sydney,** May, 2019 for resolving comments
14- **4 web meeting:** July 2019 (resolve the Japan comments)

ISO/TS 21237

Lab-Scale Electrospinning unit

Hybrid Electrospinning machine

Cartridge and needle-based Electrospinning machine

Pilot-scale Electrospinning Machine

Industrial Electrospinning Machine

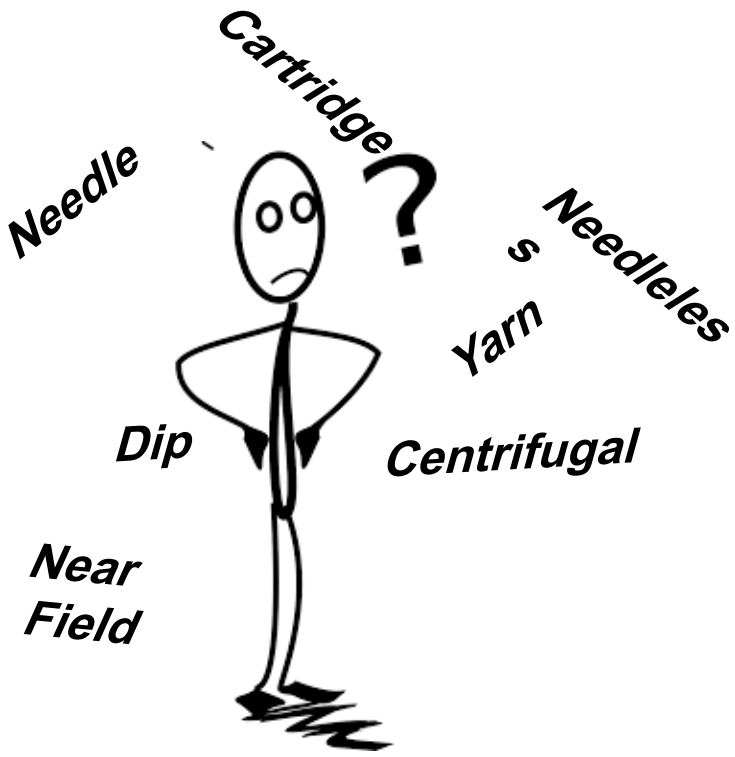
Yield

Up to 100 g/hr

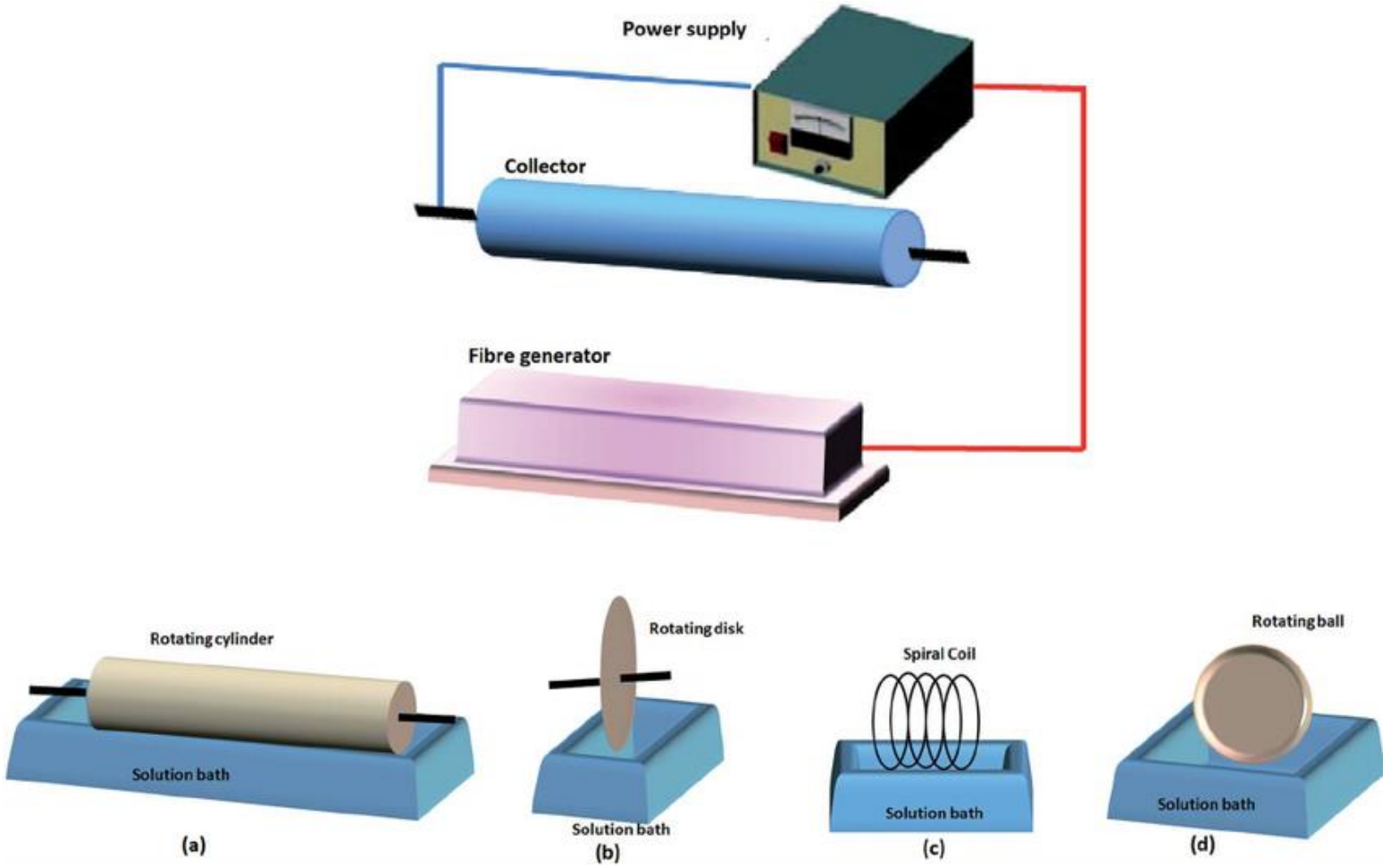
**depending on polymer solution and electrospinning parameters*

Nanofiber sizes of

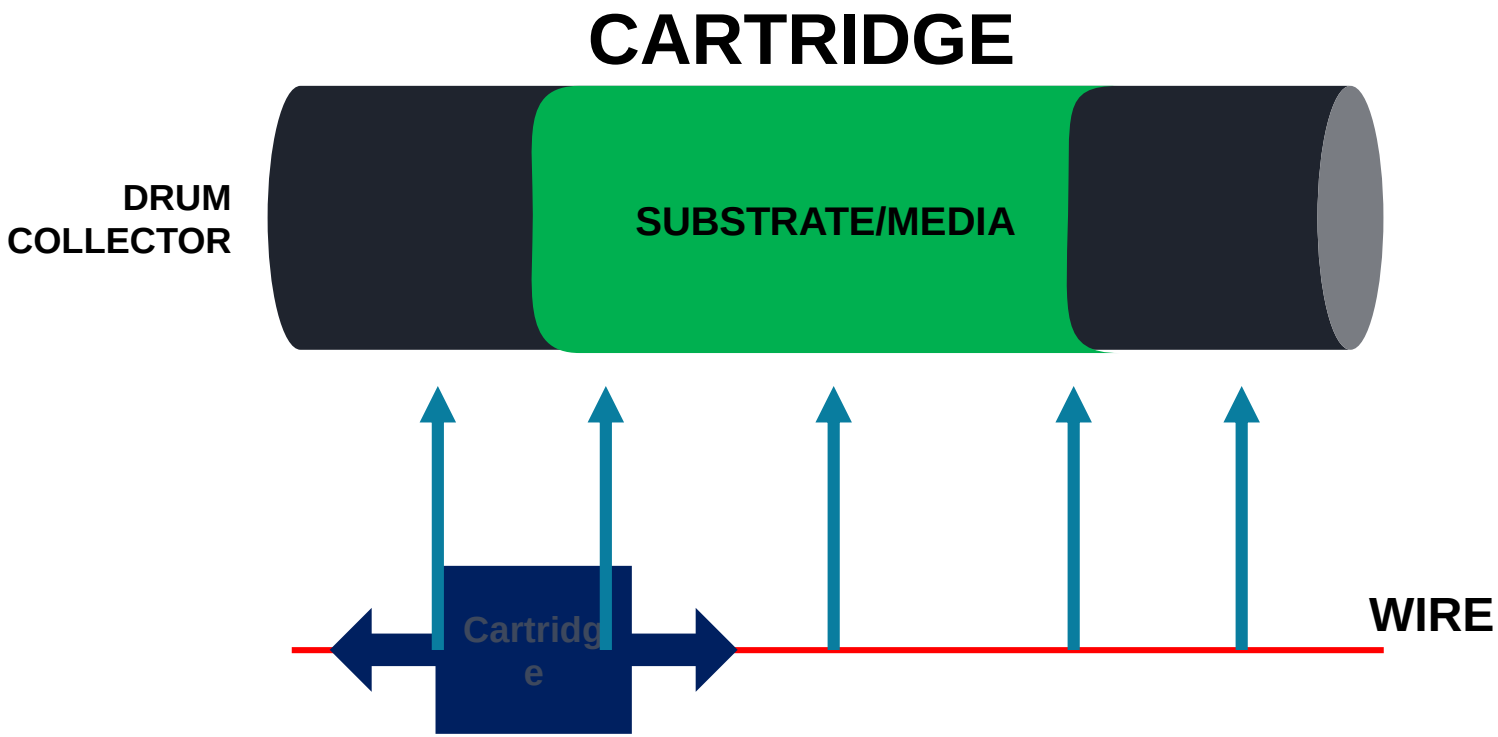
60-500 nm*


Cartridge
Needle
?
Needleles
s
Yarn
Dip
Centrifugal
Near
Field

BATH/DIP ELECTROSPINNING



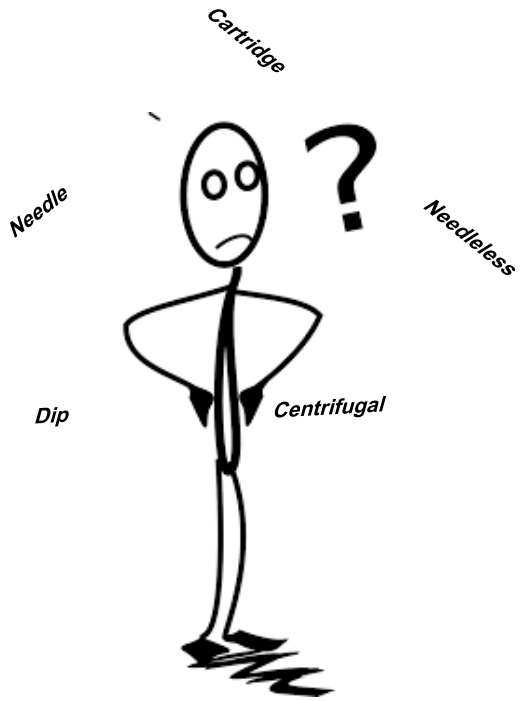
Nazir, Ahsan & Khenoussi, Nabyl & Schacher, Laurence & Hussain, Tanveer & Adolphe, Dominique & Hekmati, Amir. (2015). Using Taguchi method to investigate the effect of different parameters on mean diameter and variation in PA-6 nanofibres produced by needleless electrospinning. RSC Adv.. 5. 10.1039/C5RA13649K.


CARTRIDGE
DRUM
COLLECTOR
SUBSTRATE/MEDIA
Cartridg
e
WIRE

CONVENTIONAL MULTINEEDLE ELECTROSPINNING

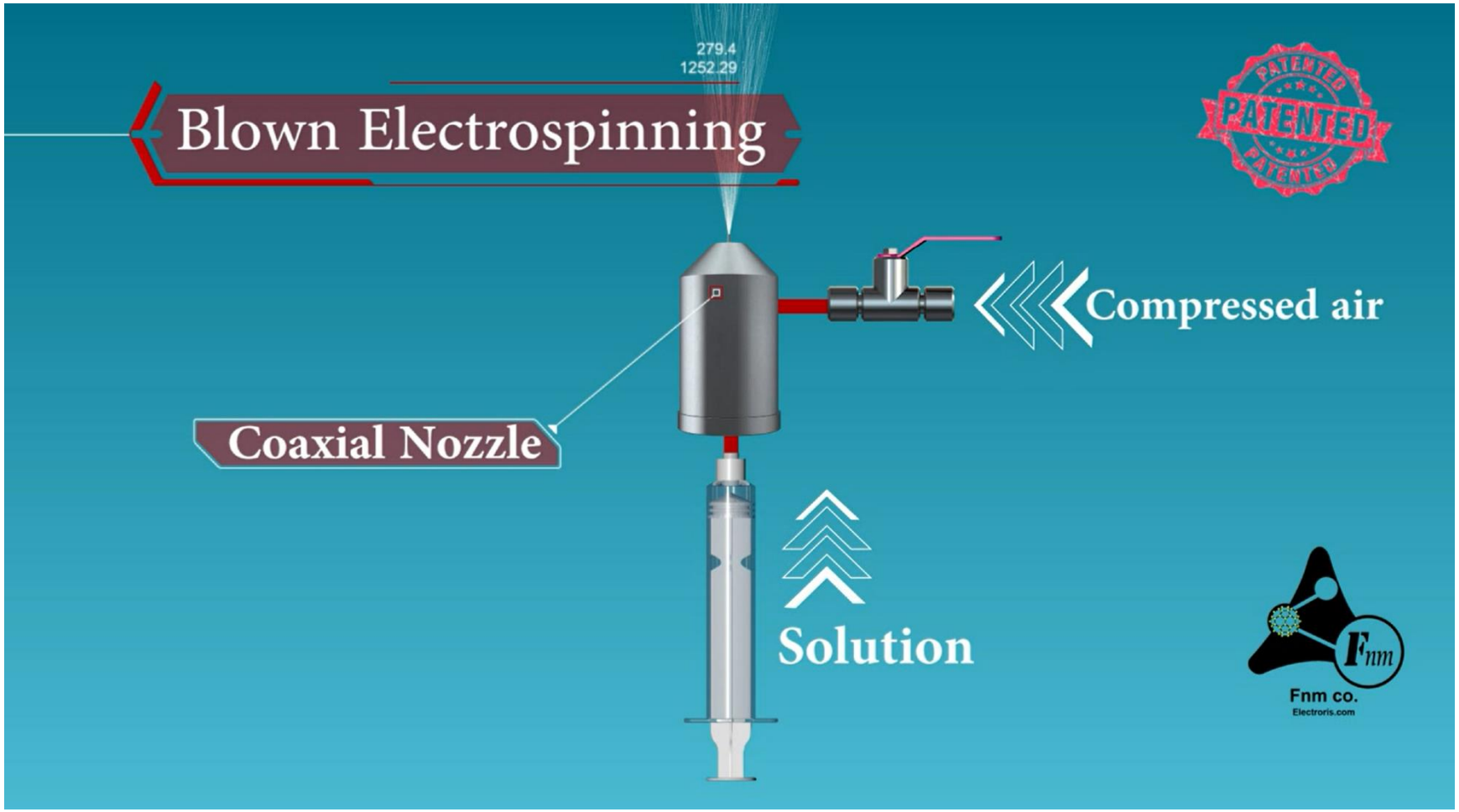
http://www.bjtechnova.com/product/show.asp?lb_id=8
https://www.qingzitech.net/electrospinning-nanofiber-production-line-mf01

Upscaling: what to think about?



- Production rate
- Wastage
- Maintenance/Cleaning
- Flexibility
- Adhesion to support layer
- Solution Concentration
- Flammability of solvents
- Thick nanofiber mat

Blowing-Assisted Electrospinning


279.4
1252.29
Blown Electrospinning
PATENTED
Compressed air
Coaxial Nozzle
Solution
Fnm co.
Electroris.com

Comparison of different electrospinning methods

Method	Production rate*	CONSTANT Solution Concentration	Flexibility (variety of materials)	Solution waste**	flammability	Adhesion to support layer	Thick nanofiber mat
Multineedle electrospinning	Poor 2gr/h/unit (10 needles)	Excellent	Good	Very Low<5%	Very Low	Low	Medium
Bath/Dip electrospinning	Medium 3gr/h/unit	Poor	Poor	High >50%	High	low	Low
Cartridge electrospinning	Medium 4gr/h/unit	Poor	Medium	Medium >25%	Medium	Low	Low
Blowing- assisted electrospinning	**High** **12gr/h/unit**	**Excellent**	**Excellent**	**Very low** **<5%**	**Very Low**	**High**	**High** **Up to 2 mm**

*Polyamide

***Based on repeated internal testing*

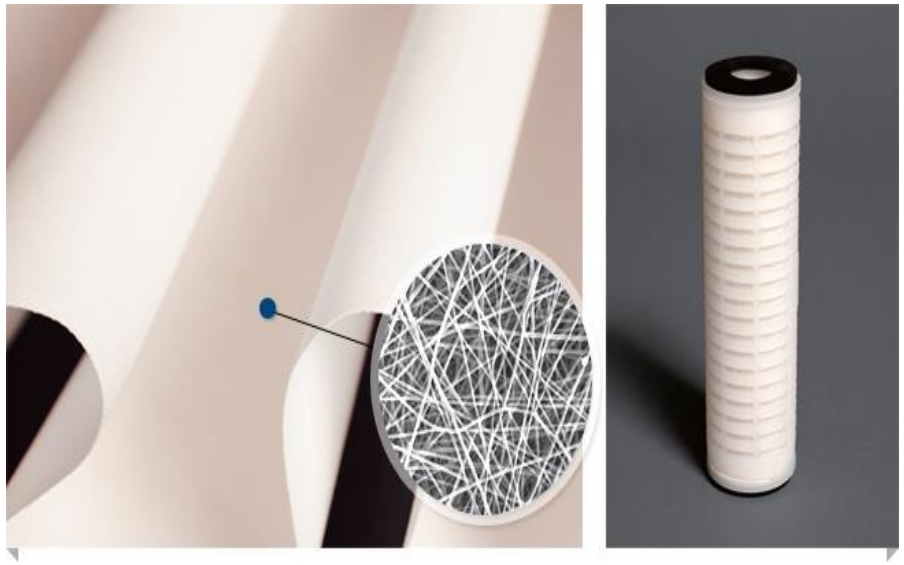
Filter Application

- HVAC air filter
- Gas turbine air filter
- Automotive air filter
- Clean room air filter
- Bag house air filter
- Antimicrobial air filter
- Catalytic filter
- Highly selective filter
- Respiratory face masks

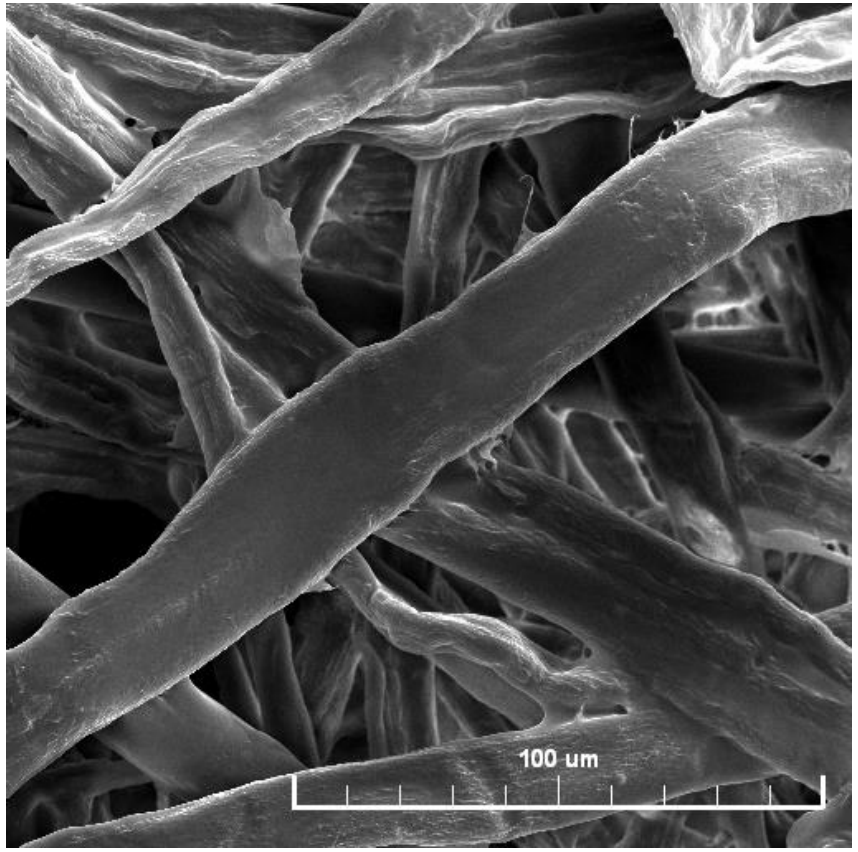
Filter Application

Major Performance Characteristics for Air Filters based on Market Survey

1-Efficiency
2-Pressure Drop
3- Dust holding Capacity (Life Time)



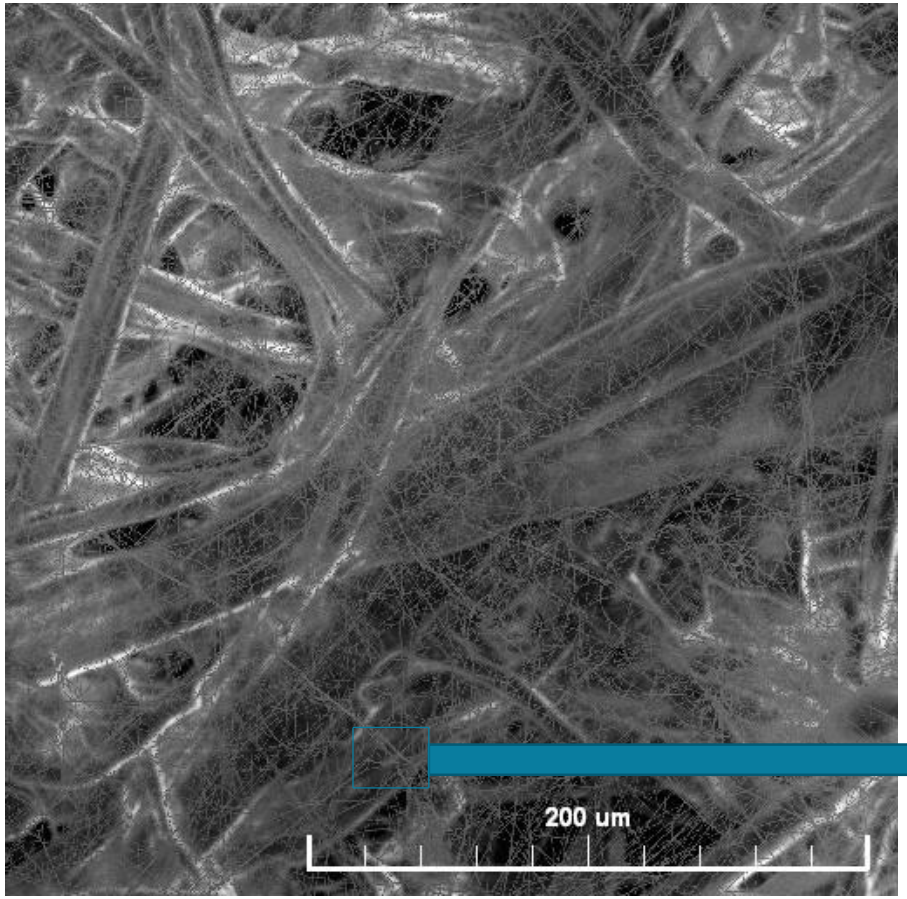
Microfiber of main filters paper

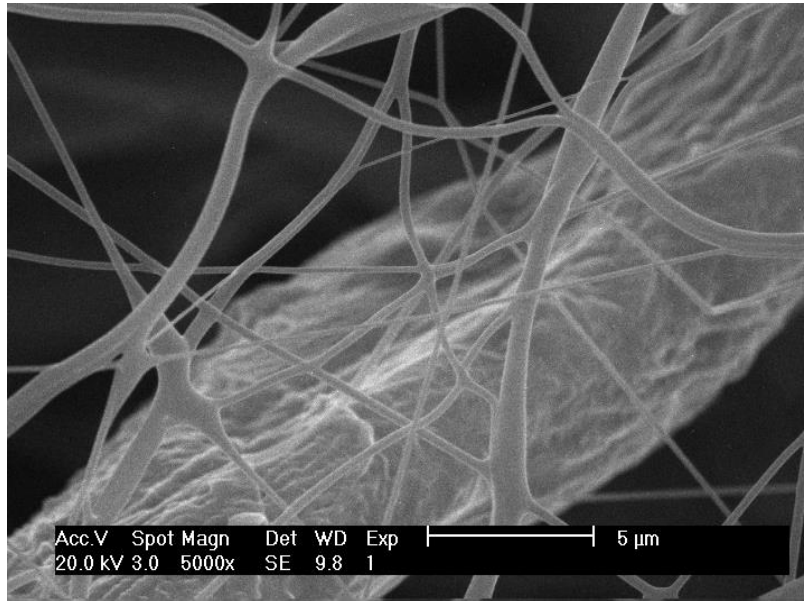


Filters' paper classification

Class	Final Pressure Drop Pa	Average efficiency (Em) of 0,4 µm particles %
F7	450	80 ≤ Em < 90
F8	450	90 ≤ Em < 95
F9	450	95 ≤ Em

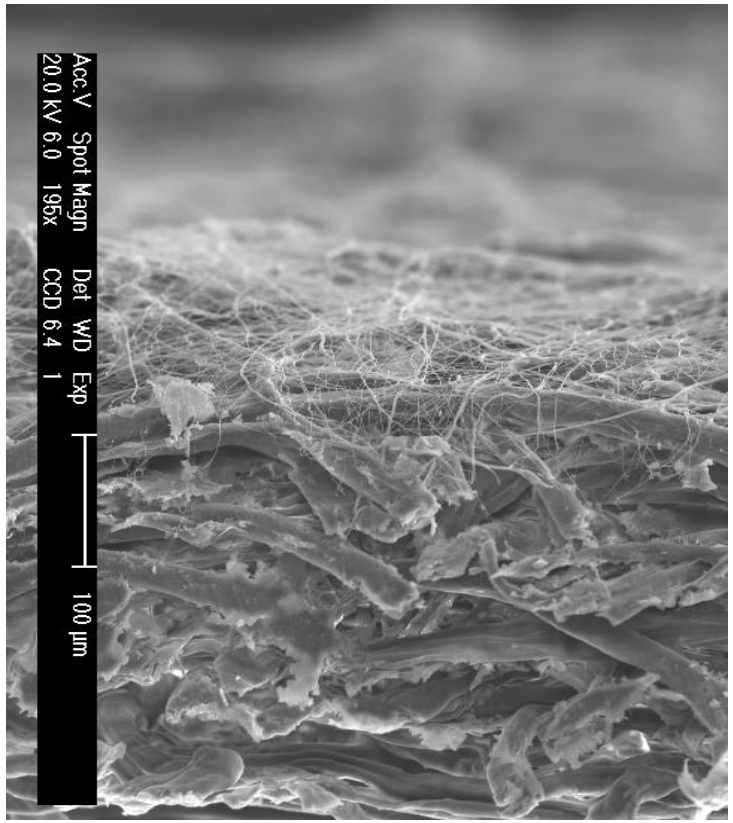
Filtration

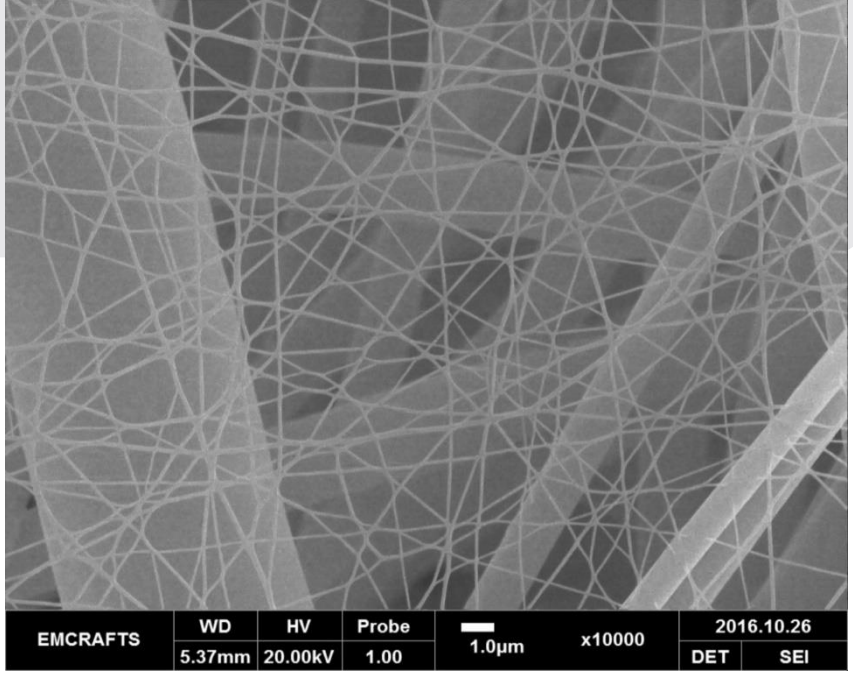


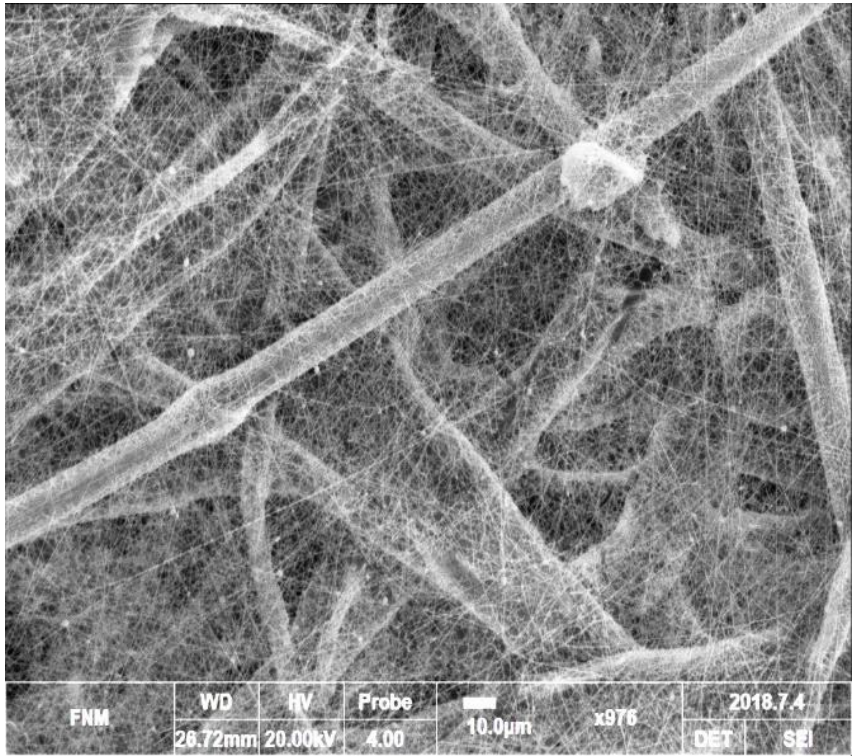


× 40

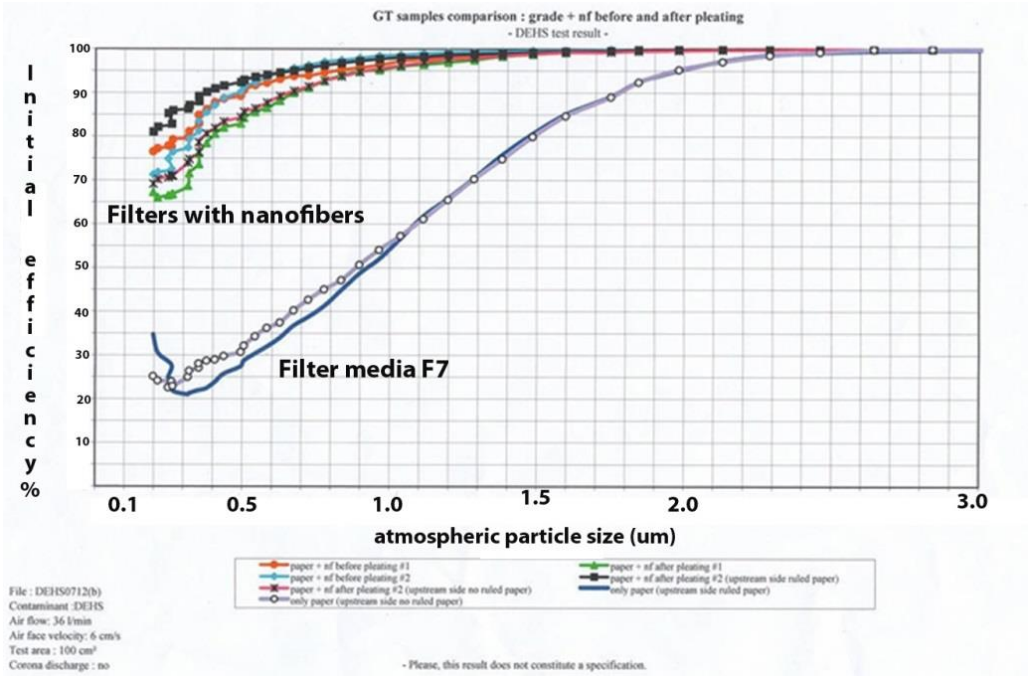
SEM Images of Nanofibers on filter paper







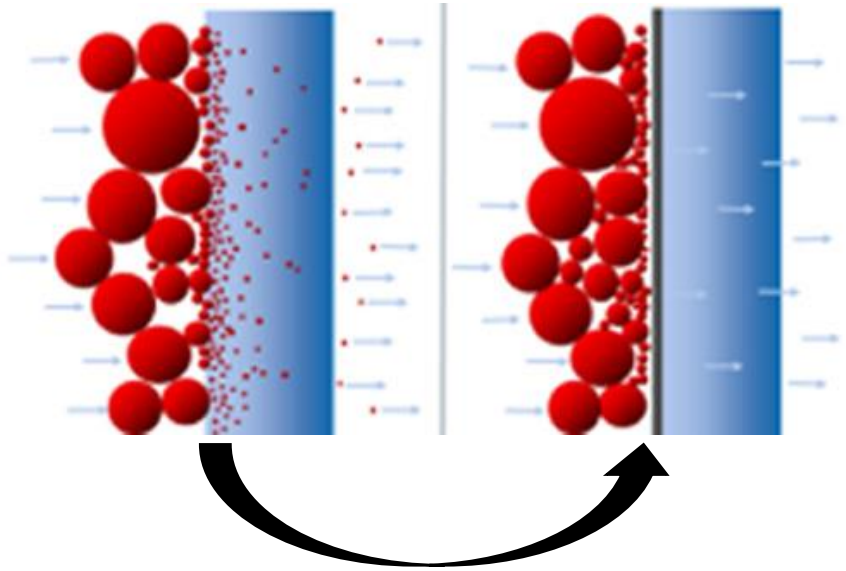
Filtration Efficiency tests



Active nanofibrous filtering layer with narrow pore size suitable for submicron filtration

A layer of NF

changes the



EN 779:2002. AIR FILTER TEST RESULTS

GENERAL

Test no.:	122876	Date of test:	28.6 and 16.- 17.7.2012	Supervisor:	RHo
Test requested by:	Behran Filter Co.			Device receiving date	
Device delivered by:	Behran Filter Co.			16.5.2012	

DEVICE TESTED

Model	Manufacturer	Construction
Gas Turbine Air Filter V94.2	Behran Filter Co.	Cylindrical filter
Type of media	**Net effective filtering area**	**Filter dimensions (diameter x length) (The length includes gaskets)**
90/40 EPE K WB2-G+NANO	19 m²	328 mm x 624 mm

TEST DATA

Test air flow rate	Test air temperature	Test air relative humidity	Test aerosol	Loading dust
0.347 m³/s	24 - 25 °C	38 - 43 %	DEHS	ASHRAE

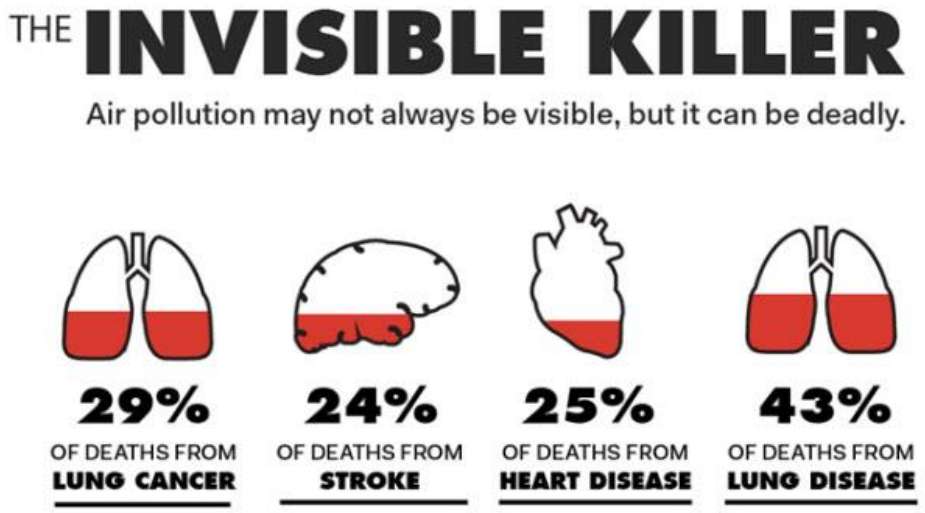
RESULTS

Initial pressure drop	Initial arrestance	Initial efficiency (0,4 µm)	Dust holding capacity	Untreated / discharged efficiency of filter material (0.4 µm)
238 Pa	>99 %	72 %	8 / 226 / 504 g	
Final pressure drop	**Average arrestance**	**Average efficiency (0,4 µm)**	**Filter class (450 Pa)**	
250 / 350 / 450 Pa	>99 / >99 / >99 %	79±1 / 97±0 / 99±0 %	F9 (0.347 m³/s)	Non Applicable

Remarks: -

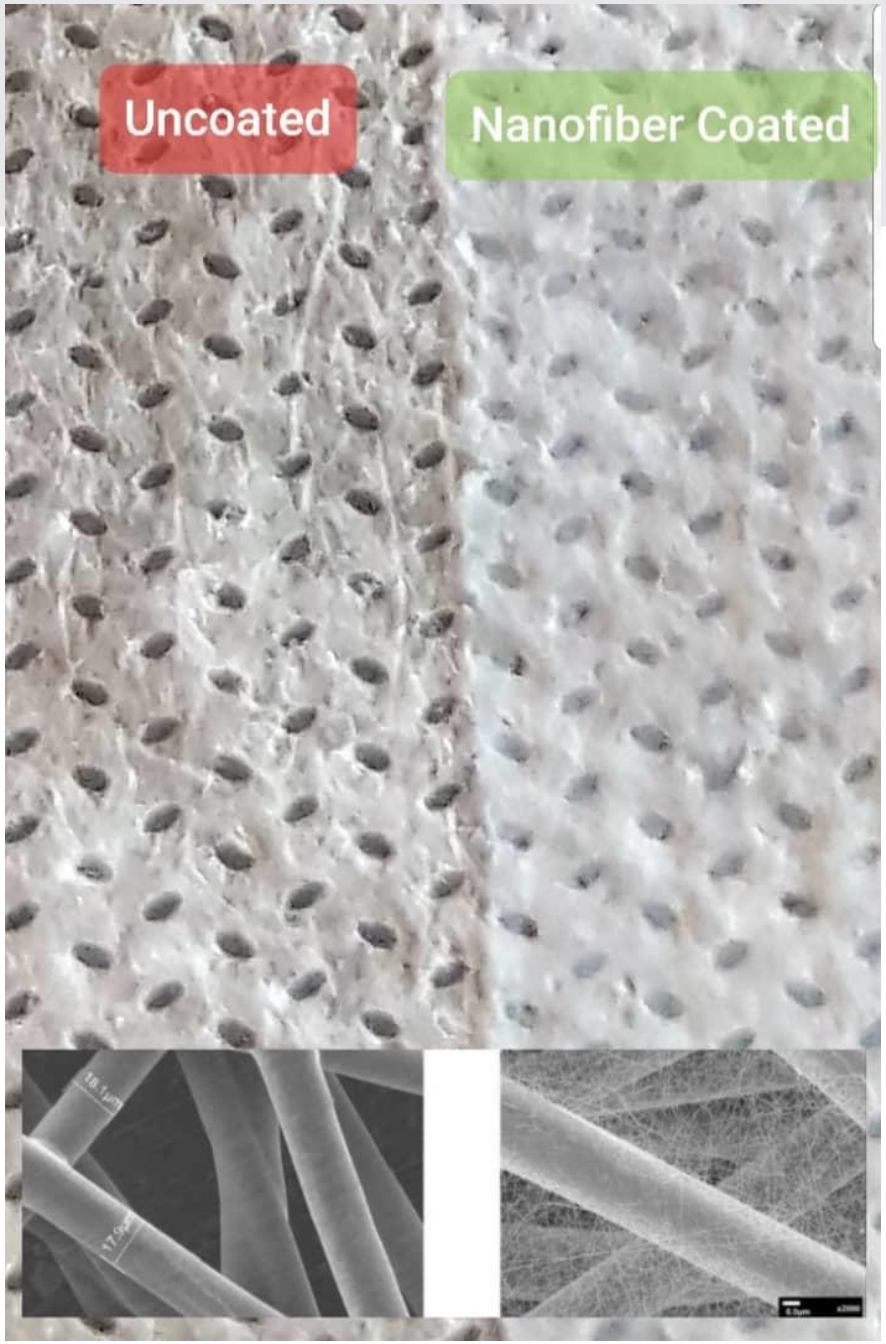
NOTE: The performance results cannot by themselves be quantitatively applied to predict filter performance in service. The results relate only to the tested item.

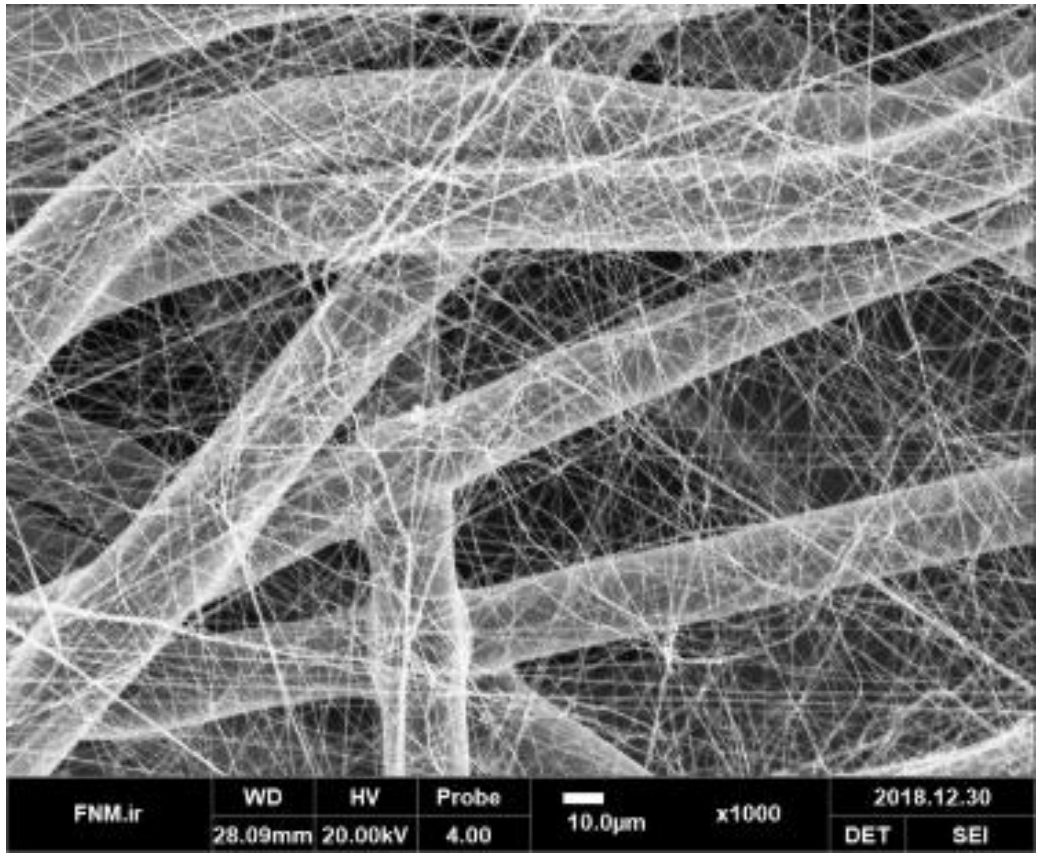
pollution



Air pollution was estimated to cause 4.2 million premature deaths worldwide per year.
(April of 2019, www.who.int/airpollution/en/)

Respiratory Face Mask



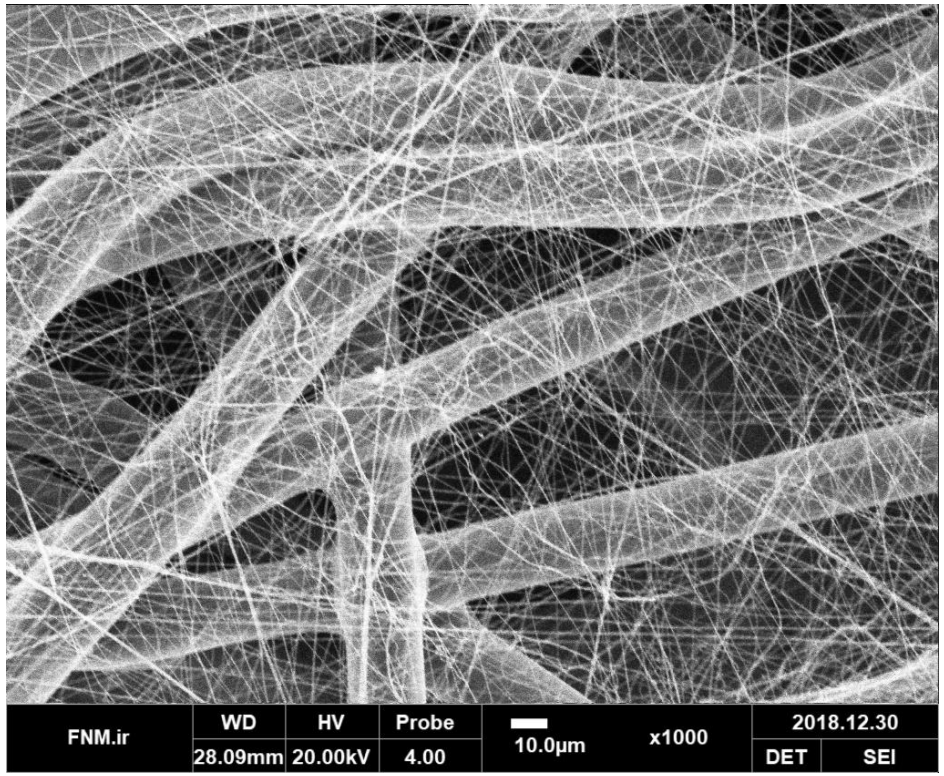


Respinano
NanoFiber Mask

Respiratory Face Mask

Respinano
NanoFiber Mask

Nanofiber-based Anti-Allergy Bedding Test Results

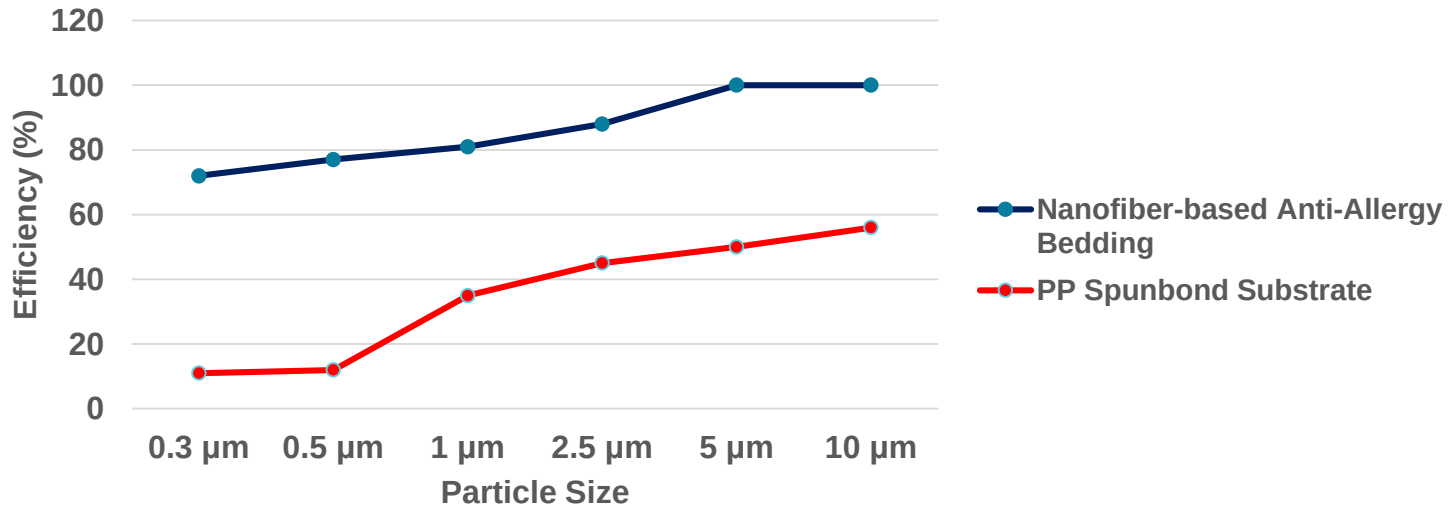


SEM image of nanofiber-based anti-allergy bedding

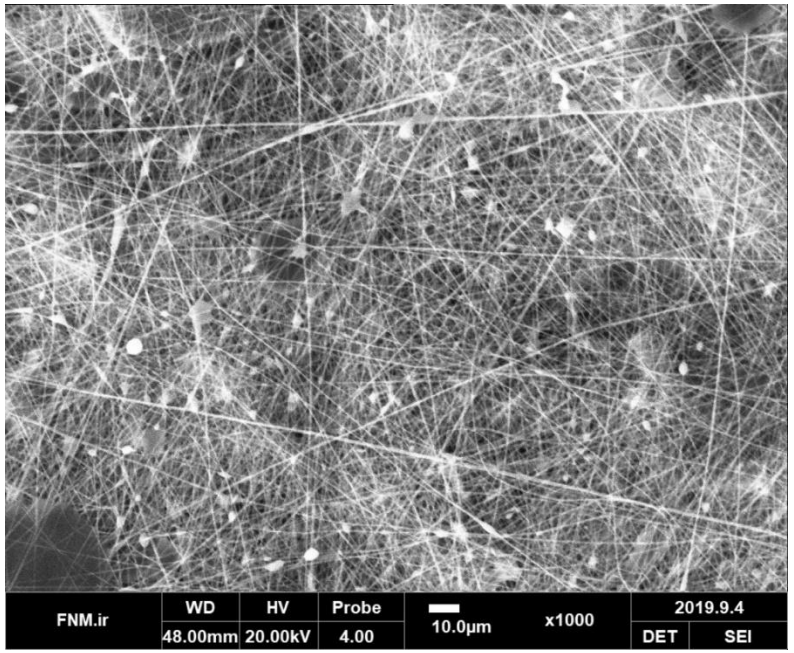
Nanofiber-based anti-allergy bedding substrate

Performance of Nanofiber-based Anti-Allergy Bedding

Performance of nanofiber-based anti-allergy bedding (According to EN 779, EN ISO 9237)							
Sample Name	Efficiency (%)						Air Permeability (l/m²/s)
	0.3 µm	0.5 µm	1.0 µm	2.5 µm	5.0 µm	10.0 µm	
Nanofiber-based Anti-Allergy Bedding	72	77	81	88	100	100	181 (@ 125 Pa)
PP Spunbond Substrate	11	12	35	45	50	56	250 (@ 60 Pa)



Nanofiber-based Beauty Face Mask Test Results

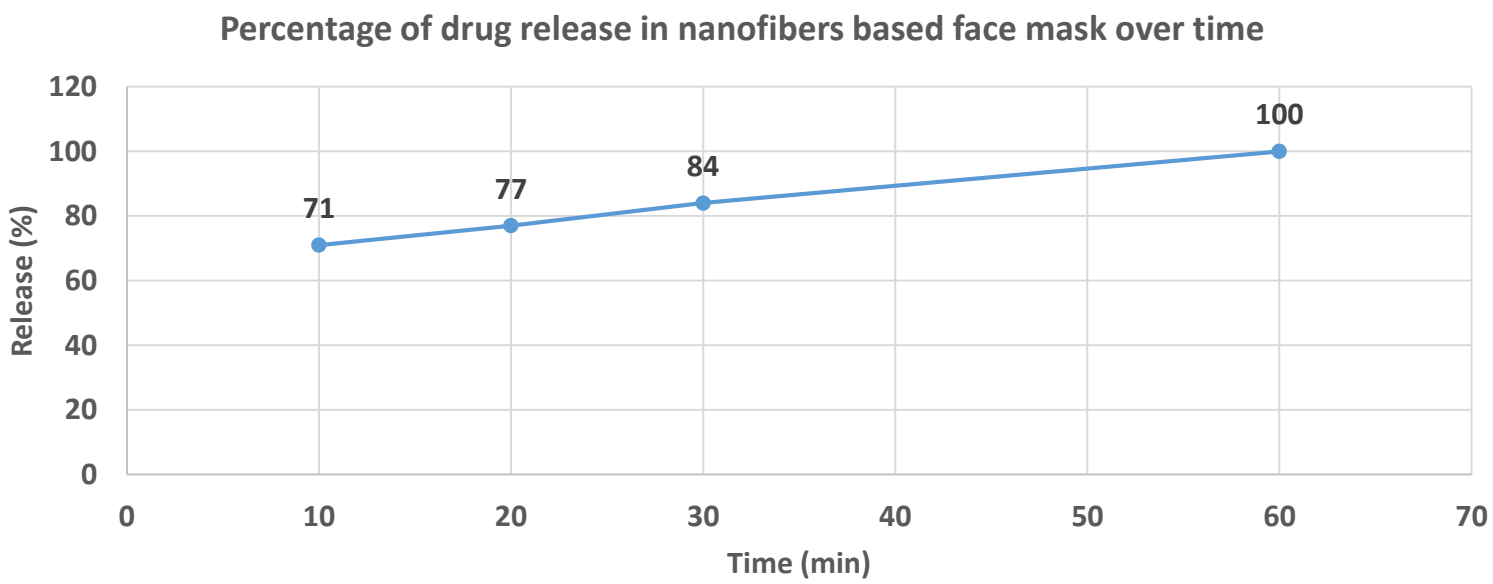


SEM image of nanofiber-based beauty face mask

Beauty Face Mask

Release Test of Nanofiber-based Beauty Face Mask

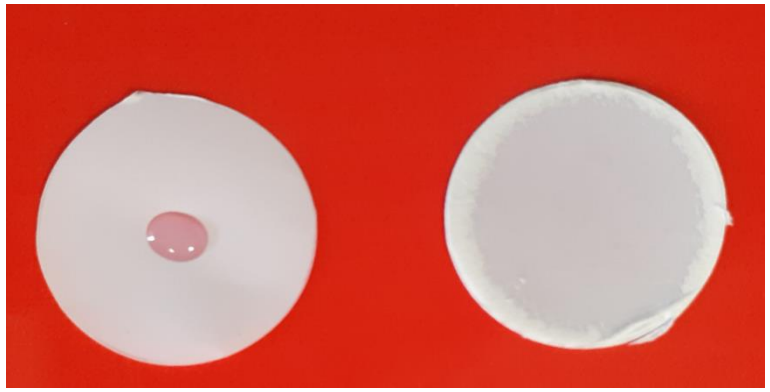
Test Method	λ_{max}
Spectrophotometry	255 nm

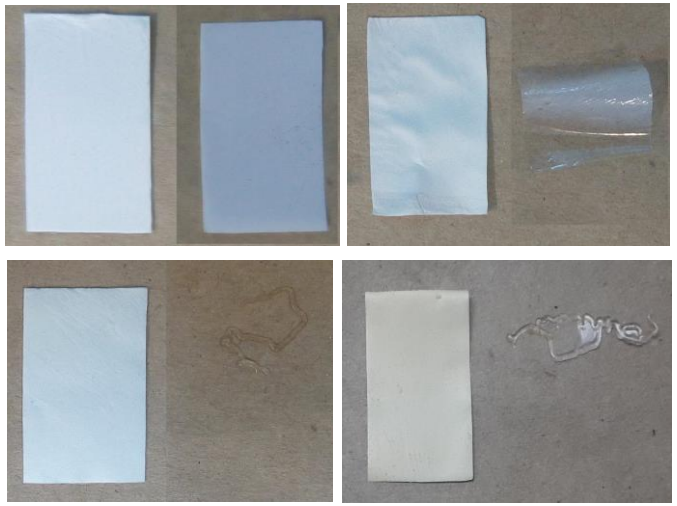


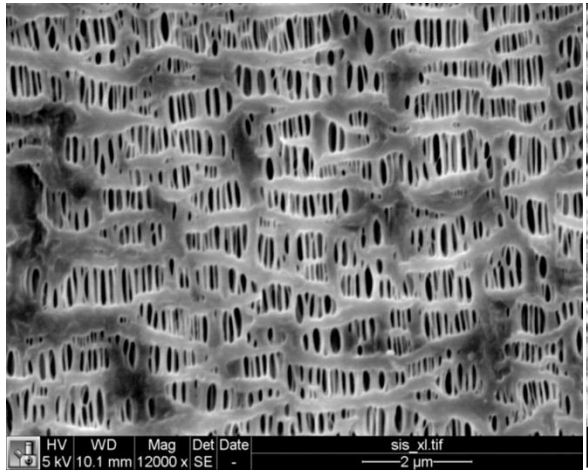
Lithium Ion Battery Separator

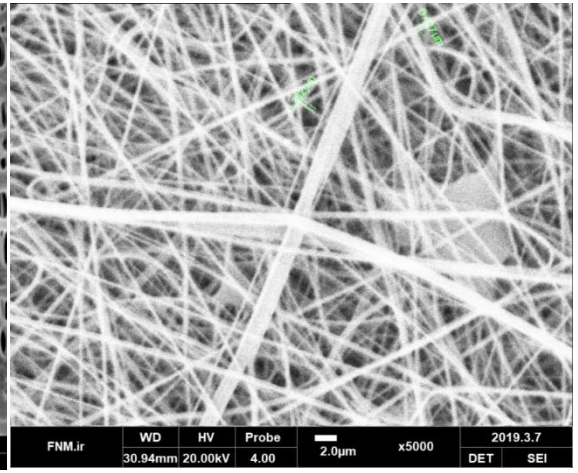
FNM Separators in Lithium-Ion Battery

1. The porosity is more than 60%
2. Electrolyte uptake 500%
3. Thermal stability above 180 ° C
4. High ionic conductance
5. No battery electrolyte leakage
6. Higher safety offered by high heat resistance
7. Shorter processing time for electrolyte injection



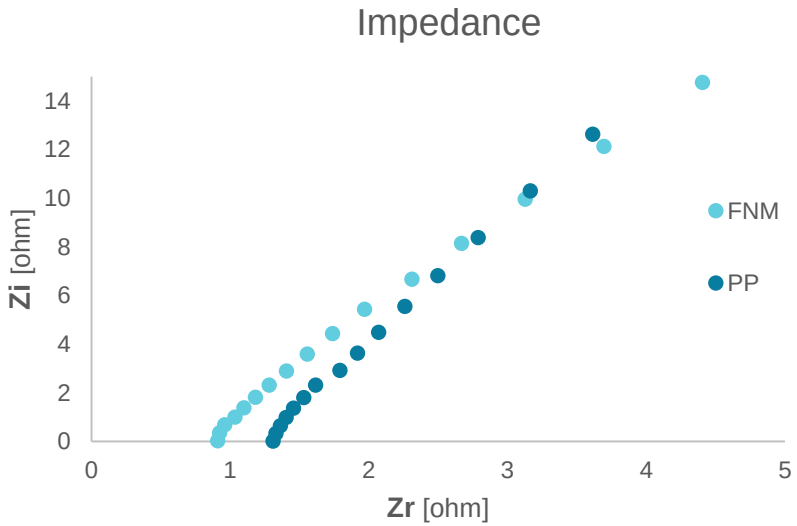




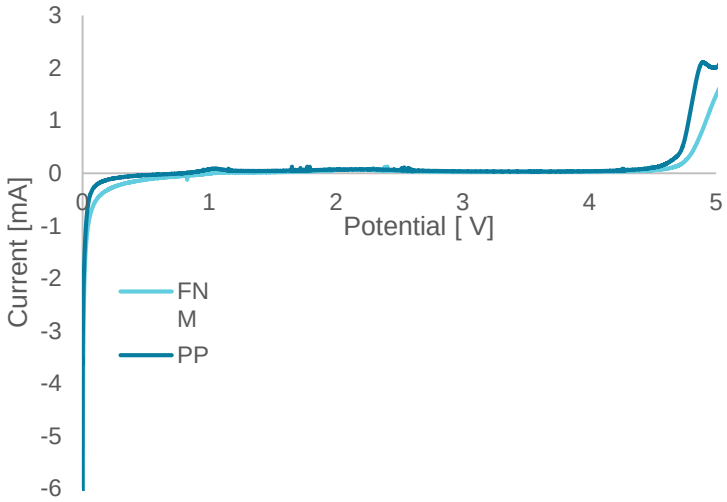


Sample	Electrolyte uptake (%)	Porosity (%)	Ionic conductivity ($mS.cm^{-1}$)
PP	86	36	0.8
FNM	500	65.02	2.3

Lithium Ion Battery Separator

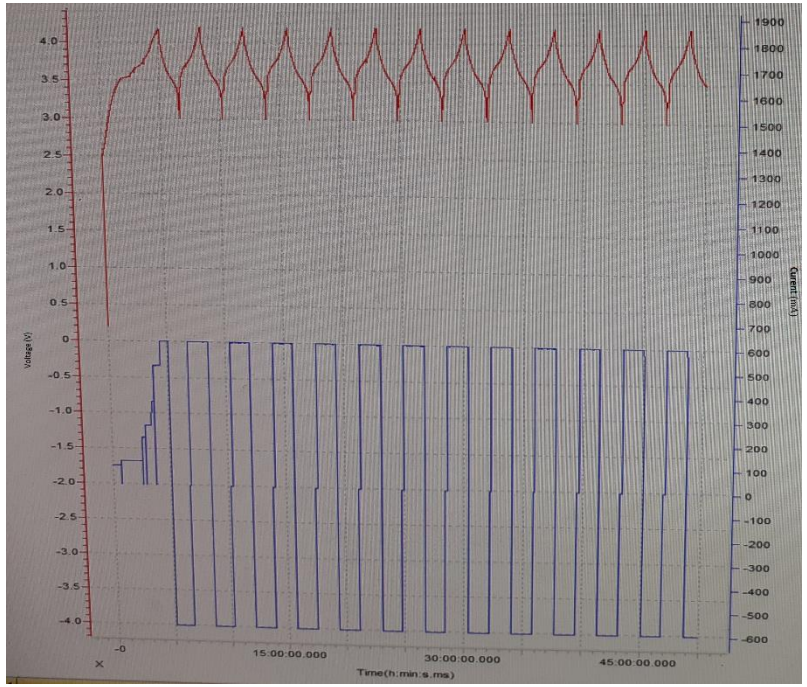


Electrochemical stability



Cycle Performance

The cycle performance of the cells using FNM separator is studied at discharge rate of 0.5C as a function of cycle number (up to 200 cycles).



Behran Filter;
4 Industrial and 1 pilot electrospinning machines

Azad Filter; (Industrial filters)
1 Industrial electrospinning machine

Serkan Filter (Car filters)
1 Industrial and 1 pilot electrospinning machines

Zist abzar Co. (Respiratory face masks)
2 Industrial and 1 pilot electrospinning machines

Deylaman Filter (Industrial filters)
1 Industrial electrospinning machines

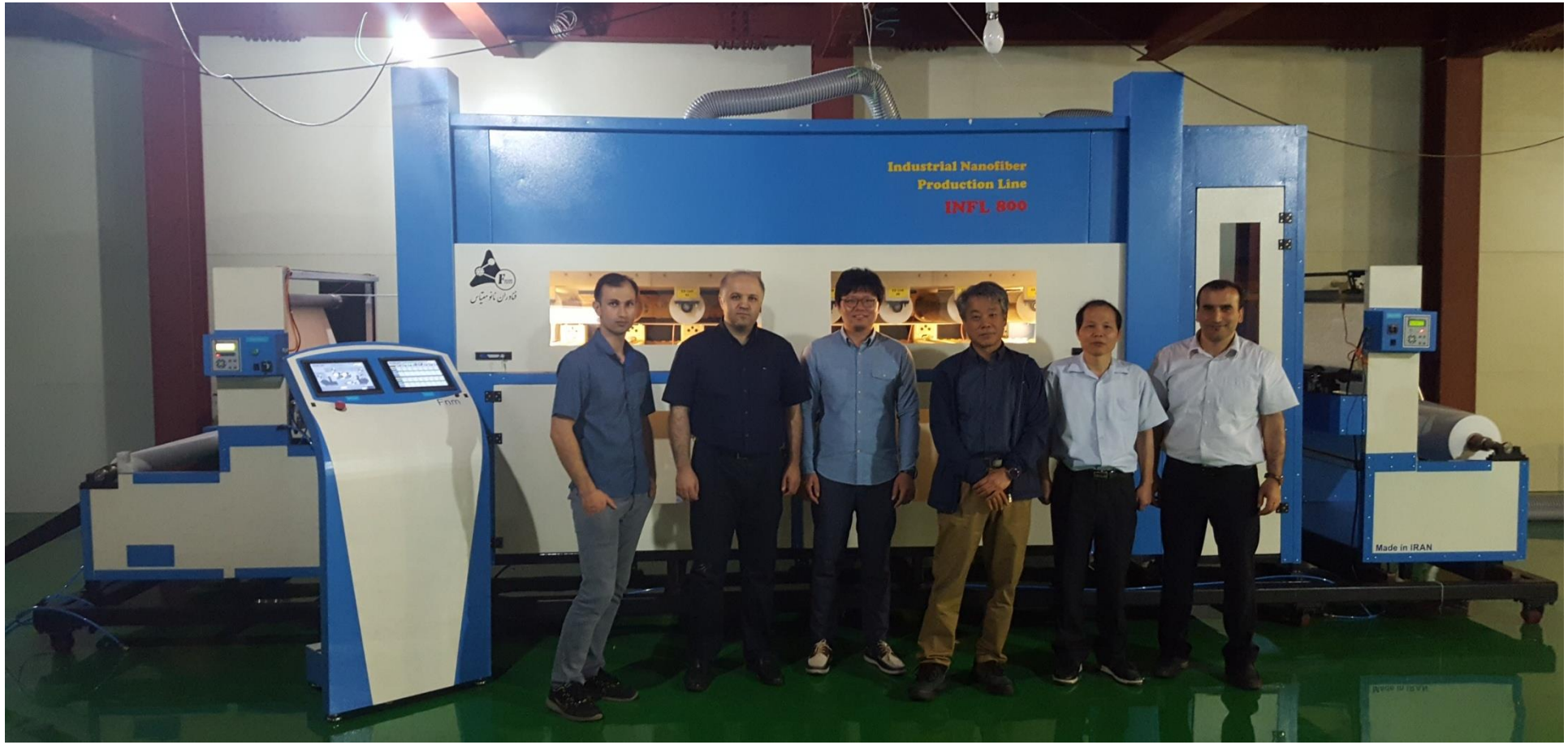
Golrang Group (Respiratory face masks)
1 Industrial electrospinning machines

Malaysia: 3 Pilot electrospinning machines, 20 lab-scale

A Joint Company in Malaysia:

NanoLab Instruments

South Korea; 1 Industrial electrospinning machine



China: 6 Industrial, 5 lab-scale electrospinning machines and 1 pilot electrospinning machines

INCC
伊朗纳米中国中心

صادرات دستگاه تست فیلتر به کشور تایلند

اطلاعات تماس شرکت

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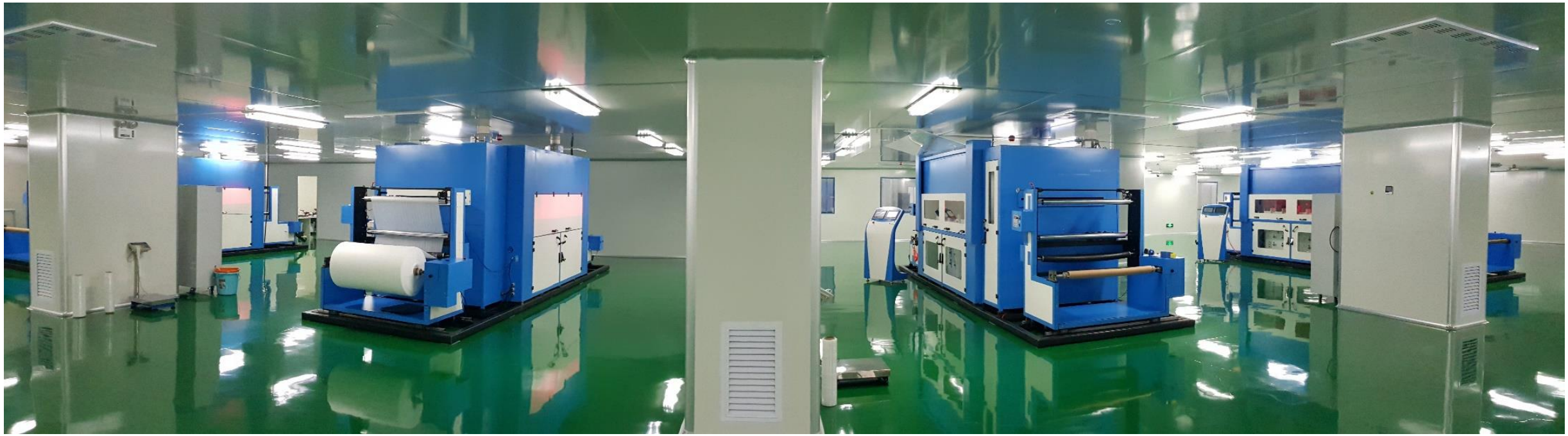
واتساپ: ۰۹۱۲۶۲۷۱۸۲۸

تشکر از توجه شما



FNM Co.

en.fnm.ir