High-tech air purification filter with Nanofiber

TN Solution

2017-2024 World's most polluted cities

PM2.5 legend (The most polluted cities according to data aggregated from over 80,000 data points)

0-5	5.1-10	10.1-15	15.1-25	25.1-35	35.1-50	>50.1
Meets WHO guideline	Exceeds by 1 to 2 times	Exceeds by 2 to 3 times	Exceeds by 3 to 5 times	Exceeds by 5 to 7 times	Exceeds by 7 to 10 times	Exceeds by over 10 times

Rank	City	2024	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2023	2022	2021	2020	2019
1	Byrnihat, India	128.2	174.4	183.7	153.3	140	105.7	88.4	90	86	68.6	87.4	146	193.7	--	--	--	--	--
2	Delhi, India	108.3	219.3	110.3	76.8	64.6	84.4	52.6	39.6	26.6	42.8	120.1	276.5	185.9	102.1	92.6	96.4	84.1	98.6
3	Karaganda, Kazak···	104.8	103.1	145.9	102.5	99.8	107.1	127.1	79.3	95.1	97.3	78.7	113.4	112.6	37.4	--	--	--	--
4	Mullanpur, India	102.3	123.3	111.2	79.6	47.2	67	53.1	72.3	42.5	62.2	142.7	302.5	146	100.4	185.5	--	--	--
5	Lahore, Pakistan	102.1	148.4	116.9	83.9	47	61.1	39.6	61.5	40.4	61.1	127.6	286.2	152.5	99.5	97.4	86.5	79.2	89.5
6	Faridabad, India	101.2	211.3	116	107.4	130.9	188.9	100.3	54.2	29.7	36.8	57.8	119.8	74.3	--	--	--	--	--
7	Dera Ismail Khan, ···	93	188.3	129.4	87.7	60.2	51.8	41.3	48.2	39.8	53.9	102	191.7	93.8	102.3	--	--	--	--
8	N'Djamena, Chad	91.8	192.8	126.9	167.3	160.8	138.9	54.2	20.6	20	24.9	40.4	70.6	102.1	56.9	89.7	77.6	--	--
9	Loni, India	91.7	135.7	81.2	60.1	56.9	68.7	63.4	54.7	32.9	58.5	134.5	235.7	120.1	--	--	--	--	--
10	New Delhi, India	91.6	190.4	91	66.4	52.8	75.4	49.9	34.6	24.5	37.8	99.6	224	152.1	92.7	89.1	--	--	--

(Source : https://www.iqair.com/in-en/world-most-polluted-cities)

Particle Pollution ?

<Source : CDC, *Air quality*, www.cdc.gov/air/particulate_matter.html>

- **Particle pollution – also called particulate matter (PM) – is made up of tiny particles of solids or liquis that are in the air.**

- **These particles may include :**
  - Dust
  - Dirt
  - Soot
  - Smoke
  - Drops of liquid

- **Where does particle poluution come from?**

  a) Primary sources cause particle on ther own.

  For example, wood stoves and forest fire.

  b) Sedondary source let off gases that can form particles. Power plants and coal fires are examples of secondary sources.

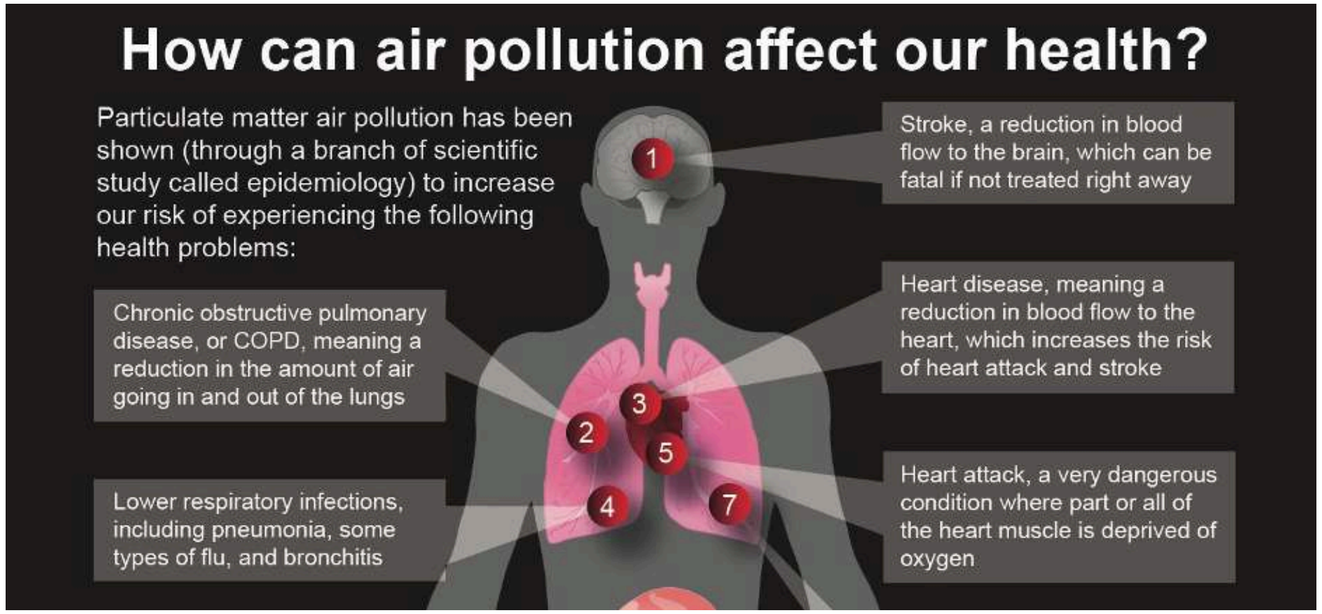
  Some other common sources of particle pollution can be either primary or secondary

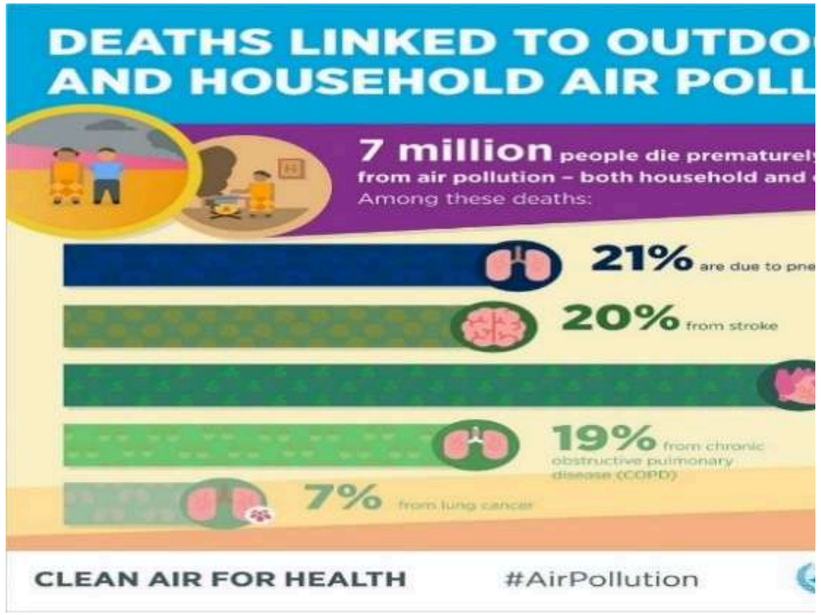
  - for example, factories, cars and trucks, and construction sites.

How to affect my health ?

The importance of clean air

Air pollution is one of the most dangerous threats to our health. Every day a person breathes in about 11,000 liters of air. The air is often contaminated with smog, dust, exhaust fumes, spores and pollen that enter the respiratory tract. Data published by the World Health Organization (WHO) shows that almost all of the world's population (99%) breathes air that exceeds WHO guidelines and contains high levels of pollutants. Air pollution is responsible for nearly 7 million premature deaths each year*. Clean indoor air can reduce this burden.





- Coarse(bigger) particles, called **PM_{10}**, can irritate your eyes, nose, and throat.

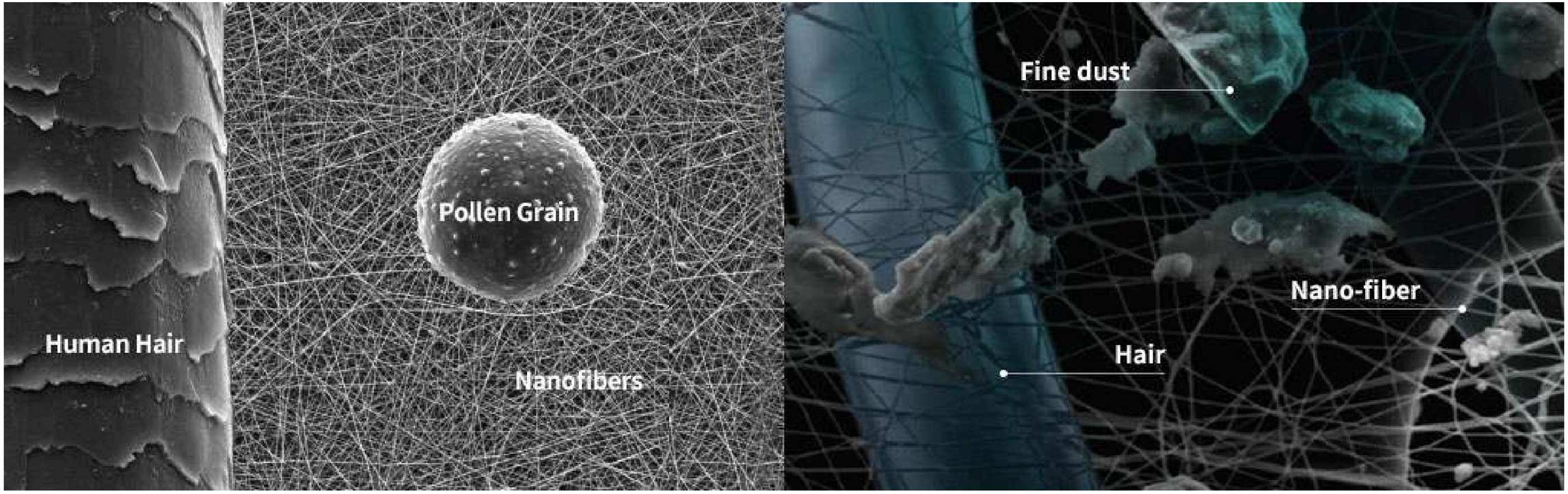
  Dust from roads, farms, dry riverbeds, construction sites, and mines are types of PM_{10}.

- Fine(smaller) partilces, called **PM2.5**, are more dangerous because they can get into the deep parts of your lungs, or even in to your blood.

Solution, Nanofiber Technology

Nanofiber of TN High-tech air purification filters

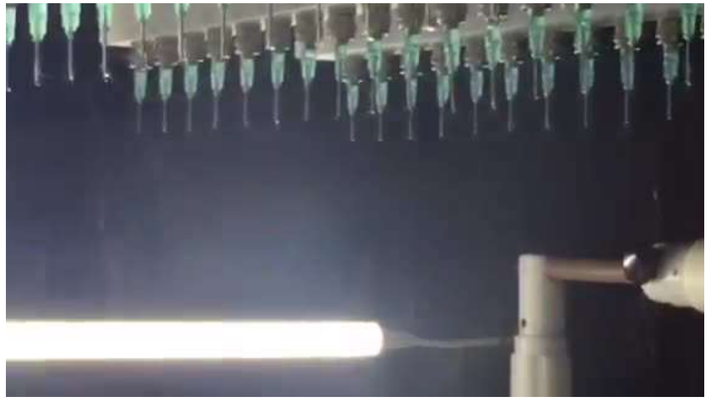
- Large extent of surface with high porosity and high-volume ratio compared to extent
- Very thin and light like the skin, a dream material where alien substances do not pass while ventilation

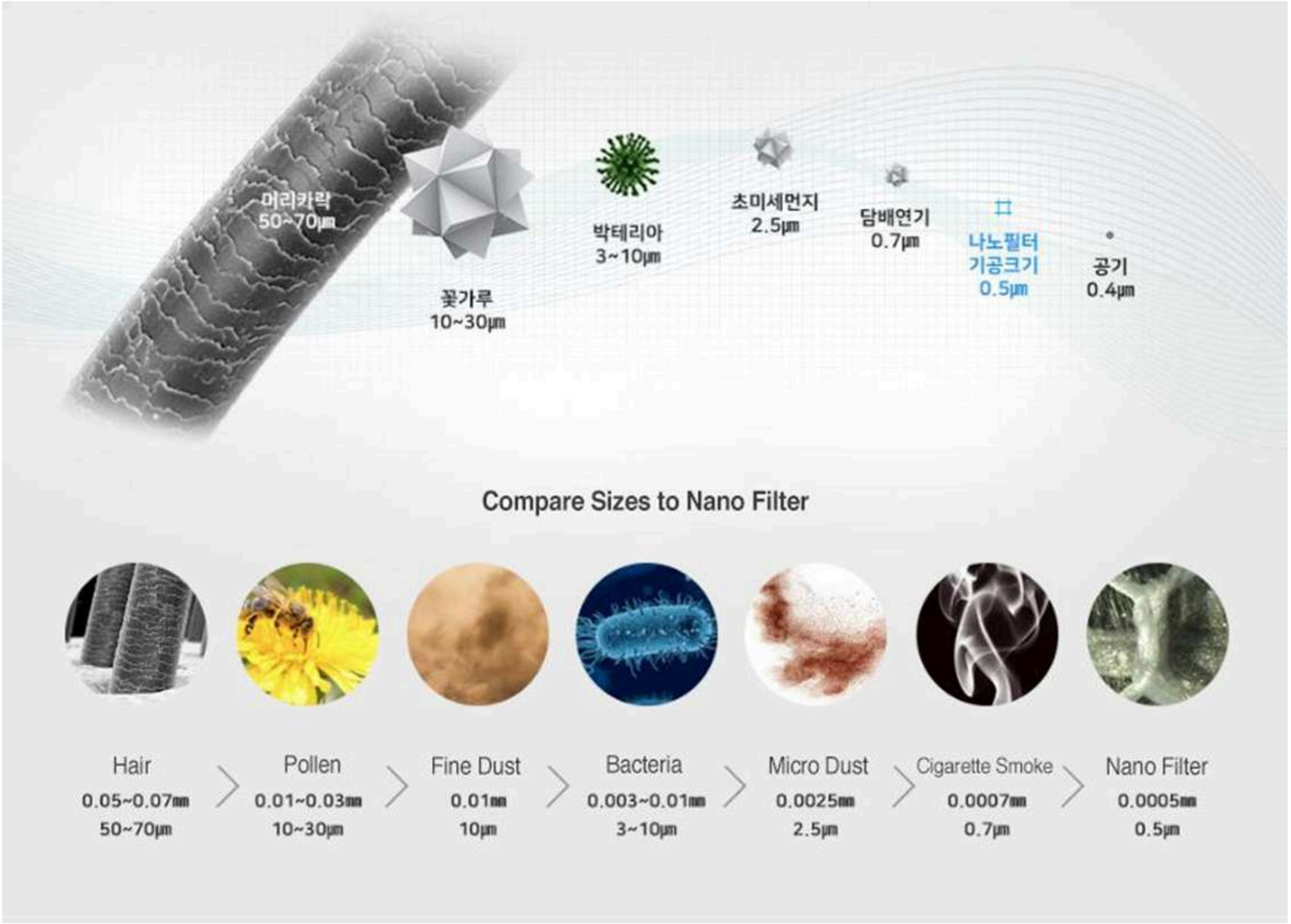


Nano Filter (∅0.5㎛)

Single Nozzle

Multi Nozzle





TN High-tech air purification filters

01 TNS-90

02 HVAC

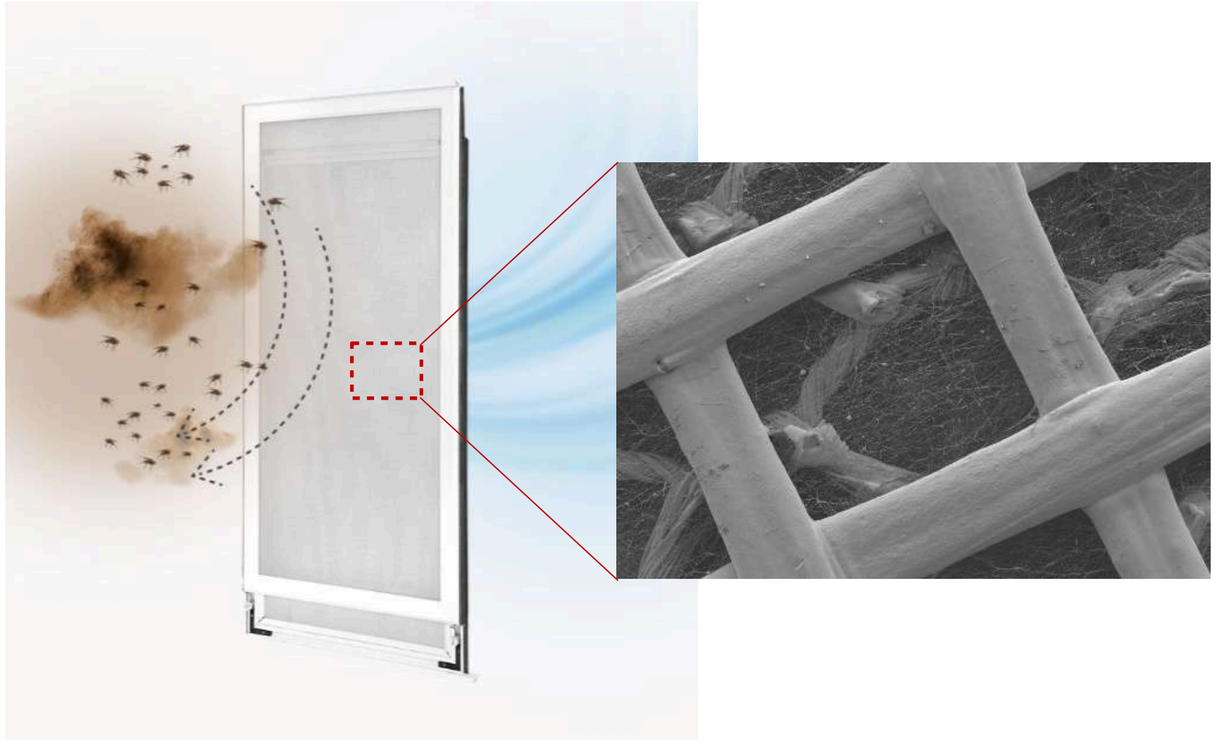
03 Fiber Tree

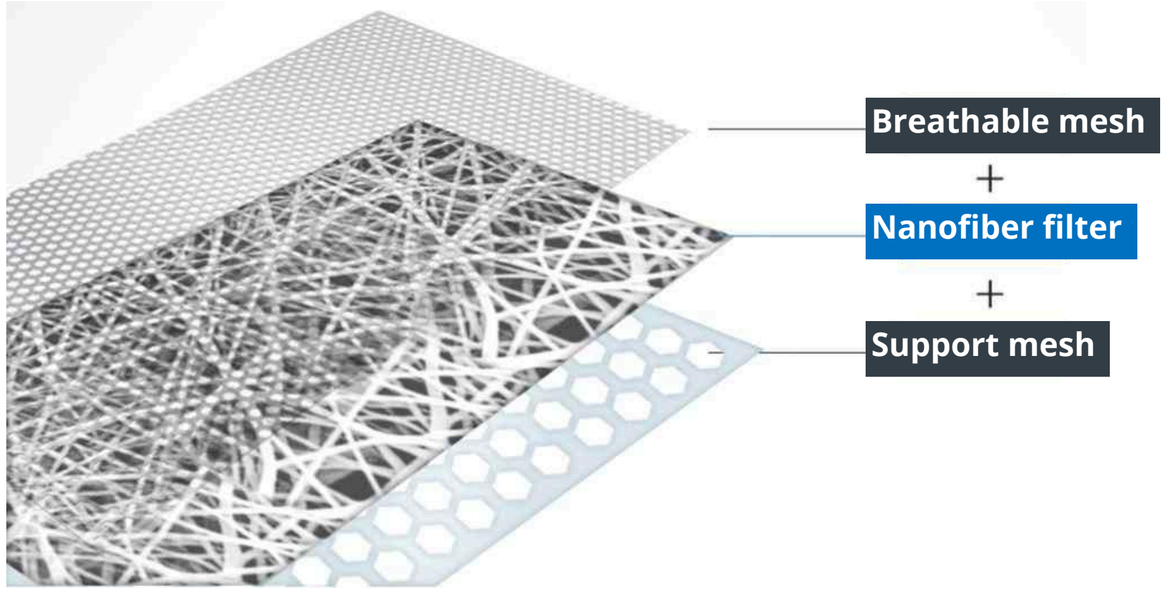
04 TNS-9001

05 TNS-70

[TNS-90] TN Window Shield

- The core of ‘TN Window Shield’ is state-of-the-art nanofiber filtration technology.
- ‘TN Window Shield’ is a high-performing functional screen that blocks or restricts a wide spectrum of unwanted airborne particles including pollen and allergens as well as fly ash, agricultural dust, coal dust, bacteria and droplets carrying many virus particles.
- ‘TN Window Shield’ has superior durability, the performance is maintained for long-term use.





Why TN Window Shield ?

Easy Installation

- Accesbillity to existing window frame instead of insect screen

State-of-the-art Nano Technology

- Excellent filtration performance from dense structure of “Nanofiber”
- High air-permeability from numerous porous structure between “Nanofibers”

Superb Durability

- Applied special lamination technology enables long-term use

Easy maintenance

- Performance is maintained through simple cleaning with hand sprayer without any detachment

[TNS-90] Product Differences

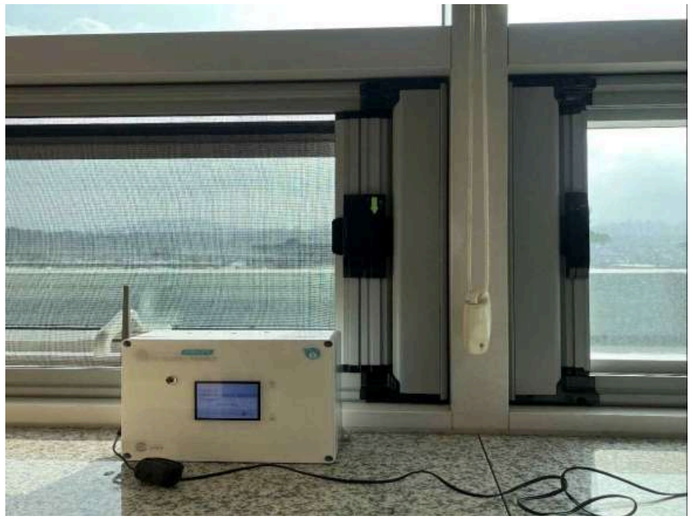
	Regular Insect screen	TNS-90
Description	An obsolete product, not efficient against current threads.	high-tech nanofiber solution to protect against air pollution.
Material	Fiberglass, aluminum, steel.	Nanofiber, polymeric mesh.
Filtration efficiency	Fail to capture the most hazardous particles.	Captures even the smallest dust, smog and PM 2.5 particles
Toughness	Vulnerable to corrosion, and more susceptible to mechanical damage.	Highly resistant because of a solid knitted structure. 3-layered laminated fabric.
Health hazards	Prolonged exposure to the external environment causes the fiberglass to degrade, releasing carcinogenic particles that are hazardous to human health.	Polymers used in the membrane do not release any harmful substances or particles.
Additional effects	Ineffective against UV light and rainwater.	Reduces UV light to passing through, keeps rain out.

Demonstration

Jeju Int'l Airport

- (General Insect screen) Jan 09. 2023 ~ Jan 13. 2023
- (TN Window Shield) Jan 16. 2023 ~ Jan 20. 2023

Subject		Fine dust (PM 10)	Ultra fine dust (PM 2.5)	Carbon dioxide (CO_2)
Limit value		100μg/㎥	50μg/㎥	1,000ppm
Departure A	Insect screen	20.9	11.1	1,005.3
	TN Window Shield	3.0	2.4	763
	Variance	-86%	-78%	-24%
Departure B	Insect screen	12.8	8.9	826.5
	TN Window Shield	8.9	2.2	597
	Variance	-30%	-75%	-28%
Departure C	Insect screen	13.0	7.3	904.8
	TN Window Shield	3.3	1.6	705
	Variance	-75%	-78%	-22%



Where to Use

TN Window Shied is an excellent choice for:

- Homeowners & Condominium Owners
- Real Estate Developers & Builders
- Construction Companies
- Hotel & Hospitality Operations
- Outdoor Patio & Swimming Pool Enclosures
- Government Agencies
- Allergy, Health & Wellness Institutions
- Architecture & Interior Design Firms
- Enclosed Greenhouse, Botanical & Sustainable Agriculture Operations
- Stables, Barns & Equestrian Facilities where Animal Allergy Defense is Required

[HVAC] Air Conditioner Filter

If the ‘TN’ logo is hard to see, replace the HVAC Filter with a new one

Before using

Need to replace

Anti-dust

Filter efficiency 83.2%

Anti-microbial

Staphylococcus aureus 99.9%
pneumococcus 99.9%

Deodorization, Formaldehyde removal

Ammonia 99.6%, Trimethylamine 99.6%
Hydrogen sulfide 59.2%, Methyl mercaptan 18.4%
Formaldehyde 85.0%

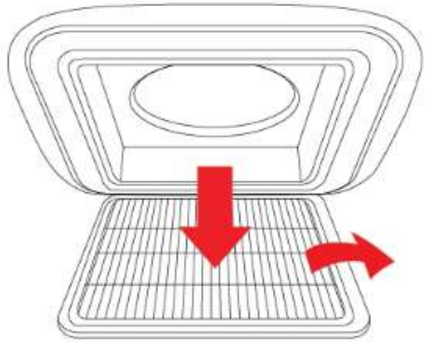
Safety

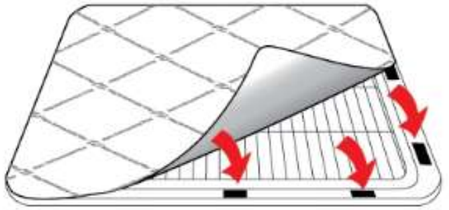
Organic/Inorganic Hybrid material
Non-toxic material

[HVAC] Air Conditioner Filter

High cost / Inconvenience

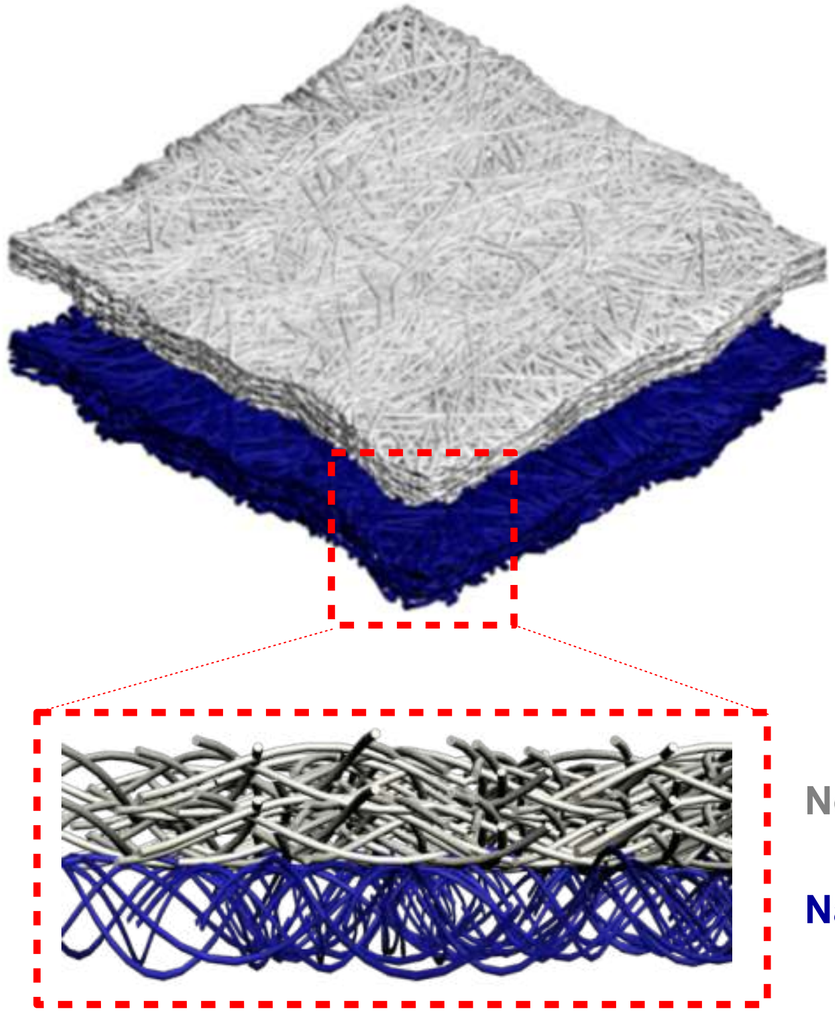
VS





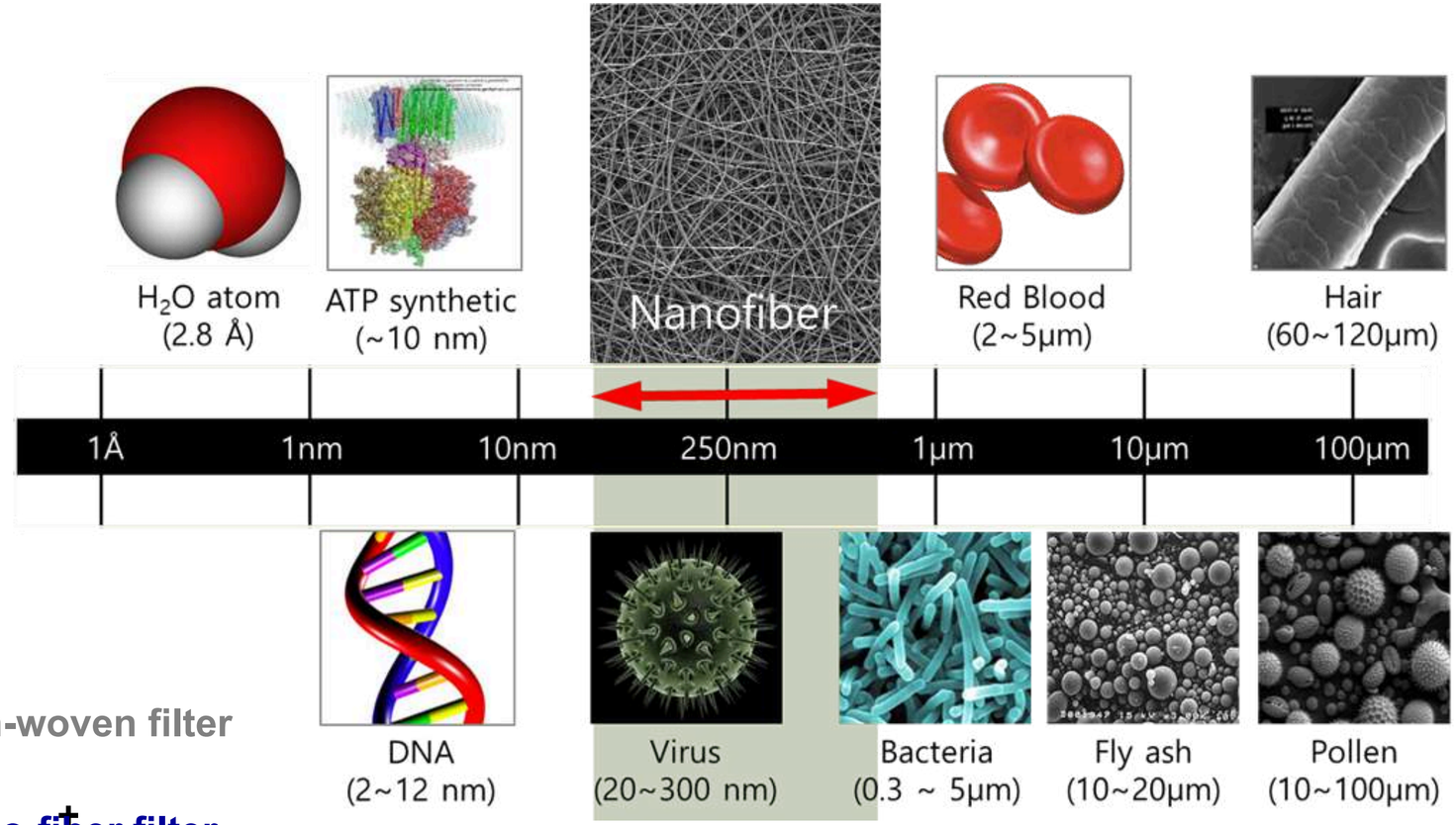
Easy application / Low cost

[HVAC] Air Conditioner Filter



Non-woven filter

Nano-fiber filter



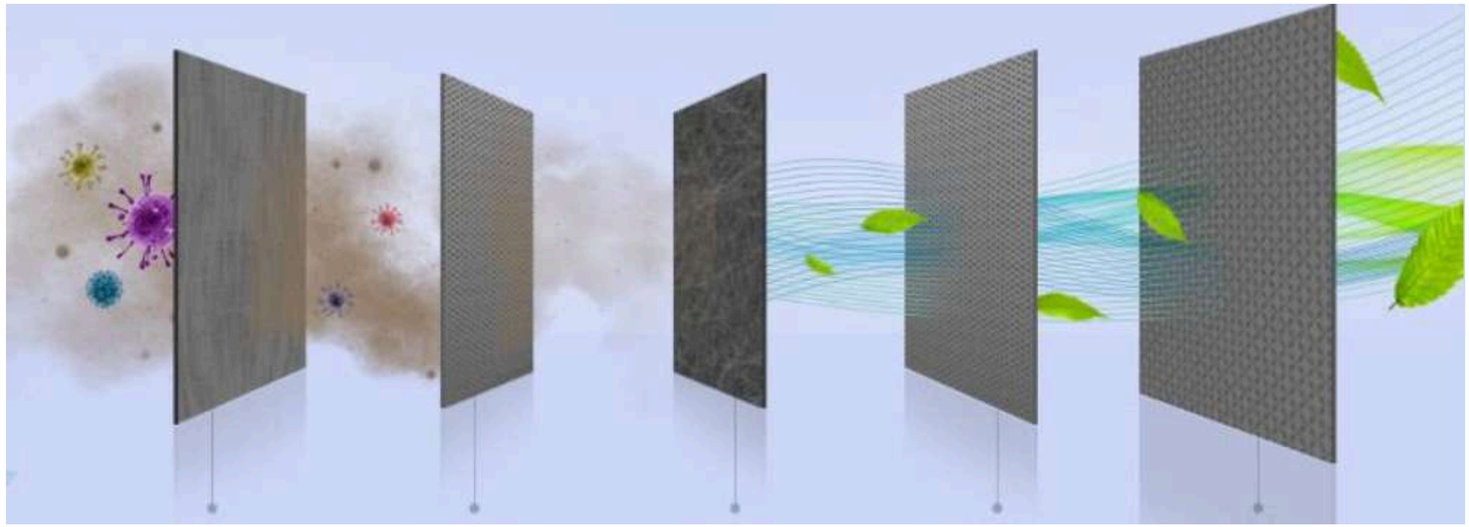
[Fiber Tree] Non-powered air purification filter

FIBER TREE is applied with special air purification technology

- **Breathable Layer**
  - Removal of airborne bacteria and bacteria
  - Removal odors and harmful gases
  - Advertising and interior effects with design printing

- **Carbon Layer**
  - Collecting and removing air pollutants
  - Removal odors and harmful gases

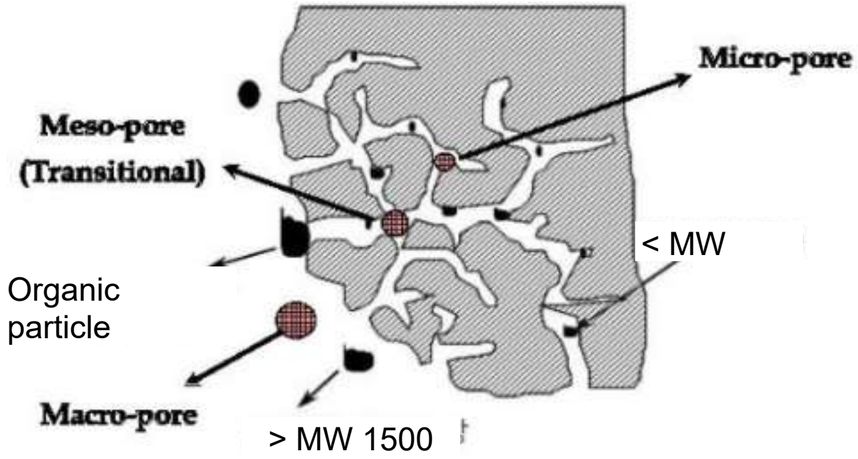
- **Nano-filter Layer**
  - Collecting and removing air pollutants

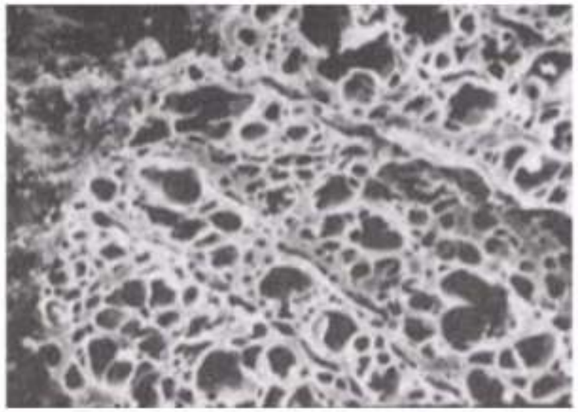


Breathable layer | Carbon layer | Nano-filter layer | Carbon layer | Breathable layer

[Fiber Tree] Non-powered air purification filter

Remove organic matter by using adsorption phenomenon made through fine pores formed on the surface of a Carbon 1st layer





Subject	Size(Radius, Å)	Specific Volume (mL/g)	Specific surface area (m2/g)
Macro-pore	500	0.2 ~ 0.7	0.5 ~ 2.0
Meso-pore	20 ~ 500	0.3 ~ 1.0	20 ~ 200
Micro-pore	< 500	0.1 ~ 1.0	> 2,000

- **Macro-pore**
  - It has a very large effective diameter and quickly transports adsorbate molecules from the outside into the particles
  - Role of Admission, Diffusion, Transport-pore
  - Capillary condensation does not block pores
- **Meso-pore**
  - Capillary retraction (liquefaction of adsorbed material) occurs
- **Micro-pore**
  - A pore with the smallest radius, accounting for more than 95% of the total specific surface area
  - Where adsorption occurs most prominently

[Fiber Tree] Non-powered air purification filter

Korea Railroad Research Institute

Adsorption performance of hazardous substances

FIBER TREE : Removal of PM2.5 66.35%, PM10 65.68%

Removal of total floating dust from indoor air 57.43%

Filter-lite 설치에 따른 실내 공기질 시계열적 변화 및 흡착성능

2021.04.03. 한국철도기술연구원

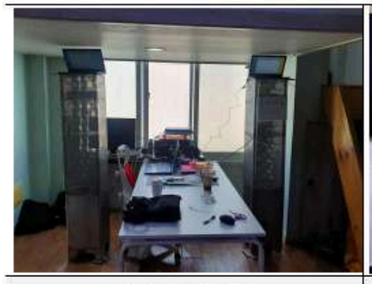
1. 개 요

- 실험 일자: 2021년 2월 25일 ~ 3월 13일
- 실험 대상: 무동력 공기정화 섬유원단(Filter-lite)
- 목 표
  - Filter-lite 설치에 따른 실내공간의 공기질 시계열적 변화 파악
  - Filter-lite의 흡착성능 확인
  - 실내 공기중의 총 부유분진(TSP) 측정
- 실험 장비: particle aerosol spectrometer (1.108, 1.109; Grimm Aerosol Technik, Ainring, Germany)

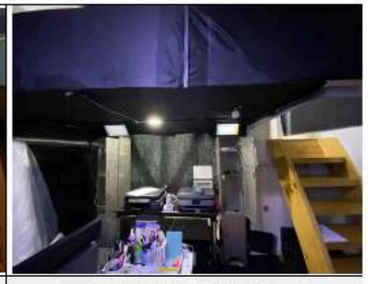
2. 실험 방법

1) 실내 공간에서의 미세먼지 비산 및 거동 관련 연구사례 검토를 통한 측정위치 확보
   - 「실내공기질 공정시험기준」 근거, 중앙점에서 바닥면으로부터 1.2-1.5m 높이에서 측정
   - 공간부의 벽체에서 최소 1m 이상 떨어진 위치에서 측정

2) 동일한 실내공간 및 환경조건에서, 미설치/Filter-lite 설치로 구분하여, 실내공간에서의 시계열적 변화상 파악 및 흡착성능 확인
   * 입자별(PM_{10}, $PM_{2.5}$), 광산란법, 6초 간격 측정
   * (미설치) 2/25-3/1 측정, (Filter-lite) 3/3-3/13 측정



미설치 조건 (전)



Filter-lite 설치 조건 (후)

3. 실험결과

- 실내공간에 2개의 Grimm 장비를 활용하여 측정된 평균값을 도출하였으며, 두 장비간 측정 값은 유사한 경향성을 보임.
- 실내공간의 미세먼지 시계열적 변화를 살펴본 결과, Filter-lite의 PM_{10}, $PM_{2.5}$ 제거효율이 각각 65.68%, 66.53%로 약 2~3% 높은 것으로 나타남.
- 실내 공기 중의 총 부유분진(TSP)의 경우, Filter-lite 설치 시, 57.43%로 나타남.

[PM 제거효율]

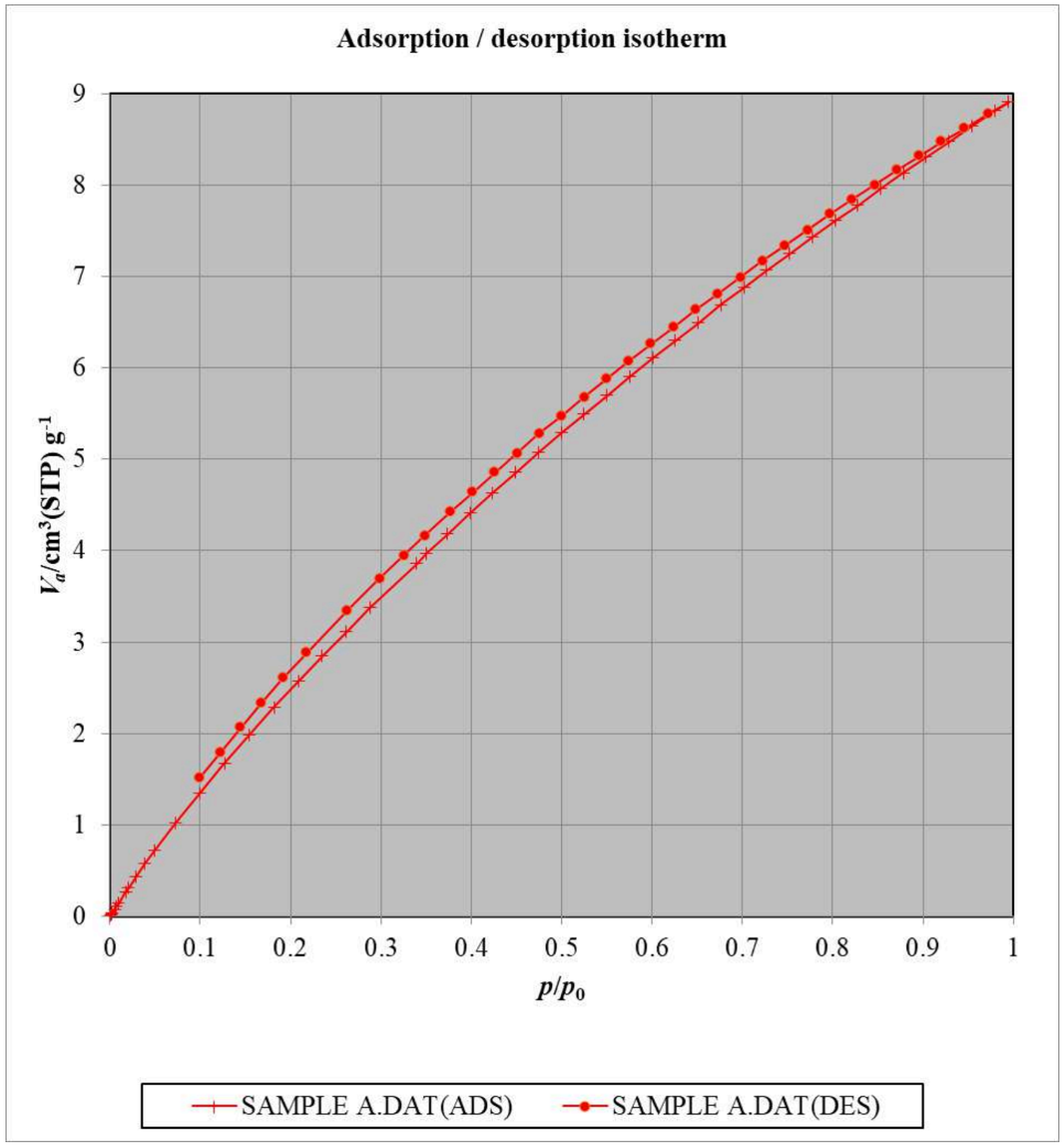
구 분	미설치		#1		#2	
	PM_{10} (ug/m3)	$PM_{2.5}$ (ug/m3)	PM_{10} (ug/m3)	$PM_{2.5}$ (ug/m3)	PM_{10} (ug/m3)	$PM_{2.5}$ (ug/m3)
1	202.45	194.10	126.35	117.80	75.50	73.30
2	214.25	204.35	62.75	60.05	54.30	50.85
3	256.25	249.50	40.50	39.05	89.95	87.55
4	126.40	124.15	44.05	41.80	50.40	47.90
5	129.95	127.60	45.30	42.45	72.80	71.40
평 균(ug/m3)	**185.86**	**179.94**	**63.79**	**60.23**	**68.59**	**66.20**
제 거 효 율(%)	-	-	**65.68**	**66.53**	**63.10**	**63.21**

[TSP 제거효율]

구 분	미설치	#1	#2
	TSP (ug/m3)		
1	220.95	139.20	81.10
2	240.65	69.35	64.55
3	286.10	45.20	97.15
4	134.45	49.90	57.80
5	137.20	50.90	77.90
평 균(ug/m3)	**203.87**	**70.91**	**75.70**
제 거 효 율(%)	-	**57.24**	**57.43**

[Fiber Tree] Non-powered air purification filter

Analysis by high-precision gas/steam adsorption analyzer
Adsorption of carbon dioxide (CO2) 9 times the weight of a FIBER TREE



[Fiber Tree] Non-powered air purification filter

01	 **vork frame**	- Easy to install and replace product and free to move after installation - There is little installation and construction cost - Choose between a normal frame type and a wide frame type - Choose between frame color black and silver
02	 **or** **rtising panel**	- Workforce is required when replacing the product and cannot be moved after installation - Installation construction cost is higher than art-work frame type - Can be custom-made, such as frame, shape material, and color - Sturdy compared to the mold type
03	 **loor** **rtising fence**	- Workforce and equipment are required for product replacement and maintenance and cannot be moved after installation - Installation construction costs are somewhat high - Can be custom-made, such as frame, shape material, and color -Sturdy and safe by adding reinforcing finishing materials to the interior type of the frame

[TNS-9001] Protection Mask

TECHNOLOGY OF NANO FILTER

Core technology to maintain high efficiency filtering

STRUCTURE OF NANOFILTER

Nanofiber filters even the smallest particles like bacteria out of your oxygen flow to protect and keep you healthy.

Flexible **nose wire** to comfortably shape to your facial features

Relaxed and secure breathing space by nanofiber **outer layer**

Designed with specially technology for a comfortable fit while close contact with the face line

Convenient stopper for secure adjustment

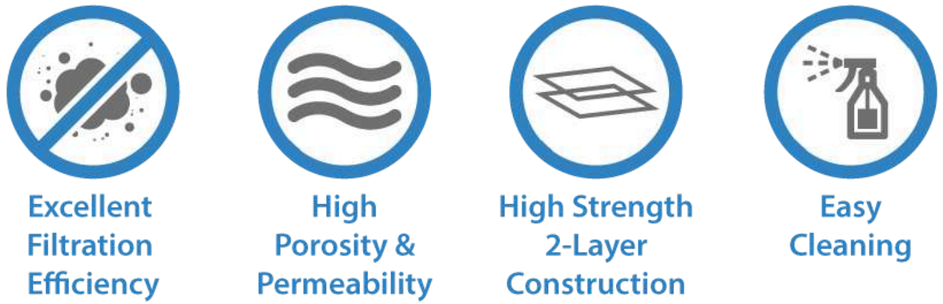
Chin guard to secure negative tair flow and promote comfortability

Soft mesh pattern inner layer for no irritation against the skin

Elastic strap to adjust for comfortable fit

[TNS-70] Protection Fan Filter

- Easy to install on the fan
- It effectively filters fine dust and pollen to help the respiratory system
- If you wash it simply, it can be used reflectively



Thank You !