

SPURTEX[®]
NANOTECHNOLOGY



The unique SPURTEX® nanostructured material is developed and manufactured by SPUR a.s., a leading Czech expert in nanotechnology. The SPURTEX® nanofibre filter membrane forms a mechanical barrier with exceptional filtration capabilities. It prevents the penetration of harmful particles, which makes it particularly suitable for healthcare use. SPURTEX®, when used in masks or respirators, is extremely effective in protecting the wearer as well as others, as it has much smaller pores than the size of undesirable particles like smog, bacteria, aerosols, and even viruses.

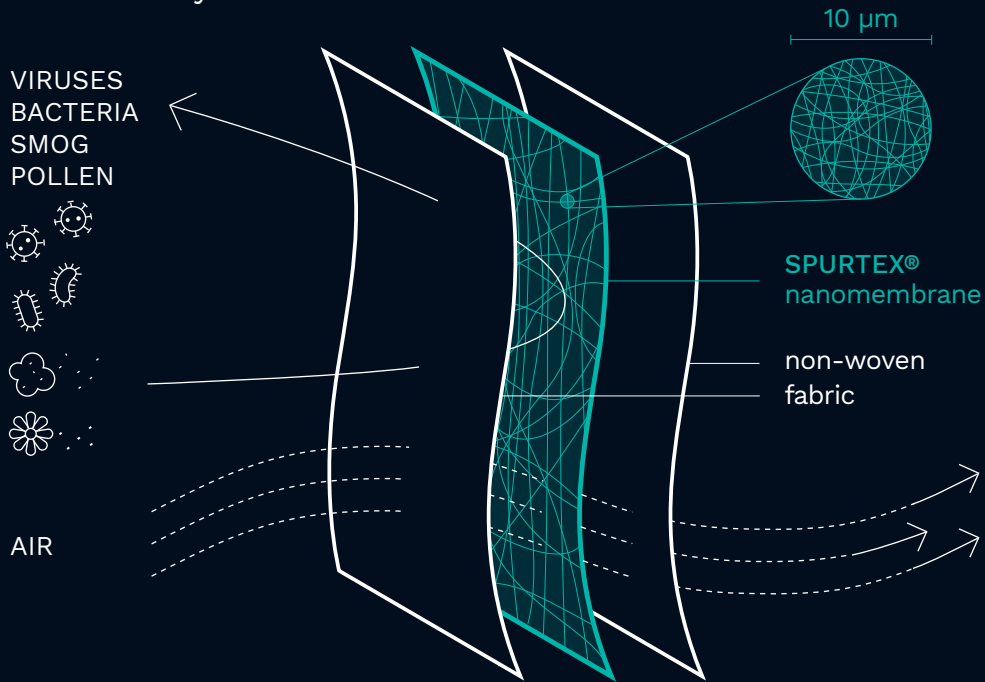
Efficiency

95–99%*

*depending on the filter class of the materials used

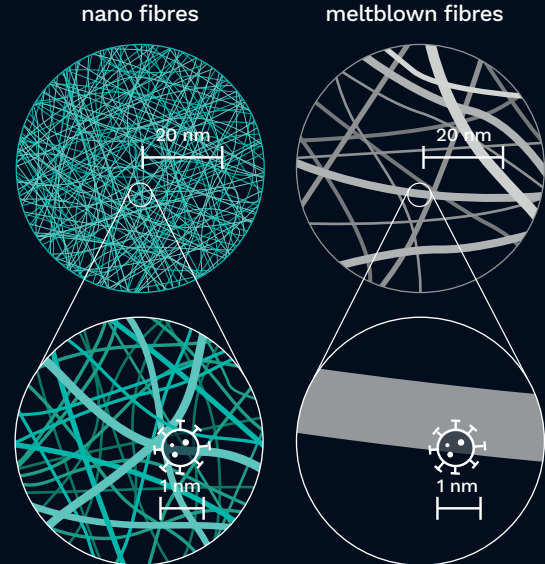


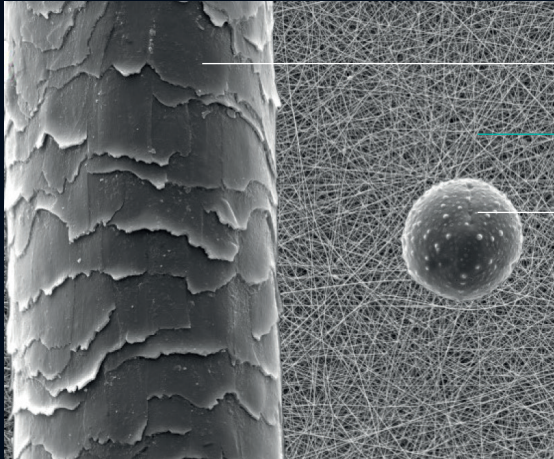
Functional filter layer



What is a nanomaterial?

Nanofibre materials are textile products with a fibre diameter of less than 1 micrometre (μm) = 1000 nanometres (nm). One nanometre is 10^{-9} metres. It cannot be seen without an optical aid. By comparison, human hair is about 75,000 nanometres in diameter. Nanofibre has a thousand times larger surface area than, for example, microfibre. Nanofibre materials are characterized by high porosity. To improve the mechanical properties of the fibres, they are applied to a base material, usually polypropylene, which is created using the spunbond technology, or in the case of SPURTEX[®] VS also to natural viscose.





human hair
thickness 80 μm

nanofibre filter
pore size less than 100 nm

pollen grain
diameter 30 μm

nanofibre
50–500 nm

ultra microfibre
1–3.5 μm

microfibre
3.5–10 μm

common fibre
<11 μm



Nanofibre filters used as part of disposable face masks, respirators or half-masks provide effective protection of the respiratory system, especially in the area of ultrafine particles with a size of 20–400 nm, including viruses with a size of 30–150 nm.

SPURTEX® VS

MAXIMUM PROTECTION AND COMFORT

SPURTEX® VS is a laminate consisting of three layers. Its surface is made of a viscose-based material, which protects the middle filter layer made of nanofibre. Viscose is a biodegradable material, so it is more environmentally friendly than conventional polymeric materials. Non-woven viscose fabric is distinguished by its weight of 60–90 g/m². It is very pleasant to the touch and completely biocompatible with human skin. A nanomembrane made of PVDF (polyvinylidene fluoride) fibre provides maximum user protection. PVDF fibre processing is one of the leading

technologies for polymer solution spinning in an electrostatic field and industrial preparation of nanofibres. The SPURTEX® VS material does not contain any highly brittle borosilicate microfibres. These are commonly used in standard respiratory protective equipment and have a negative effect on both the environment and especially on human health (their use can result in the separation of sharp needle-shaped particles with potentially carcinogenic effects). SPURTEX® VS face masks distinguish themselves with their unique air permeability and wearing comfort.



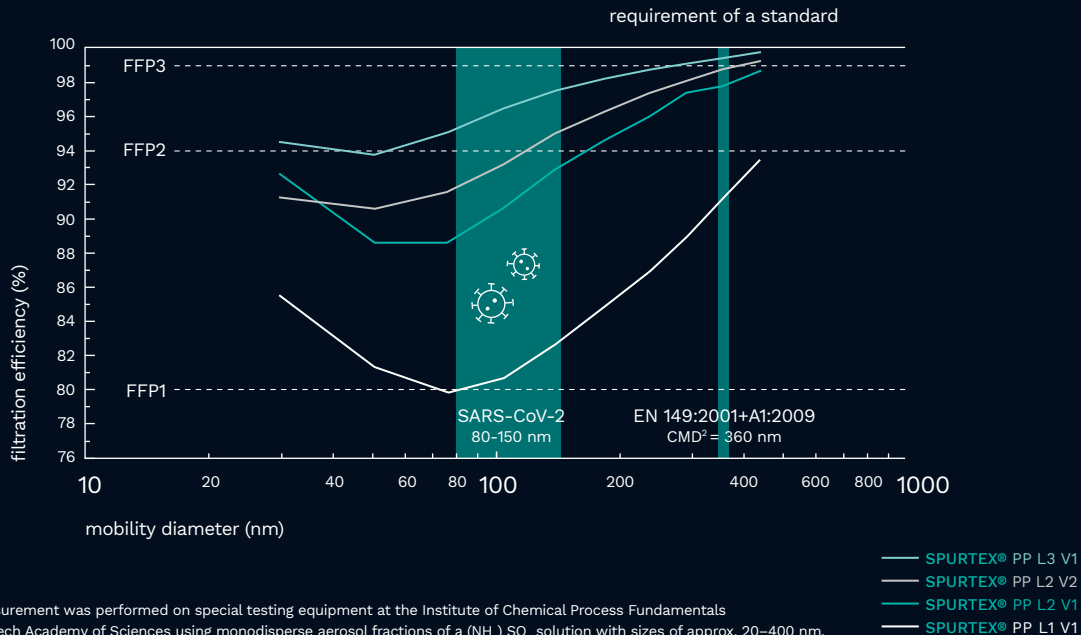
SPURTEX® PP

TECHNICAL MATERIAL WITH EXCELLENT PROPERTIES

SPURTEX® PP is a unique five-layer filter membrane made of polypropylene non-woven fabrics and a specially developed active filter layer made of PVDF (polyvinylidene fluoride) polymer nanofibres. The polymer nanofibre filter layer is secured between the outer layers, which ensures adequate mechanical properties of the final product and eliminates damage to the ultrafine polymer nanofibres during handling and use. According to expert opinions, the outer layers, which are based on polypropylene (non-woven fabric), do not contain any significant skin irritants and can be used safely on the skin. The SPURTEX® PP filter material fully complies with the requirements of EN149:2001+A1:2009 (or equivalent USA NIOSH-42CFR84) for filtering half masks to protect against particles.

Thanks to the unique technology, the material can be produced in various quality classes (FFP1/FFP2/FFP3 or N95/N99) with different filtration efficiency and pressure resistance, depending on the final application (face mask, respirator, half-mask, filter). However, the unique SPURTEX® PP filter layer has excellent filtration efficiency in the range of ultrafine particles (20–400 nm), which makes it ideal for capturing all types of bacteria and viruses (SARS-CoV-2 has an actual size between 80–150 nm). In addition, these filtering properties are achieved with ultra-low pressure losses, which significantly increases breathing comfort when wearing a face mask and at the same time reduces air leakage in respirators and masks, further eliminating the possible risk of penetration of undesirable particles.

Nanofibres – exceptional removal of nanoparticles with the size of a virus



* The measurement was performed on special testing equipment at the Institute of Chemical Process Fundamentals of the Czech Academy of Sciences using monodisperse aerosol fractions of a $(\text{NH}_4)_2\text{SO}_4$ solution with sizes of approx. 20–400 nm.

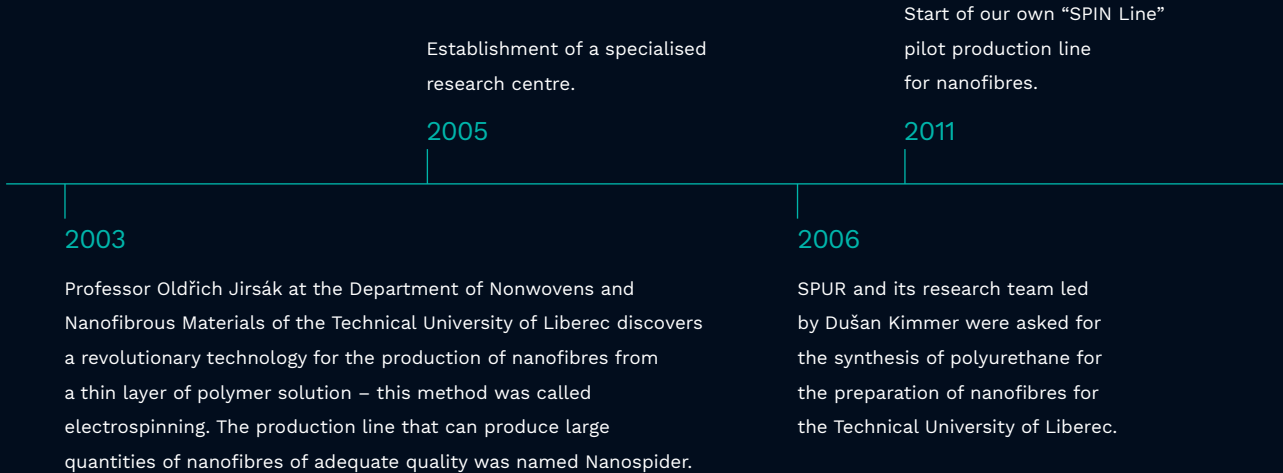


About SPUR a.s.

SPUR a.s. is a family business that has been manufacturing plastic products since its establishment in 1992. Its production is based on own research and development activities, which reflect customer requirements and demand for new properties of plastics, including polymers. At present, SPUR a.s. has 240 employees and in 2019 it reached a turnover of more than CZK 1 billion. More than 70% of SPUR a.s. production is exported.



NANO history of SPUR a.s.



2012

Participation in the NANOTECH 2012 trade fair in Japan, where the company presented the SPIN Line and for the first time its own filter materials with SPURTEX® nanostructures.

2013

Registration of a trademark for the SPURTEX® filter material containing nanofibres.

2014

The first small-batch production of the SPURTEX® filter material.

2016

SPUR is intensively engaged in research and development activities for the application of nanomaterials for various industrial uses.

2020

Start of large-scale production of SPURTEX® for filters, masks and respirators.

Properties of SPURTEX®



virus
protection



two-way
protection



excellent
air permeability



protection against
mould, smog, 2.5 µm,
pollen and microbes



mechanical
filtration



skin
tolerance



narrow pore size
distribution



uniformity



application of
functional additives

Other unique properties



very high
specific surface



perfect 3D structure
of open pores
(no closed pores)



high
porosity





Breathing comfort

Tests performed with an infrared thermal camera have shown that a nanofilter provides excellent breathing comfort and good thermal behaviour compared to a meltblown filter. This is achieved by the nanofilter's uniform morphology with very small pore diameters of 50–100 nm, which are larger than air particles (~4 nm) including CO₂, but smaller than foreign

substances including bacteria and viruses (for example, the size of coronavirus is between 80 and 150 nm). In contrast, a meltblown filter does not have a uniform morphology and therefore the dispersion of values is larger, which may result in thermal discomfort and barriers in the permeability of CO₂ and other substances.

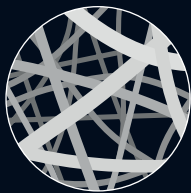




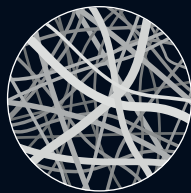
SPURTEX® protects people as well as the environment

Nanofibre masks and respirators have a much longer lifespan than conventional medical masks and industrial respirators. While a conventional medical mask should be changed at least every two hours, a nanofibre mask will serve users reliably throughout their workday (thus substituting four or more common medical masks). If necessary, SPURTEX® masks and respirators can be

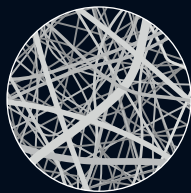
immediately sterilised using the SPURTEX® disinfectant. Because masks and respirators capture hazardous substances like viruses and bacteria, the law dictates they must be incinerated. Thus, if one nano mask or respirator can substitute four to five common medical masks or industrial respirators, the use of nanofibre masks and nanofibre respirators is the more environmentally friendly choice.



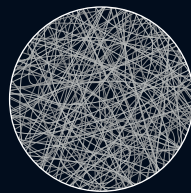
Spunbond
70 fibres/cm²
ø 16 microns
21 m²/g



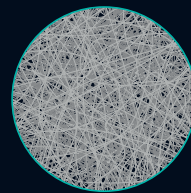
Flashspun
400 fibres/cm²
ø 10 microns
1 m²/g



Meltblown
4,000 fibres/cm²
ø 3 microns
2 m²/g



HMT
110,000 fibres/cm²
ø 0.4 microns
8 m²/g



PVDF nanofibre
1–2 millions fibres/cm²
ø 0.08 microns
0.3 m²/g

NANO – technology of the 21st century

Industrial respirators capture the smallest pollution particles on non-woven fabric electrostatically. However, the electrostatic charge is affected by moisture, so the efficiency is reduced not only by breathing, but also by long storage. Within two years, industrial respirators stop meeting the efficiency requirements of Czech and European standards.

Nanofibre respirators do not have this problem. They still capture viruses and bacteria even after five years of storage.

If you compare the options of gradually purchasing several industrial respirators for storage every two years and purchasing one nanofibre respirator for storage for five years, the nanofibre option is more cost-efficient.

Reliable protection against microbes



RANGE OF SPURTEX® MATERIALS

* can be customized based on preferences

property	testing method	unit	nominal values for SPURTEX® PP materials		
			L1V1 for masks	L2V1 for N95/KN95 respirators	L2V3 for FFP2
mass per unit area	EN ISO 9073-1	g/m ²	65–70	65–70	68–75
thickness	EN ISO 9073-2	µm	0.3–0.4	0.3–0.4	0.4–0.5
roll width	-	mm	1500	1500	1500
roll length	-	m	375	300	300
roll diameter	-	mm	430–440	430–440	430–440
bacterial filtration efficiency (BFE)*	EN 14683	%	≥98 (type II)	-	-
pressure drop*	EN 14683	Pa/cm ²	≤40 (type II)	-	-
filtration efficiency (NaCl, 360 nm)**	EN 149	%	≥99	≥99.8	≥99.9
filtration efficiency (NaCl, 150nm)**	EN 149	%	≥91	≥96	≥97.64
pressure drop (30l/min, 3.4 m/min)	-	Pa	38–50	60–70	50–60
pressure drop (95l/min)	-	Pa	130–140	210–220	190–200

* measured at the Hyggen laboratory (AT) accredited by AA (Akkreditierung Austria) according to EN ISO/IEC 17025:2018 (Report No. B24819 issued on 22 June)

** measured in the testing laboratory of the Energy Institute of the Faculty of Mechanical Engineering, Brno University of Technology (at a head speed of 3.4 m/min)

SPURTEX® PRODUCTS

SPURTEX® V100 FFP2 NR NANO RESPIRATOR



- | FFP2 respirator with a nano layer
- | excellent filtration of ultrafine virus-sized particles of 30–150 nm
- | high air permeability
- | adjustable nose wire
- | full certification according to EN 149:2001+A1:2009

SPURTEX® PP Standard NANO MASK



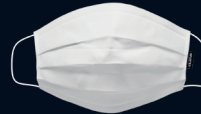
- | surgical mask + nano layer
- | mechanical filtration using nanofibres
- | filtration efficiency at the FFP2 level
- | high air permeability
- | elastic rubber bands
- | adjustable nose wire

SPURTEX® VS PREMIUM NANO MASK



- | nano layer applied to viscose (bio-based product)
- | viscose is made of renewable materials
- | mechanical filtration using nanofibres
- | filtration efficiency at the FFP2 level
- | high air permeability
- | hand-sewn
- | adjustable nose wire
- | fits well on the face and maintains its shape
- | elastic rubber bands

SPURTEX® VS PREMIUM JUNIOR NANO MASK



- | for children aged 10–15
- | nano layer applied to viscose (bio-based product)
- | viscose is made of renewable materials
- | mechanical filtration using nanofibres
- | filtration efficiency at the FFP2 level
- | high air permeability
- | hand-sewn
- | adjustable nose wire
- | fits well on the face and maintains its shape
- | elastic rubber bands

FILTRATION EFFICIENCY OF SPURTEX® MATERIALS



parameter	standard	particle challenge type	head velocity (cm.s ⁻¹) ¹	value (%)
bacterial filtration efficiency (BFE)	ASTM F2101–19, EN 14683	Staphylococcus aureus	11.8	>99.9 ²
viral filtration efficiency (VFE)	adapted from ASTM F2101	bacteriophage ΦX174	11.8	>99.9 ³
particle filtration efficiency (PFE)	ASTM F2299	0.3 μm latex polystyrene spheres	5.2	99.89 ⁴



¹head velocity according to EN 143 and EN 149 is 5,7 cm.s⁻¹ (air flow 30 l.min⁻¹) and 18 cm.s⁻¹ (air flow 95 l.min⁻¹) ²based on test report No. 1350068–S01

³ based on test report No. 1350069–S01 ⁴ based on test report No. 1350070–S01

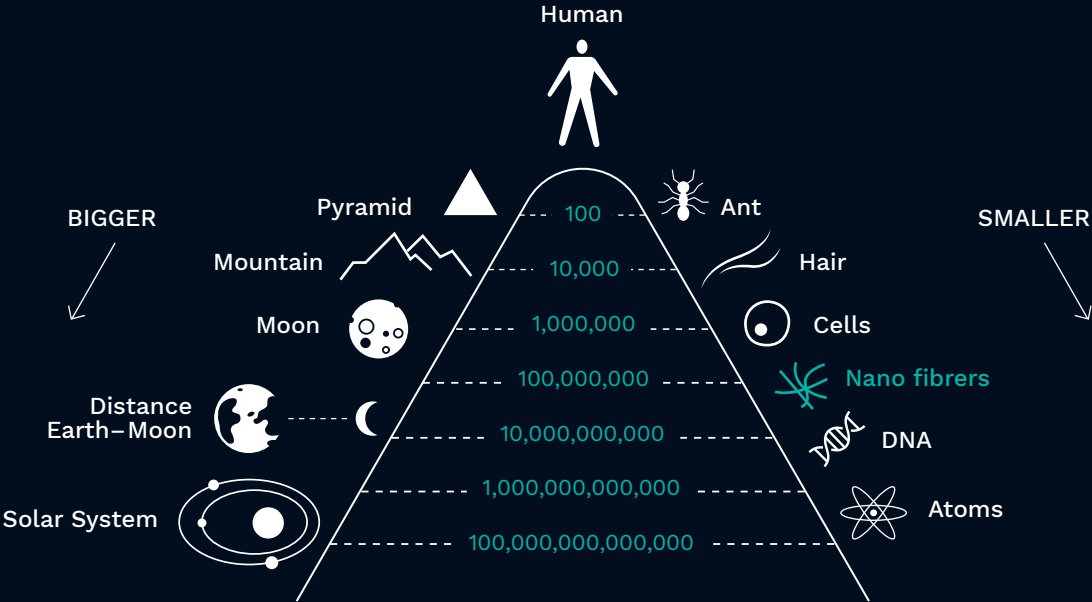
FULLY CERTIFIED AND TESTED



FACE MASKS COMPARISON

<p>Standard face mask Standard FFP2 respirator</p> 	<p>SPURTEX® PP face mask SPURTEX® FFP2 NANO respirator</p> 
<p>✗ Combines mediocre mechanical barrier and electrostatic charge</p>	<p>✓ Works 100 % as a mechanical barrier</p>
<p>✗ Loses its efficiency due to wetness from breathing (electrical discharge)</p>	<p>✓ Not losing its properties while getting damp from breathing</p>
<p>✗ Protects only the environment against viruses and bacterias</p>	<p>✓ Protects the environment and user against viruses and bacterias</p>
<p>✗ Usually (if) tested for bigger particles</p>	<p>✓ Tested material filtration efficiency of SARS-CoV-2 (80-150 nm)</p>
<p>✗ Can not be reused in emergency situations</p>	<p>✓ Can be used multiple times in emergency situations</p>

Human and the world around us in numbers



CERTIFICATION



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