Textile Engineering
KMI/TEN

Technical applications of nonwovens & Nanofibrous materials

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TECHNICAL APPLICATION OF NONWOVENS

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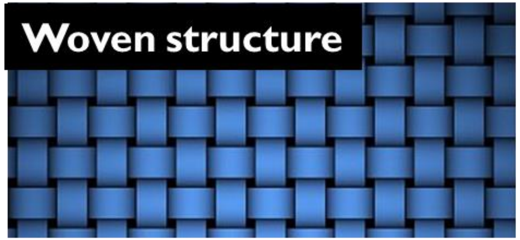
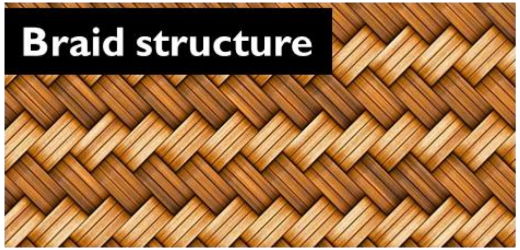
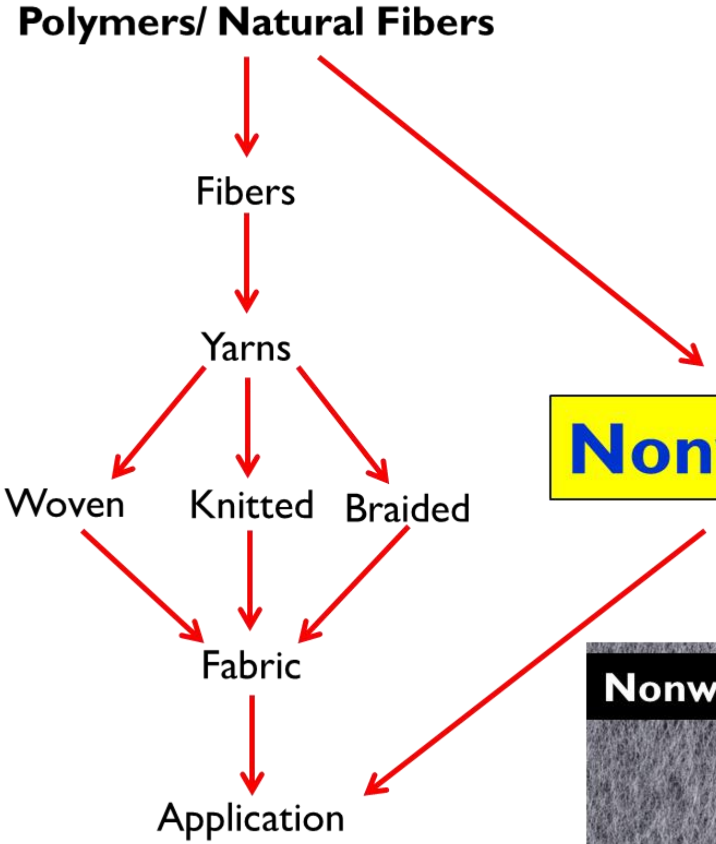
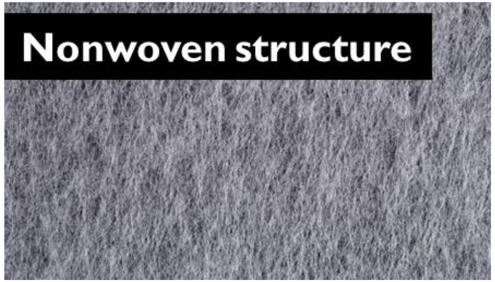
Process of fabrics









What is nonwoven?

A manufactured sheet, web or batt of directionally or randomly orientated fibers, bonded by friction, and/or cohesion and/or adhesion, excluding paper and products which are woven, knitted, tufted, stitch-bonded incorporating binding yarns or filaments, or felted by wet-milling, whether or not additionally needled (ISO9092).

Some definitions in nonwoven

FRICTION

The force of two surfaces in contact. Important from different view points: against skin is an important aspect of comfort, important in appearance control of the fabric, holds the fibers in a sliver and the interlacing threads in a fabric, increase yarn strength, increase dimensional stability of cloth.

COHESION

Means: intermolecular attraction by which the elements of a body are held together, the tendency of similar or identical particles/surfaces to cling to one another. Fiber cohesiveness means the capacity of the fibers to hold together during spinning. Depends on fiber crimp and twisting process.

ADHESION

The tendency of dissimilar particles or surfaces to cling to one another. The ability of fibers in a textile yarn to adhere to each other. Affect the strength, durability, and appearance of the finished textile product. Help to increase the overall strength and durability

BINDER

Coating forming polymeric materials which sticks pigment particles on fiber/fabric surface. Forms a very thin invisible film on fabric surface during curing. Usually with a particle size range of 0.05 to 2 microns

BONDING

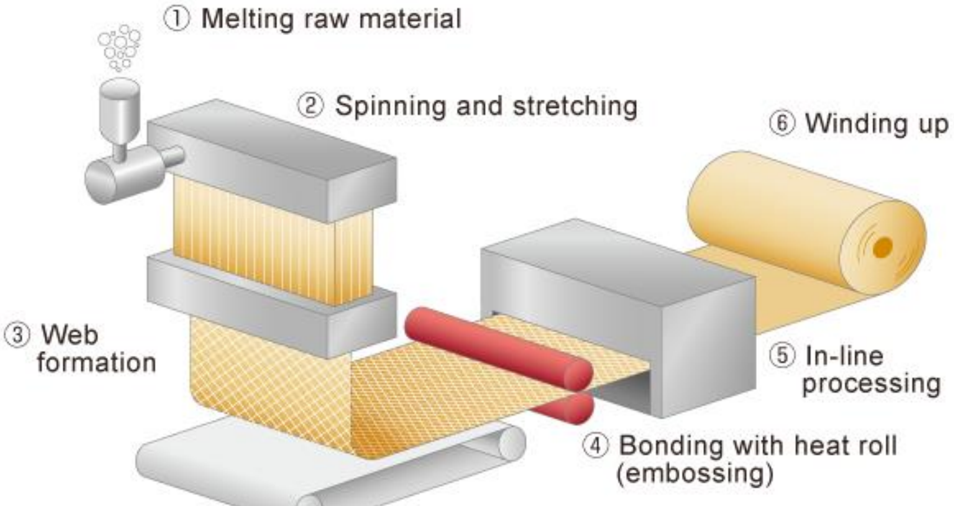
Made from fibres, not yarns-results in weaker and prone to tearing, don't stretch or fray. Generally used for disposable products. the fibres are laid in a random pattern and are held together by adhesive (glue), or heated if made from synthetic fibres.

LAMINATION

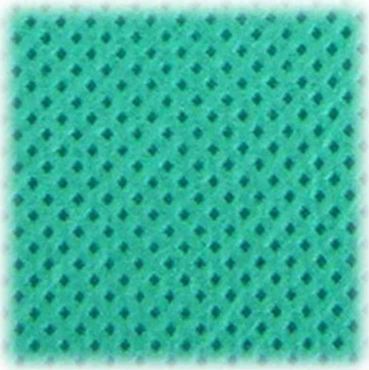
Formed when two or more fabric layers are stuck together, usually with an adhesive (glue).
If the fabrics are made from synthetic yarns (thermoplastic) they can be joined together using heat, melting the fabrics together

Types of nonwoven

1. Spunbond nonwovens: These are made by extruding molten polymer through a spinneret to form continuous filaments, which are then laid down in a random web and bonded together using heat or pressure. Spunbond nonwovens are typically lightweight and strong, making them suitable for applications such as hygiene products, geotextiles, and protective apparel.

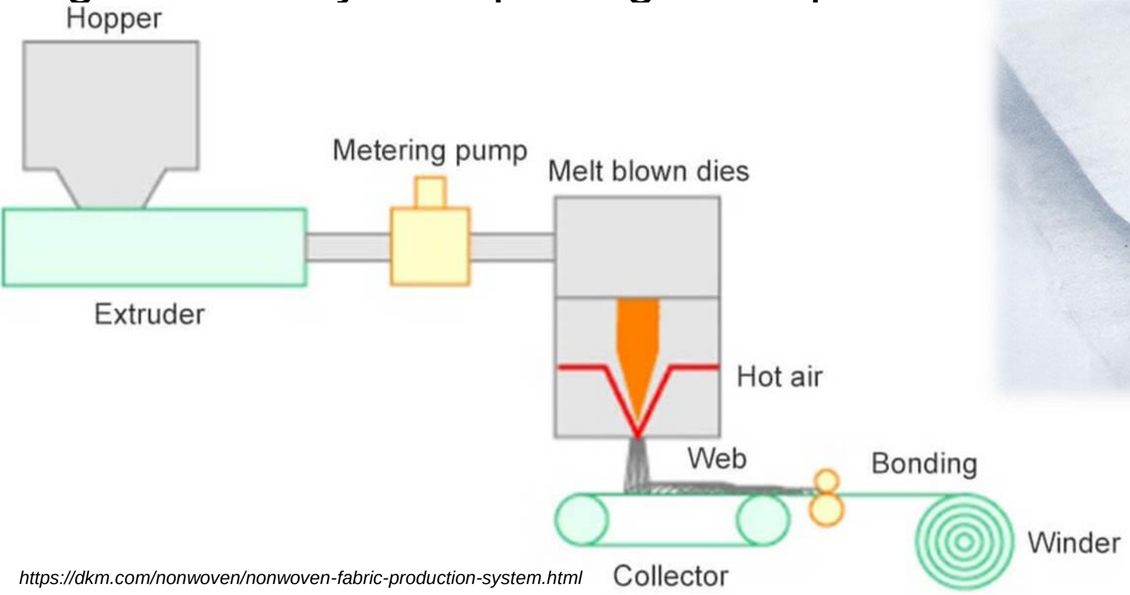


https://www.unitika.co.jp/nonwoven/e/about/manufacturing-process.html



Types of nonwoven

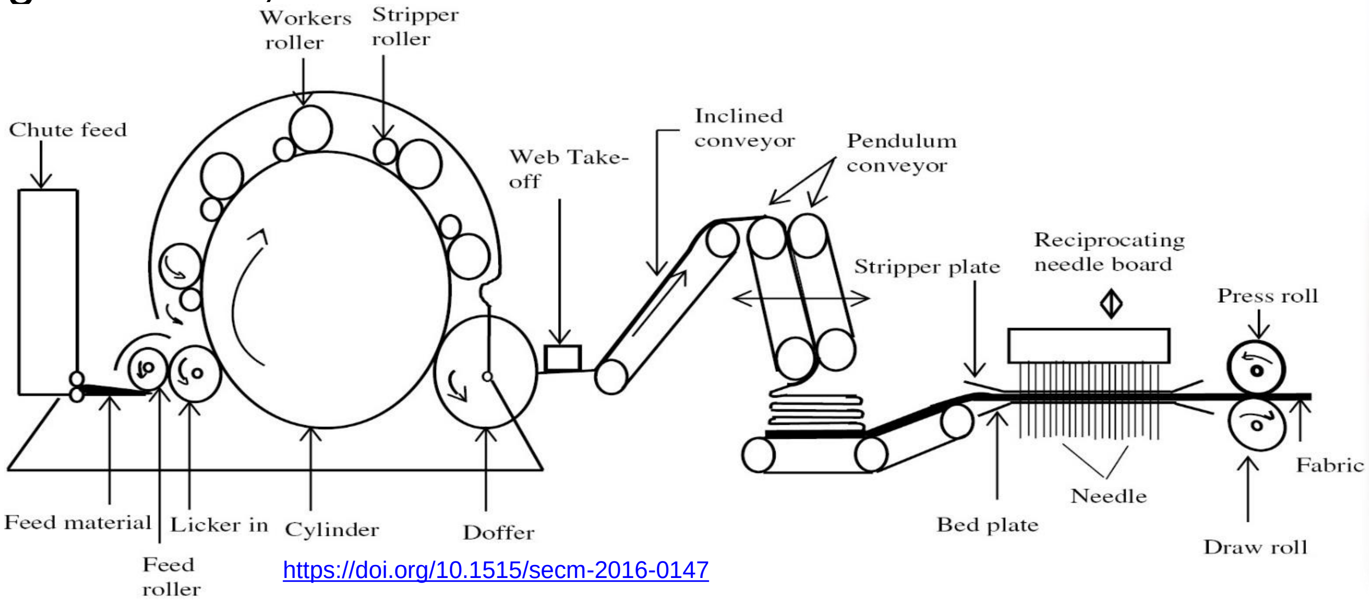
2. Meltblown nonwovens: Meltblown nonwovens are made by blowing molten polymer through a spinneret, which creates fine fibers that are then collected on a moving belt or drum. The resulting fabric is then bonded using heat or pressure. Meltblown nonwovens are often used as filtration media due to their high efficiency at capturing small particles.



https://dkm.com/nonwoven/nonwoven-fabric-production-system.html

Types of nonwoven

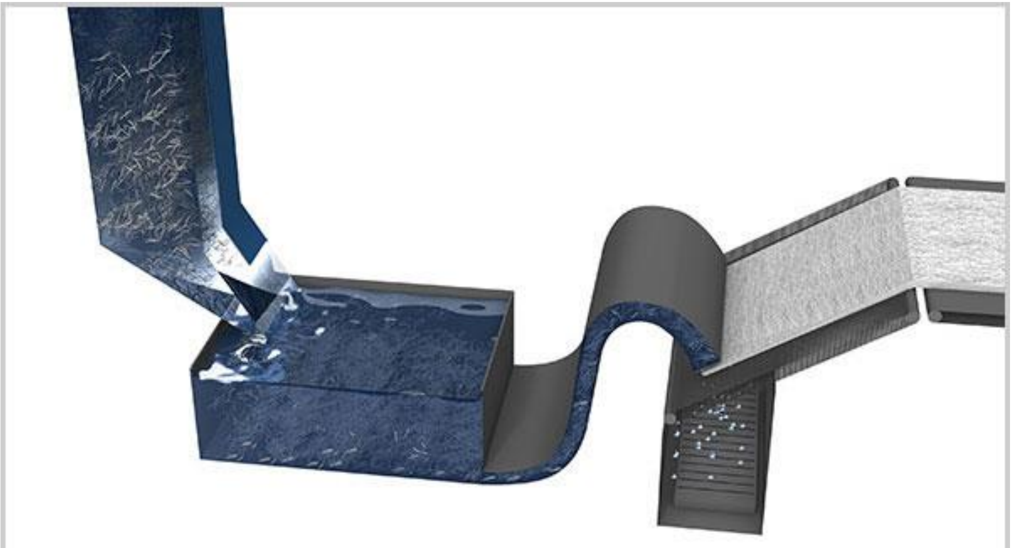
3. Needle punched Nonwovens: Needle punched nonwovens are made by mechanically interlocking fibers using a series of needles. The resulting fabric is typically strong, durable, and resistant to tearing. Needle punched nonwovens are often used in applications such as automotive interiors, geotextiles, and insulation.



https://doi.org/10.1515/secm-2016-0147

Types of nonwoven

4. Wet-laid Nonwovens: Wet-laid nonwovens are made by suspending fibers in water and then forming a mat using a paper-making process. The mat is then dried and bonded using heat or pressure. Wet-laid nonwovens are often used in applications such as filtration, medical textiles, and wipes.

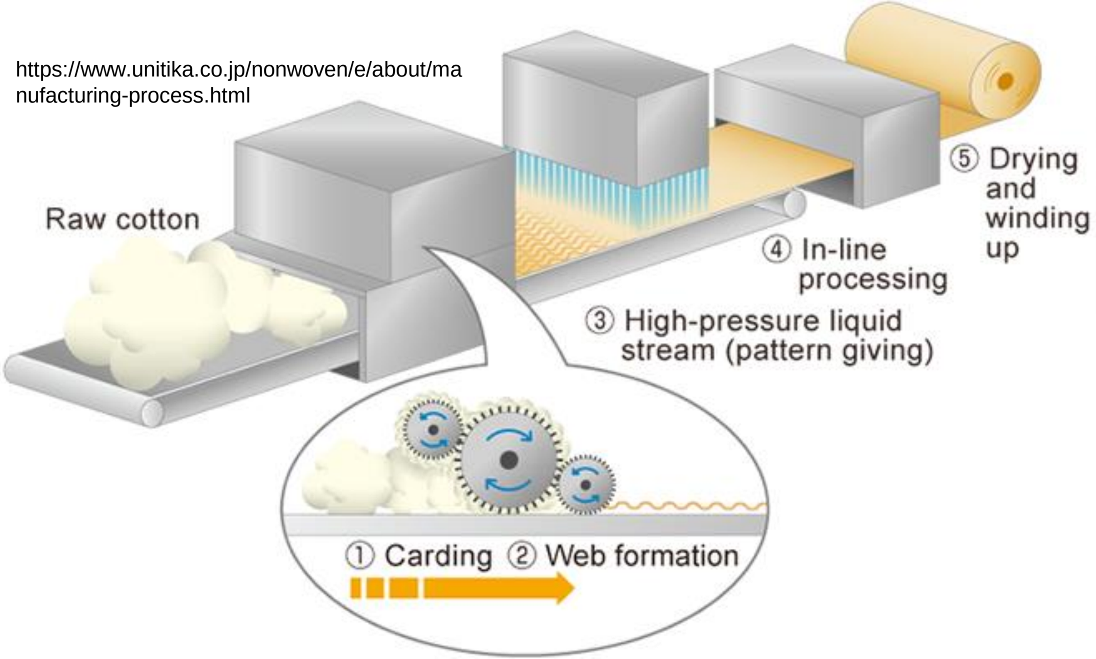


https://www.freudenberg-pm.com/Materials/Nonwoven/Wetlaid-nonwovens

Types of nonwoven

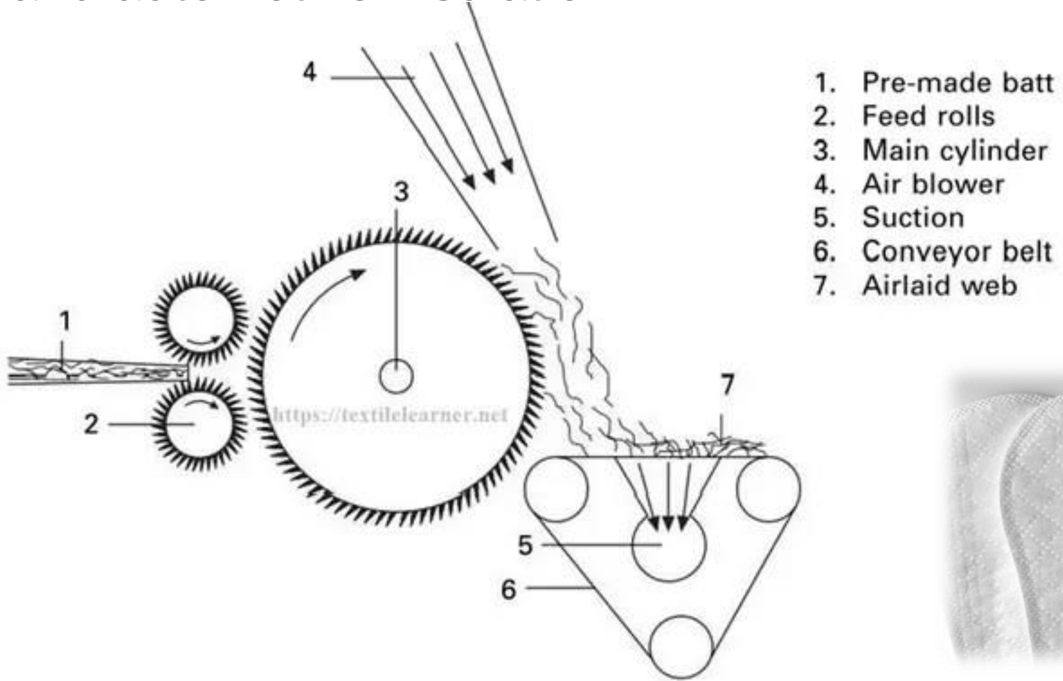
5. Spunlace Nonwovens: Spunlace nonwovens are made by using high-pressure water jets to entangle fibers together. The resulting fabric is typically soft, strong, and highly absorbent. Spunlace nonwovens are often used in applications such as wipes, hygiene products, and medical textiles.

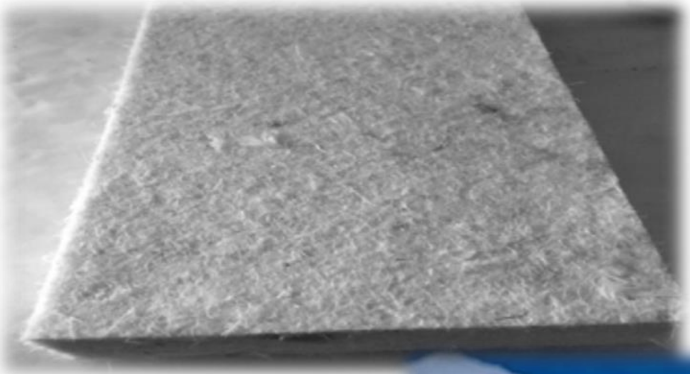
https://www.unitika.co.jp/nonwoven/e/about/manufacturing-process.html



Types of nonwoven

6. Air-laid Nonwovens: Air-laid nonwovens are made by suspending fibers in air and then bonding them together using heat, pressure, or chemicals. Air-laid nonwovens are often used in applications such as wipes, home furnishings, and automotive insulation.

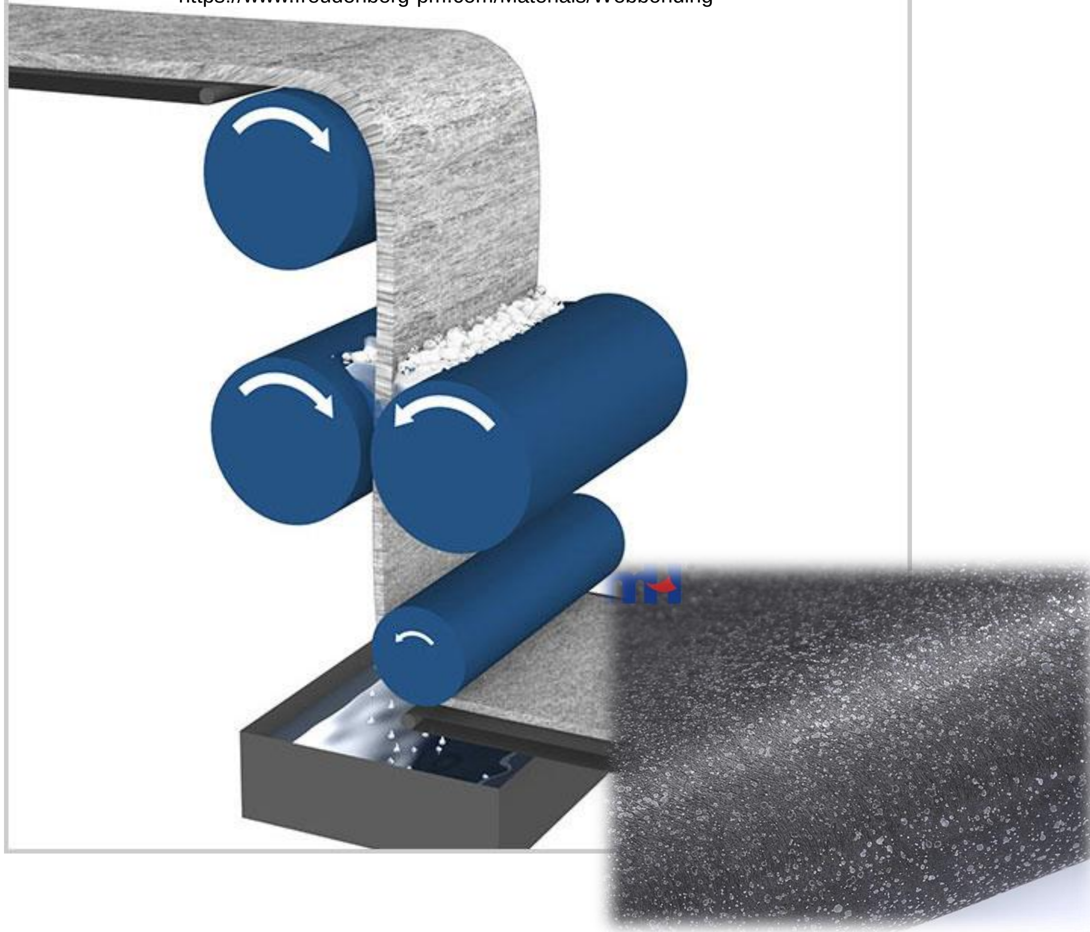




Types of nonwoven

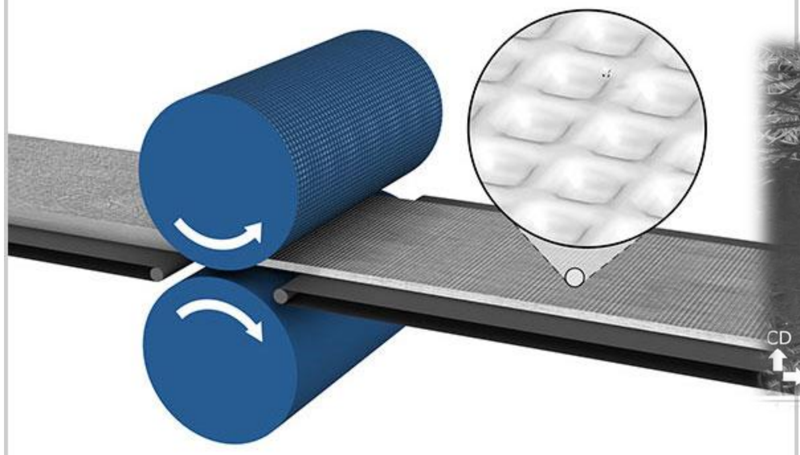
7. Chemical-bonded Nonwovens: Chemical-bonded nonwovens are made by applying a chemical binder to fibers, which then cures and forms a bond between the fibers. Chemical-bonded nonwovens are often used in applications such as filtration, automotive interiors, and insulation.

https://www.freudenberg-pm.com/Materials/Webbonding



Types of nonwoven

8. Thermal-bonded Nonwovens: Thermal-bonded nonwovens are made by heating fibers using hot air or calendering rollers to bond them together. Thermal-bonded nonwovens are often used in applications such as filtration, insulation, and hygiene products.



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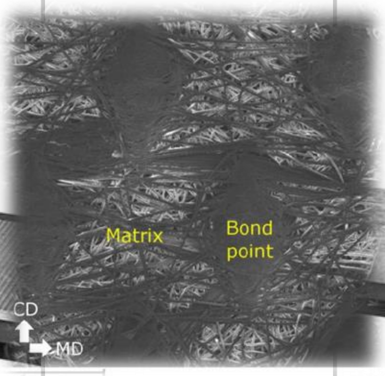
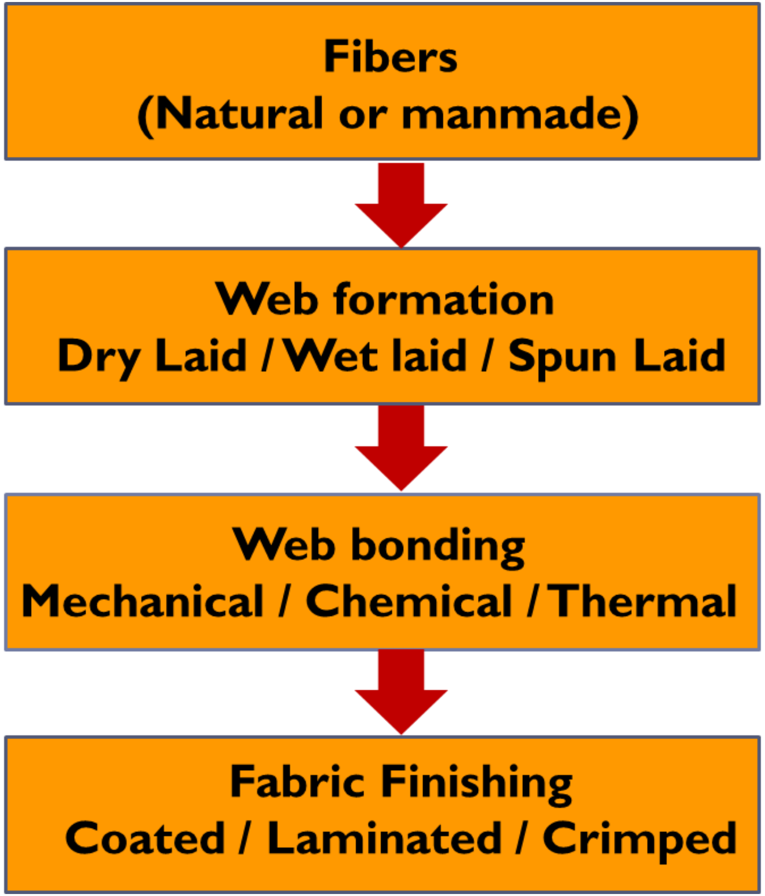
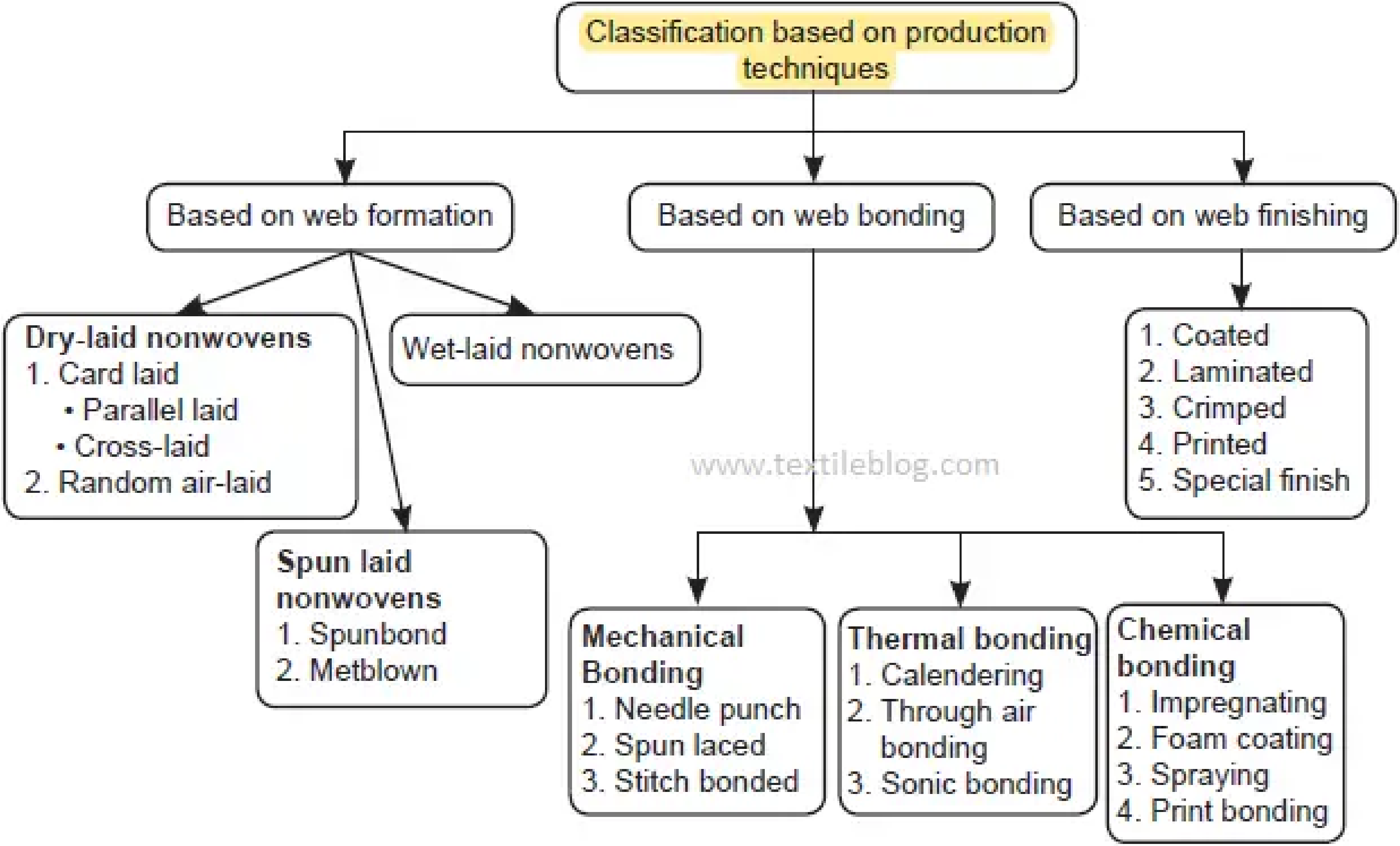


DOI: 10.1088/1742-6596/451/1/012021

https://www.freudenberg-pm.com/Materials/Webbonding

Manufacturing steps of Nonwovens




Classification based on production techniques
Based on web formation
Based on web bonding
Based on web finishing
Dry-laid nonwovens
1. Card laid
• Parallel laid
• Cross-laid
2. Random air-laid
Wet-laid nonwovens
Spun laid nonwovens
1. Spunbond
2. Metblown
1. Coated
2. Laminated
3. Crimped
4. Printed
5. Special finish
www.textileblog.com
Mechanical Bonding
1. Needle punch
2. Spun laced
3. Stitch bonded
Thermal bonding
1. Calendering
2. Through air bonding
3. Sonic bonding
Chemical bonding
1. Impregnating
2. Foam coating
3. Spraying
4. Print bonding

Pros and Cons of Nonwovens

- Cost-effective
- Versatile
- Lightweight
- High strength
- Customizable
- Eco-friendly
- Sterility
- Enhanced comfort
- Easy to Clean
- Chemical resistance

Technical Properties of Nonwovens

- Tensile strength,
- Elongation,
- Stiffness,
- Permeability,
- Bulk,
- Vapor and liquid absorption,
- Chemical resistance
- Thickness
- Porosity
- Permeability
- Basis weight and density
- Tear strength
- Burst strength
- Melt flow rate
- Air permeability
- Water repellency
- Oil repellency
- Thermal stability
- Surface energy
- Electrical conductivity
- Abrasion resistance

Applications of nonwovens

Technical Applications

Medical textiles
Geotextiles
Filtration media

Emerging Applications

Energy storage
Thermal insulation
Sound insulation
Automotive industry

Future Developments

Sustainable materials
Advanced manufacturing techniques
Integration with smart technologies

Technical Applications

Medical textiles: Medical Textiles Nonwovens are widely used in the medical industry, where they are used to produce surgical gowns and drapes, wound care dressings, face masks, and respirators. Nonwovens used in medical applications are often sterilizable, and they are designed to be comfortable and breathable for patients.

Technical Applications

Medical textiles: Surgical gowns and drapes, wound dressings, disposable diapers and incontinence products, face masks, medical wipes and swabs, sterilization wraps, filter media, orthopedic padding, surgical masks and caps…

What are the technical properties required for medical applications, such as barrier properties and sterility?

Technical Applications

Geotextiles: Geotextiles Nonwovens are commonly used in civil engineering and construction projects, such as roadways, embankments, and landfills. The main function of geotextiles is to provide separation, filtration, drainage, and reinforcement. Nonwovens are ideal for these applications due to their high porosity, high strength, and ability to maintain their properties in wet conditions. For example, nonwoven geotextiles can be used to prevent soil erosion by reinforcing the soil structure and promoting vegetation growth.

Application: Nonwovens used for erosion control, drainage systems, and road construction.

Required technical properties?

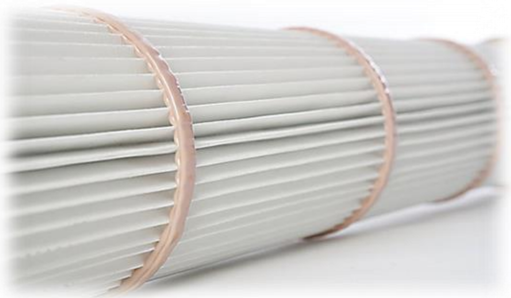
Technical Applications

Filtration media: Nonwoven filtration media are used in various filtration applications, including air, water, and oil. Nonwovens used in filtration applications are often treated with chemical coatings to enhance their properties. For example, air filters made from nonwovens are designed to remove dust, pollen, and other particles from the air, while water filters made from nonwovens can remove sediment, bacteria, and other contaminants from water.

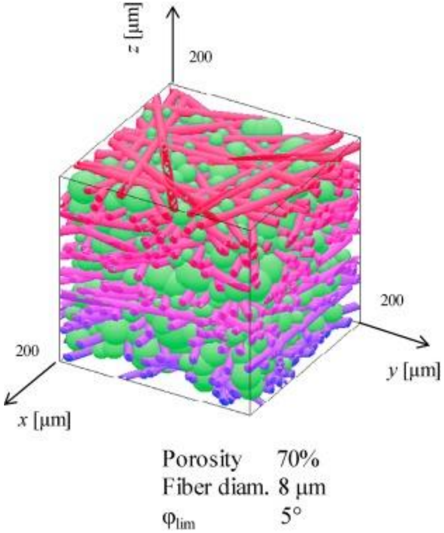
Required technical properties?

Technical Applications

Filtration media: Air filtration, liquid filtration, medical filtration, personal protective equipment, automotive filtration, industrial filtration



Some of the Technical properties required for filtration applications of nonwovens



Filtration Efficiency

Porosity

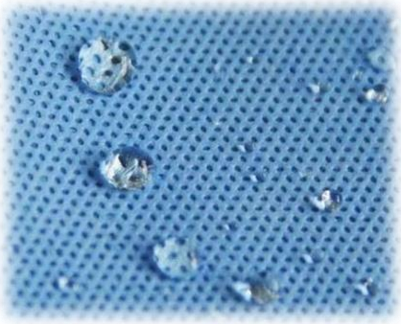
Air Permeability

Burst Strength

Fiber Diameter and Distribution

Hydrophobicity or Hydrophilicity

Chemical Resistance



Face Mask

Definitions

Face Mask – A mask that covers the user's nose and mouth and may or may not meet fluid barrier or filtration efficiency levels.

Surgical Mask – A mask that covers the user's nose and mouth and provides a physical barrier to fluids and particulate materials.

Filtering Facepiece Respirator – A filtering facepiece respirator (FFR) is a device that is a disposable half-face-piece non-powered air-purifying particulate respirator intended for use to cover the nose and mouth of the wearer to help reduce wearer exposure to pathogenic biological airborne particulates.

N95 Respirator – A disposable half-mask filtering facepiece respirator (FFR) that covers the user's airway (nose and mouth) and offers protection from particulate materials at an N95 filtration efficiency level per 42 CFR 84.181. (CFR=Code of Federal Regulations)

Surgical N95 Respirator – A disposable FFR used in a healthcare setting that is worn by HCP during procedures to protect both the patient (HCP=Health care personnel)

https://www.ahrmm.org/health-care-masks-types-definitions-classifications-and-approved-models

Classification of the Mask

<u>Based on functionality:</u>

- Surgical face mask
- Surgical respirators
- Comfort mask
- Particulate respirators

<u>Based on usage:</u>

- Disposal
- Reusabale

https://www.xamax.co.uk/blog/how-to-pick-a-dust-mask-rating-p1-vs-p2-vs-p3.html

Particulate Filters

As per AS/NZS 1715 there are 3 different classes of particulate filters, P1, P2 and P3.

P1 (FFP1): are used against mechanically generated particulates. Protects against: low levels of dust, solid and liquid aerosols. It can be used for hand sanding, drilling, and cutting.

P2 (FFP2): are used for protection against mechanically and thermally generated particulates. Protects against: moderate levels of dust, solid and liquid aerosols. It has higher protection than FFP1 and can be used for plastering and sanding.

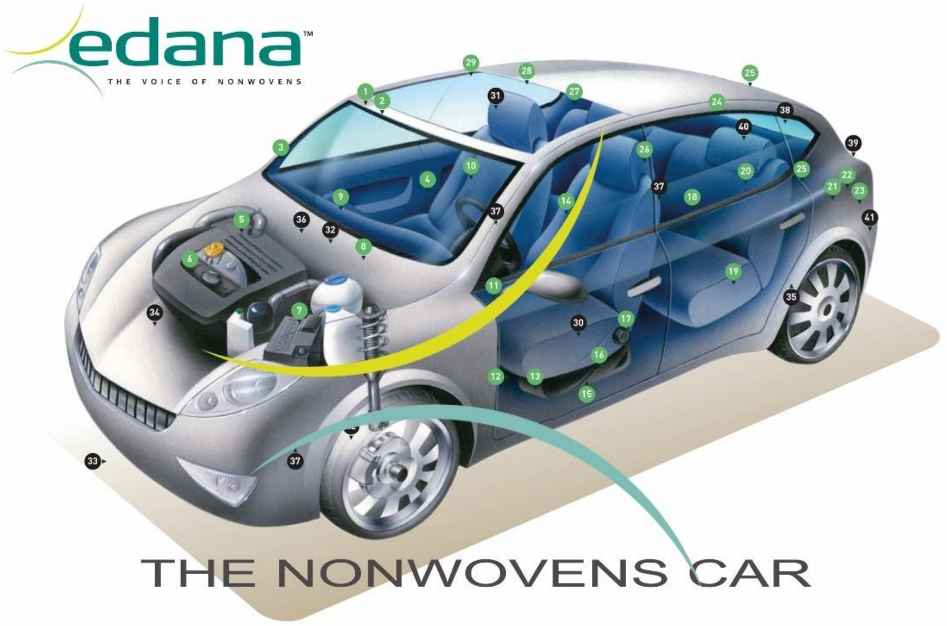
P3 (FFP3): are used for protection against highly toxic or highly irritant particulates. Protects against: higher levels of dust, solid and liquid aerosols. It has higher protection than FFP1 and FFP2. It can be used for handling hazardous powders (such as those in the pharmaceutical industry) and Asbestos mask.

https://www.xamax.co.uk/blog/how-to-pick-a-dust-mask-rating-p1-vs-p2-vs-p3.html

Emerging Applications

Automotive Industry: Nonwovens have found widespread use in the automotive industry due to their durability, versatility, and cost-effectiveness. For example, nonwovens can be used in car interiors, as well as for acoustic insulation and air filtration systems.

Application: Sound insulation, thermal insulation, filtration, padding, etc.



1 Covering material for sun-visors
2 Padding for sun-visors
3 A, B, C, column padding
4 Door trim pads
5 Fuel filters
6 Oil filters
7 Battery separators
8 Cabin air filters
9 Loudspeaker cover
10 Covering for moulded seats
11 Transmission tunnel
12 Carpet & carpet reinforcement
13 Car mats
14 Vinyl backing for seat covers
15 Backing for tufted carpeting
16 Covering for seat belt anchorage
17 Covering for seat belt
18 Decorative fabric
19 Polyurethane coated backing
20 Seat slip agents
21 Boot (trunk) liners
22 Moulded fuel tanks
23 Bodywork parts
24 Window frames
25 Headliner facings
26 Upholstery backing
27 Loudspeaker housing
28 Sunroof
29 Saloon roof

Acoustic absorber applications

30 Doors
31 Headliner
32 Inner & outer dashboard insulation
33 Under engine shield
34 Moulded bonnet liner
35 Rear wheel arch liner
36 Cowl
37 Pillar trim panels
38 Parcel shelf
39 Trunk trims
40 Rear seat strainer
41 Air extractor
42 Wheel arch liners

Emerging Applications

Sound Insulation: Nonwovens can also be used in sound insulation applications, such as in automotive interiors or soundproofing walls.

Thermal Insulation: Nonwovens can be used in thermal insulation applications due to their high porosity and low thermal conductivity. For example, nonwoven insulation can be used in construction projects to improve energy efficiency.

Energy Storage: Nonwoven materials can be used as separators in batteries and other energy storage devices, as they can prevent short circuits and improve the performance of the device.

Future Developments

Sustainable Materials: Sustainability is becoming an increasingly important consideration in the production of nonwovens. Manufacturers are exploring the use of renewable and biodegradable materials, such as bamboo, hemp, and flax, to create eco-friendly nonwovens.

Advanced Manufacturing Techniques: New manufacturing techniques are being developed to create nonwovens with advanced properties. For example, 3D printing technology can be used to create nonwovens with customized structures and properties.

Integration with Smart Technologies: Nonwovens are also being developed with integrated sensors and other smart technologies. These materials can be used in a range of applications, from medical devices to wearable technology.

Future Trends in Nonwovens

- Sustainability
- Smart nonwovens
- Nanotechnology
- Medical and hygiene applications
- Automotive and construction applications
- 3D printing
- Digitalization

Děkuji za pozornost

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