

Introduction to textile materials and their innovative possibilities



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Introduction



From its origin, humans had the need to dress, and as a result of this, the first cloths are born.

Since then, the processes have been modernised and adapted to the new times, also the chemicals, whether polymers for fibres or products for dyeing and finishing.

Those are emerging as a result of research and development of new materials.

This R&D enabled the development of new fabrics that have facilitated or made possible tasks that previously could not be carried out.

Keywords

Textile process, fabrics, knitting, nonwoven, printing, coating, laminating, dyeing

Goals



The main goals of this lecture are to explain the textile process and to discuss the fields of application of the fabrics.

Thus, we will start with an overview of the textile sector, its processes and then we will deepen on what are the main applications of functional fabrics.

This lecture covers the fundamentals and the needed background about general textile materials and complements the different lectures of DESTEX virtual training.

With this lecture, we aim to provide an overview about advanced textile materials, with examples of their applications.

Structure

In the current content you will find:

- An introduction to the textile process: fibres used, how yarns and fabrics are made and textile finishing
- Textiles functionalities
- Overview of textile applications

Learning outcomes



Knowledge

- Obtaining a general knowledge about the different textile processes
- Identifying the different kinds of fibres, fabrics, and textile finishing process. A key outcome will be to acquire a general idea about the spinning process and yarn characteristics.
- Understanding the wide range of textile applications.

Competences

- Identify the basic steps of the textile process and give some examples of them. Understand the product flow from fibres to garment.
- Identify the different areas where fabrics are applied, and which are their main features they need to accomplish.
- Be able to think about a fabric and describe its functions and applications.

1. Textile materials



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1. Textile materials

1.1. General textile process

TEXTILE PROCESSES

FIBRES

YARNS

FABRICS

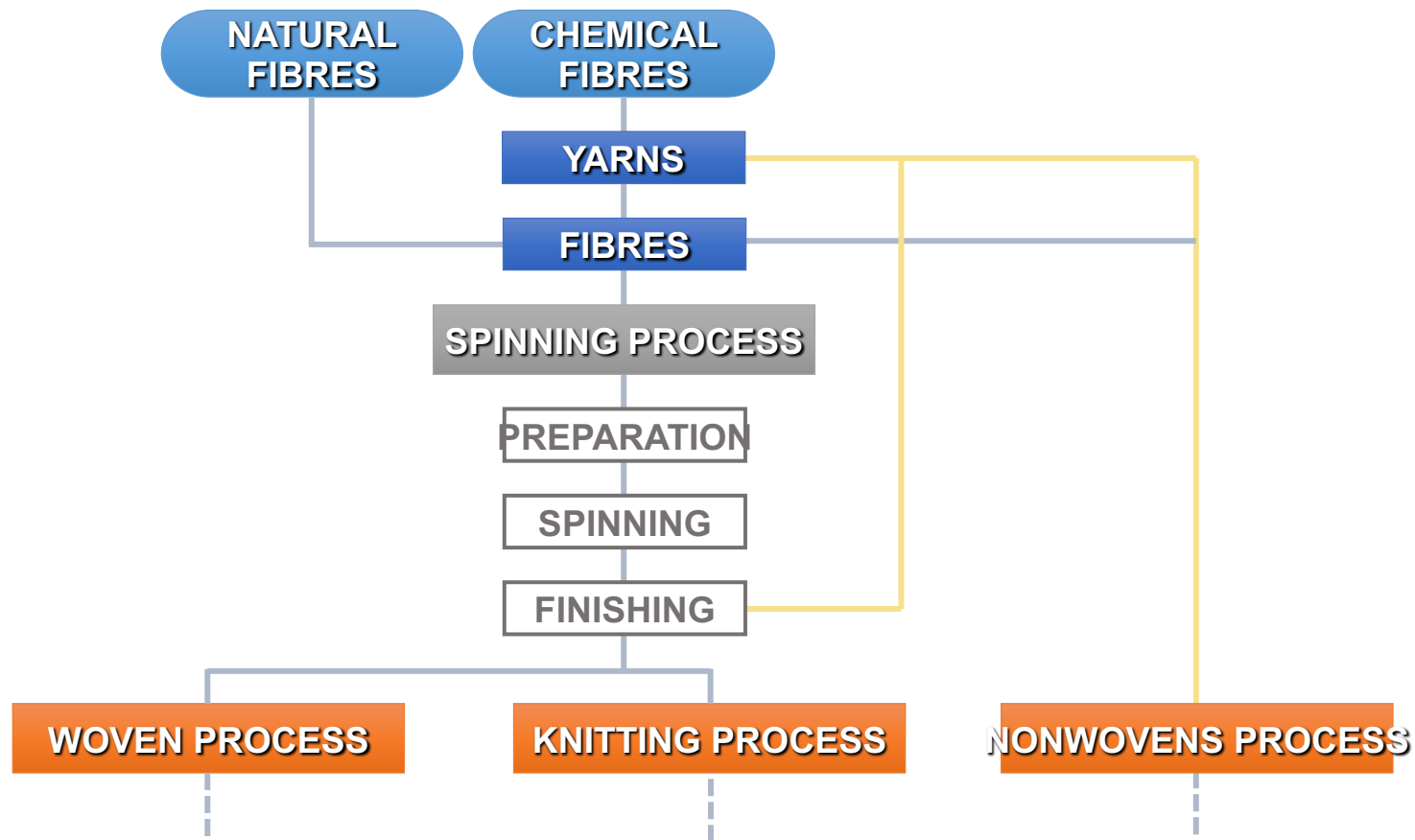
DYEING AND
FINISHING



1. Textile materials

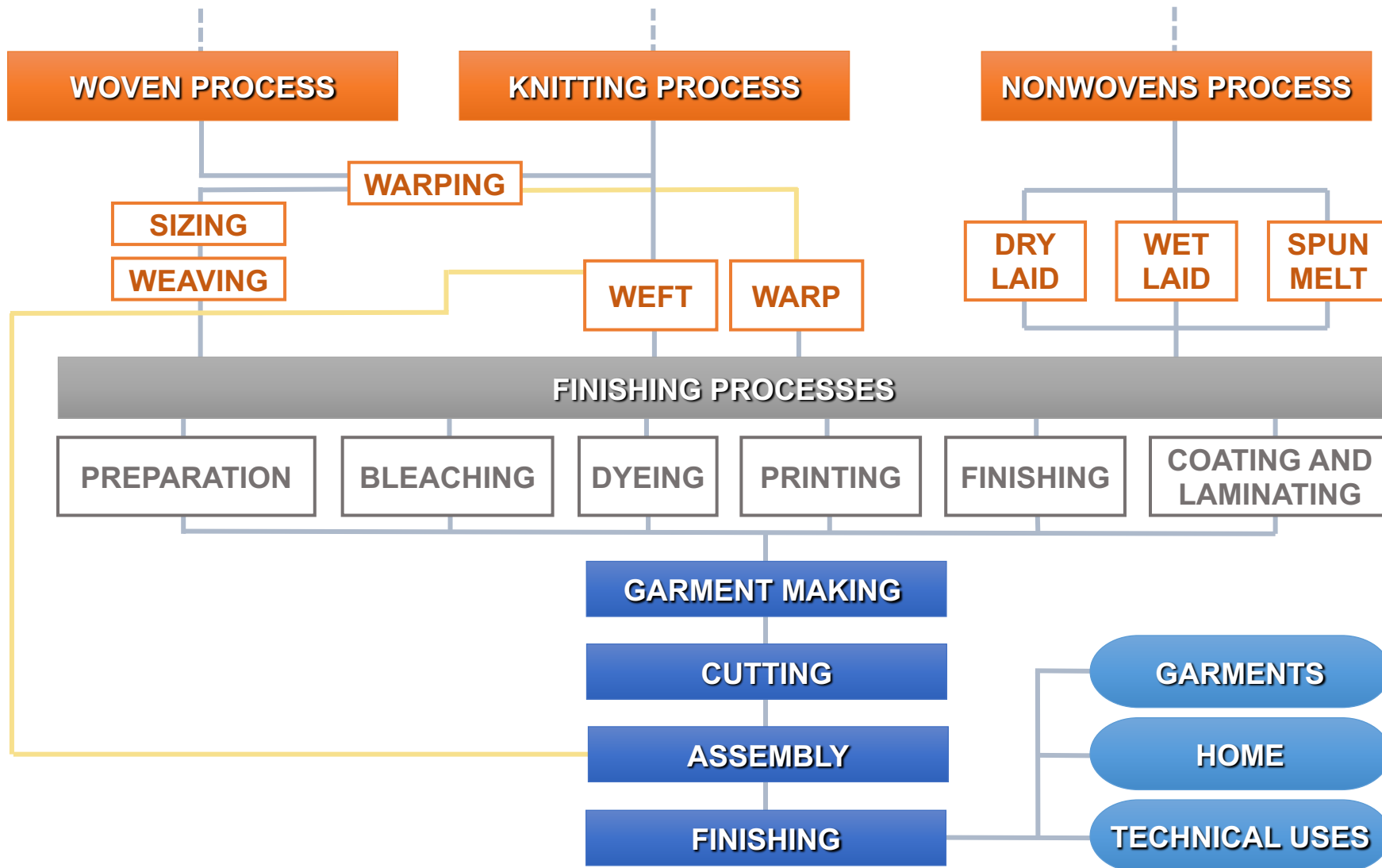
1.1. General textile process

In the following pages, the general process that a fibre needs to follow to become a fabric is explained in the diagram. There are several paths the production process can take depending on the kind of fabric and its final use.



1. Textile materials

1.1. General textile process



1. Textile materials

1.2. Textile materials

A **textile fiber** is a solid with a cylindrical structure, macroscopically homogeneous, characterized by its flexibility, small cross section and a high length / thickness ratio. They are used as raw material to obtain textile materials. Depending on their origin, textile fibers can be classified into two main groups: **natural fibers**, which include vegetable, animal and mineral sources, and **man-made** fibers, which are obtained through transformation processes of the raw materials.

NATURAL	Vegetable	Cotton, linen, hemp, jute, esparto
	Animal	Wool, angora, alpaca, silk, mohair
	Mineral	Metallic, glass
MAN-MADE ARTIFICIAL FIBERS	Organic	Viscose, acetate, modal
MAN-MADE SYNTHETIC FIBERS	Conventional	Polyester, polyamide, acrylic, polypropylene
	High physical resistance	Polyester HT, polypropylene HT
	Elastic	Elastane
	Thermal resistance	Modacrylic, chlorine fibre
	Thermal and physical resistance	Aramids, polybenzimidazole

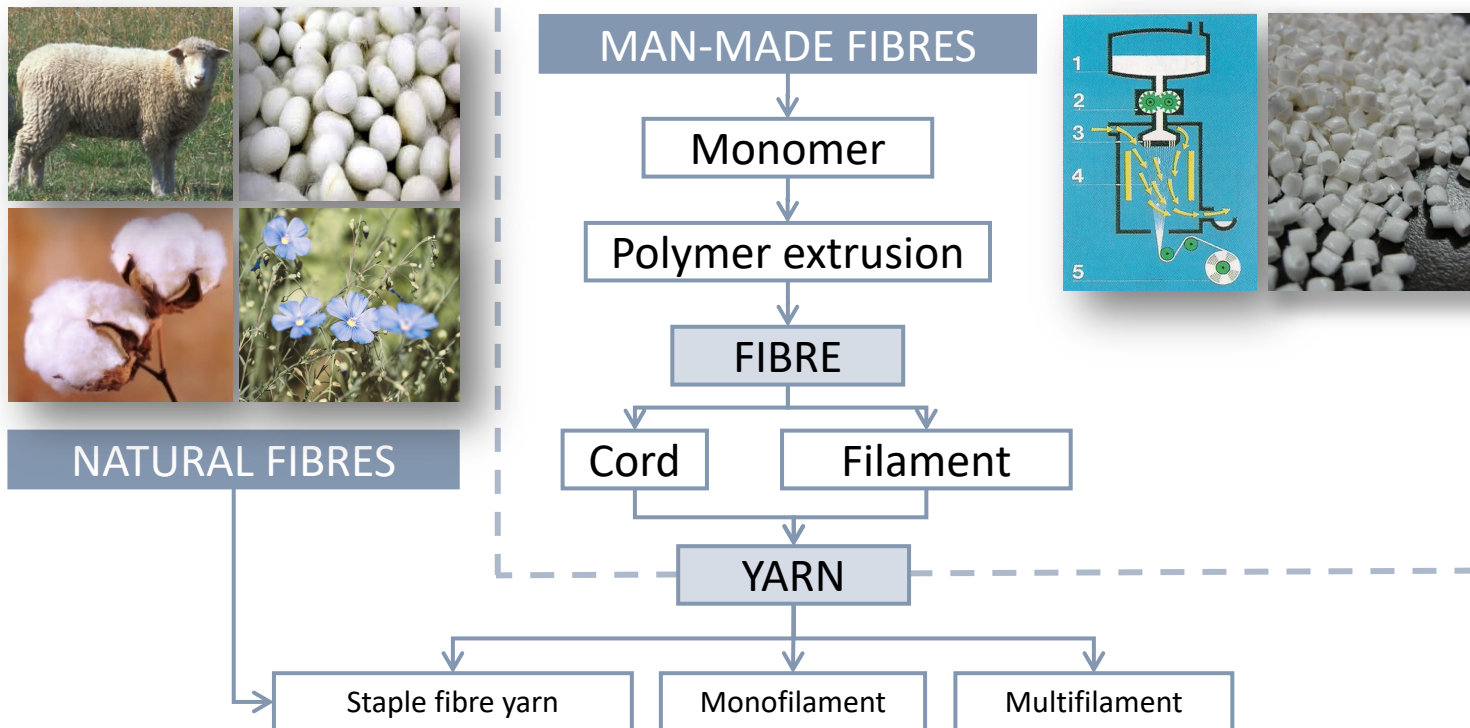


1. Textile materials

1.2. Textile materials

In order to obtain a man-made fibre, a chemical process is needed in order to transform the raw material. Then, through a mechanical process, the yarns are formed.

On the other side, natural fibres do not need a chemical transformation, besides some cleaning in order to process them into yarns.

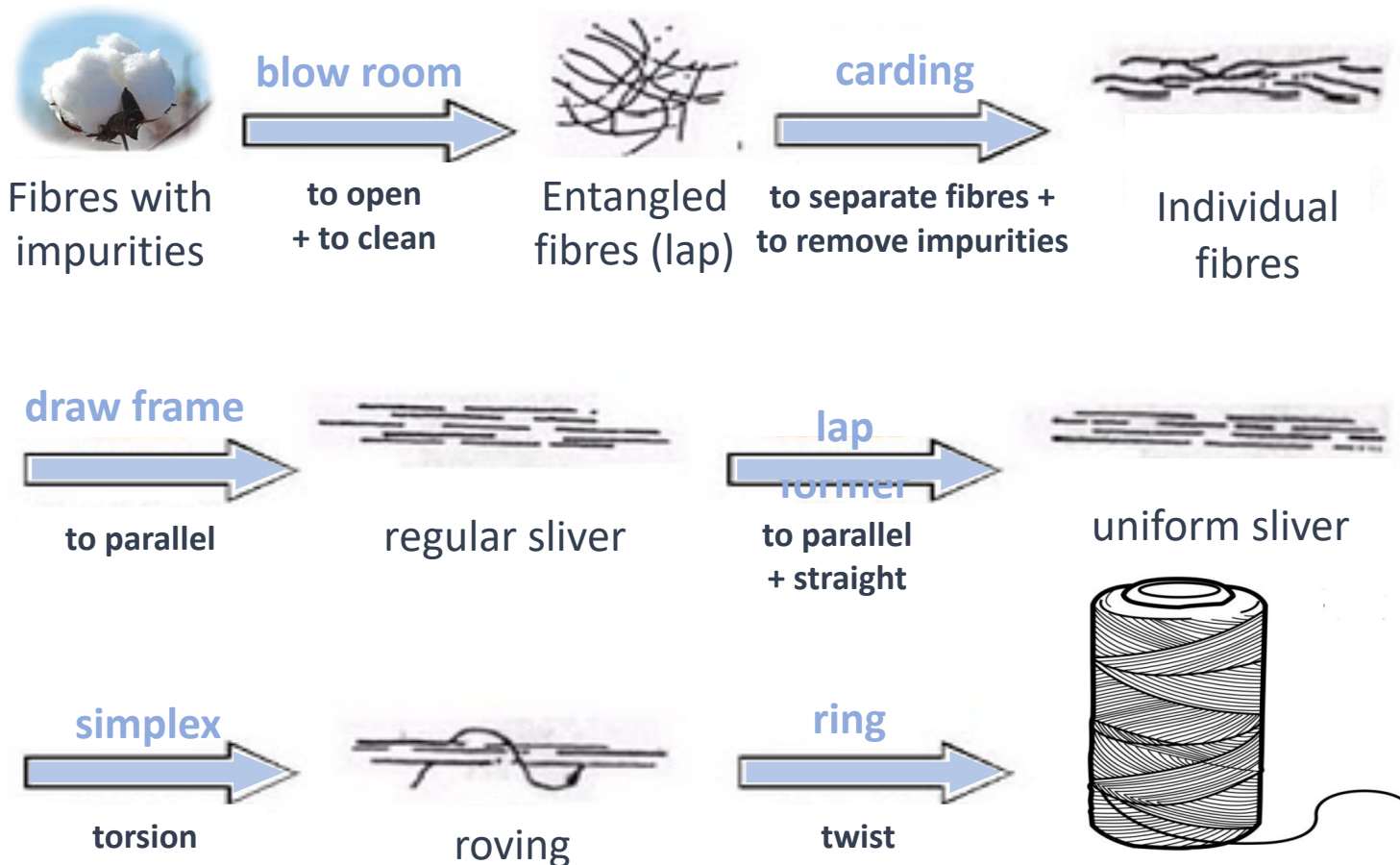


1. Textile materials

1.3. Yarns

The general process that a natural fiber needs to follow in order to transform it to a yarn is summarized in the diagram that follows. This process is called spinning.

Except for the cleaning processes, the man-made fibers can follow the same process in order to obtain a multifilament yarn.



1. Textile materials

1.3. Yarns

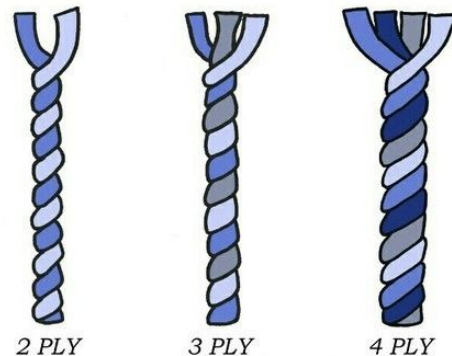
Yarn characteristics:

A yarn is characterized by different parameters:

- **Raw material.** Type of fibres which it is made of.
- **Yarn count.** Thickness of the yarn, expressed in weight, in grams, of 1.000 m of yarn (or equivalent).
- **Twist.** Described as the number of twists per metre.
- **Dyed** (for striped, checked, jacquard patterns, etc.) or **raw**.
- **Ply number.** Number of yarns twisted together. Yarns can be described as single, or one-ply; 2 ply, 3 ply; or as cord, including cable and hawser types.



Twisting direction



*Ply number
(tradeindia.com)*

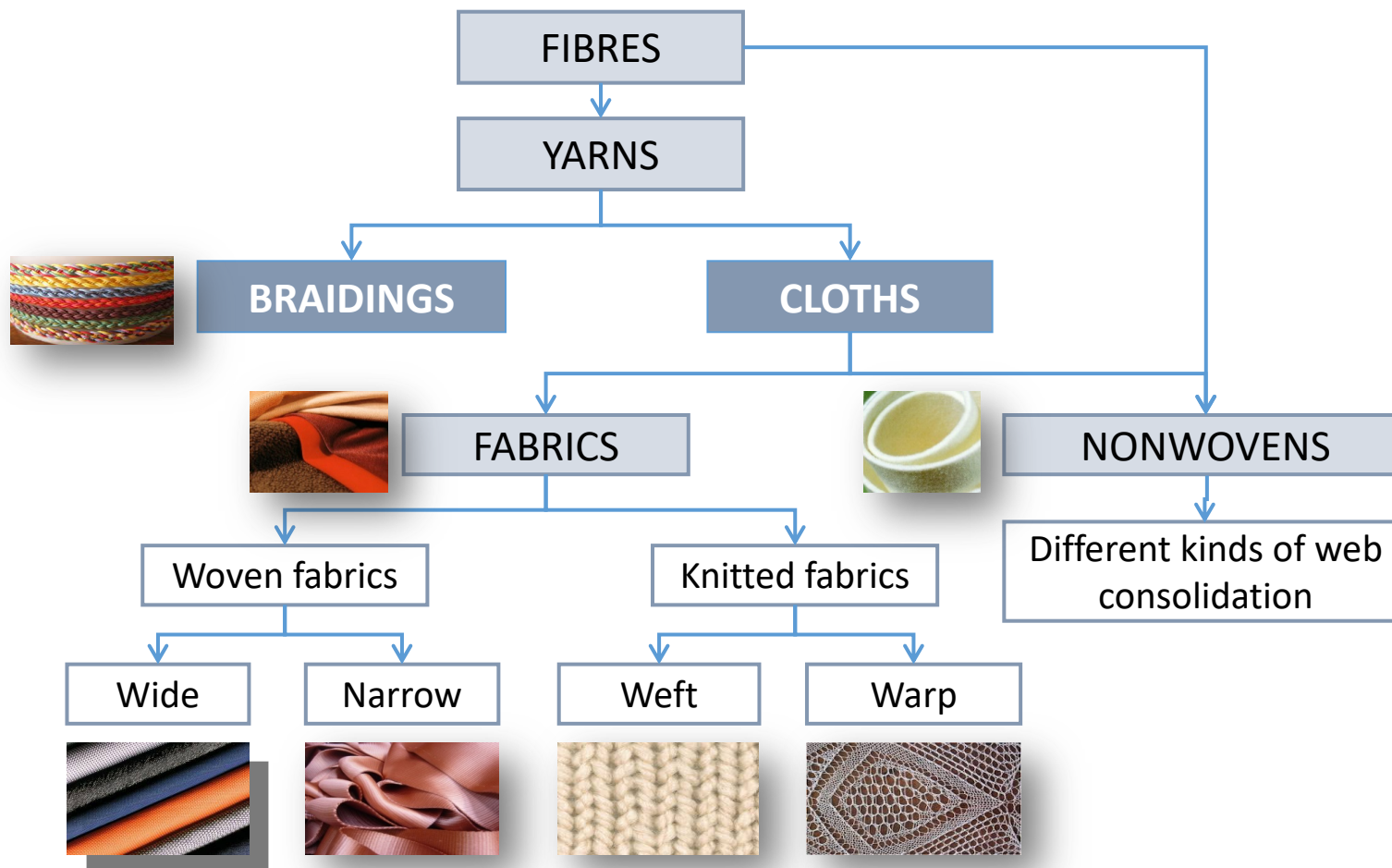


Sewing thread with 2, 3 or 5 ply

1. Textile materials

1.4. Fabrics/nonwovens

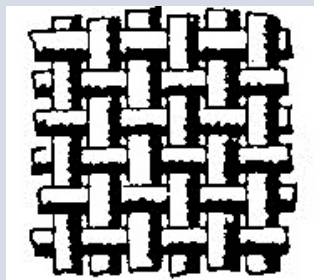
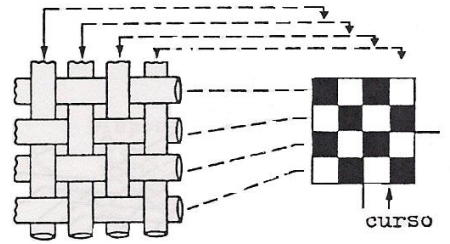
Fabric is a pliable material made usually by weaving, knitting or felting natural or synthetic fibers and filaments. The definition itself describes the three main different mechanisms to put the yarns together and create a woven, knitted or nonwoven fabric.



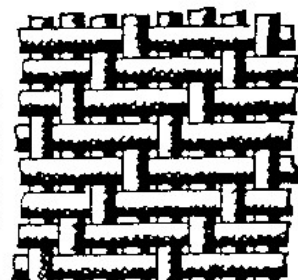
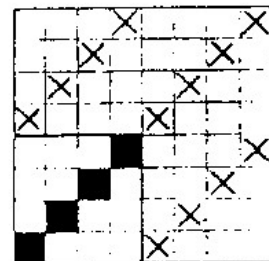
1. Textile materials

1.4. Fabrics/nonwovens

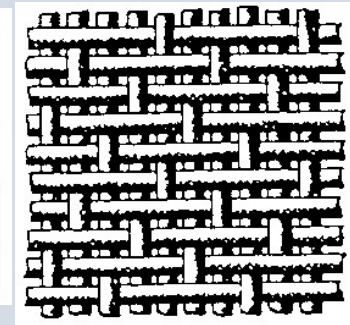
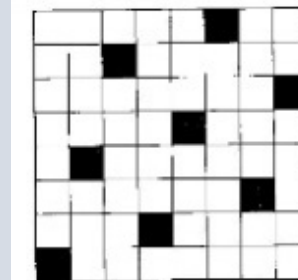
Woven fabrics always originate from the intersection of two sets of threads, called warp and weft. The different combinations between them create different kind of woven fabrics divided in three big groups: plain (A), twill (B) and satin (C).



(A)



(B)



(C)

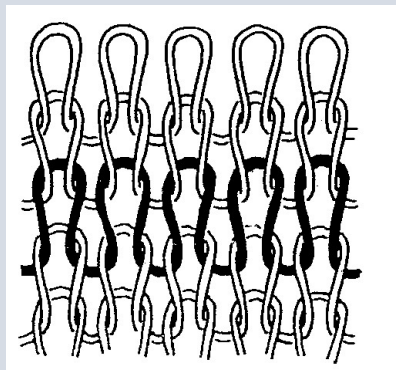


1. Textile materials

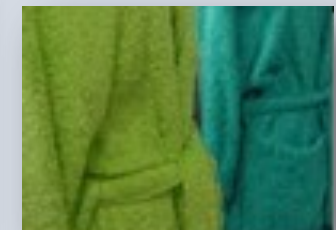
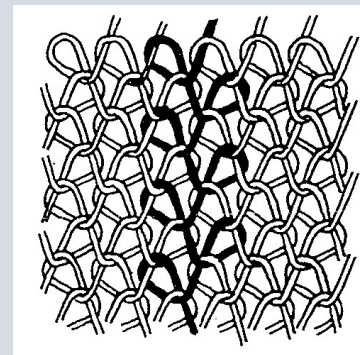
1.4. Fabrics/nonwovens

Knitted fabrics result from knitting, the process of inter-looping of yarns or inter-meshing of loops. Depending on the evolution of the yarn, knitted fabrics are woven by warp (vertical yarns) or by weft (horizontal yarn). Knitted fabrics are more flexible than woven ones, so it can be used in garments like sweaters, sportswear or underwear, for example.

Weft knitted fabric



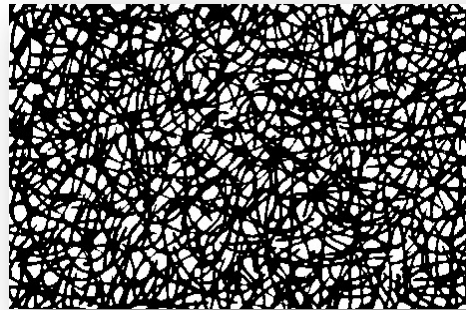
Warp knitted fabric



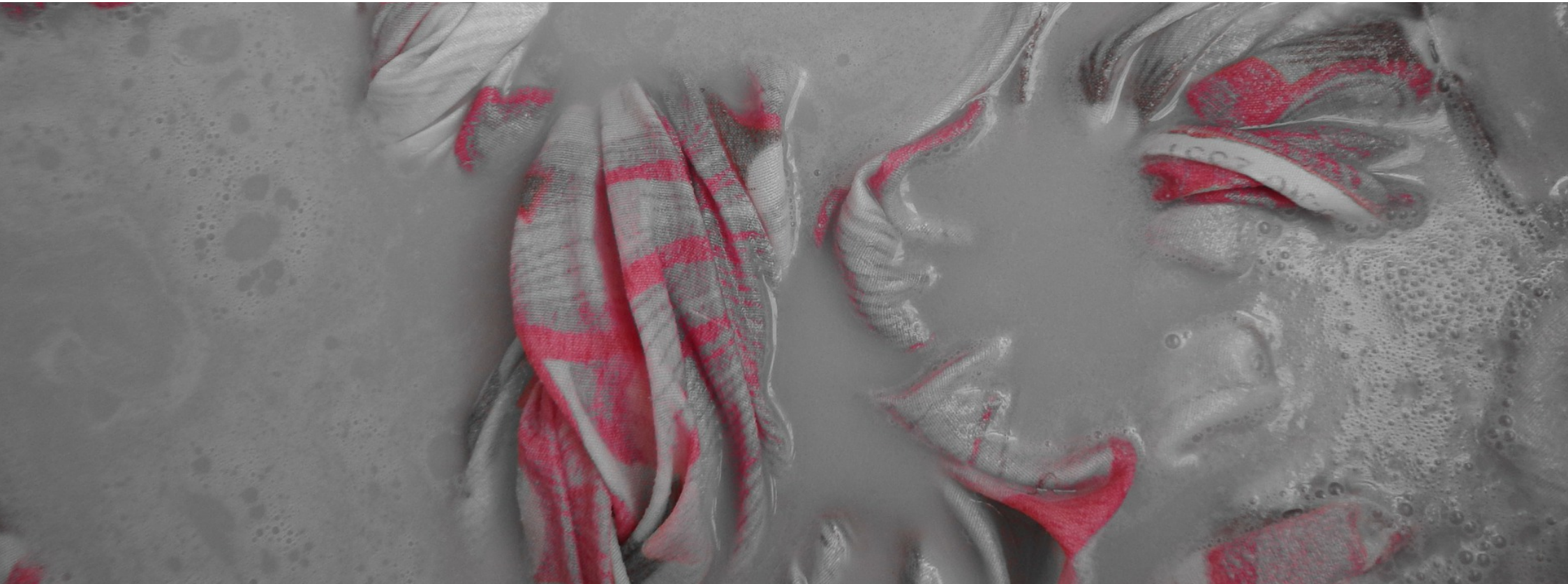
1. Textile materials

1.4. Fabrics/nonwovens

Nonwoven fabrics are broadly defined as sheet or web structures bonded together by entangling fibre or filaments, and bonded together by chemical, mechanical, heat or solvent treatment. The fibers don't have a specific order; to the contrary, they are entangled with one of the existing methods and fixed on its position.



2. Finishing processes



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2. Finishing processes

Textile finishing processes convert the woven or knitted fabrics into a usable material. A finishing process is any process performed on the fabric to improve its look, performance, or "hand" (feel). It also includes dyeing and bleaching processes. In order to achieve the desired colour, performance or feel, more than one finishing is often needed.

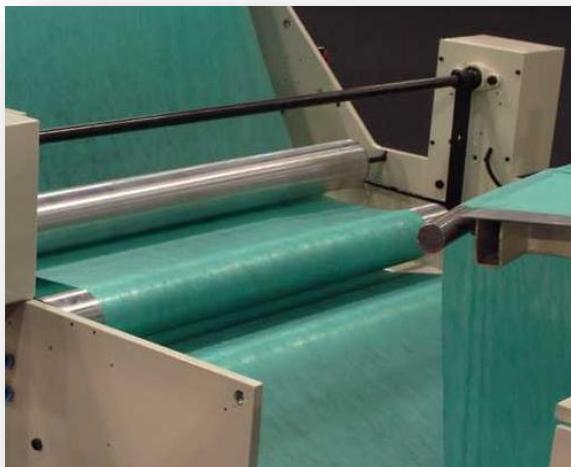
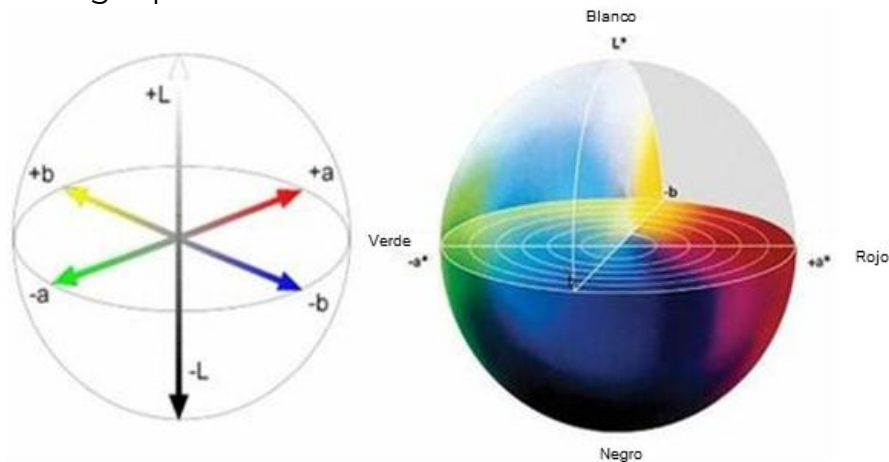
There are a lot of finishing processes, so in general there are divided in the following categories:

- **DYEING:** which includes preparation, bleaching, dyeing to provide homogeneous colour and printing, for instance in specific zones using screen printing, perforated cylinders or digital Technology
- **CHEMICAL FINISHING:** which provides improves or gives properties that the original fabric did not have such as softening, fireproofing, water or dirt repellence, wrinkle-free, non-shrinkable, etc.
- **MECHANICAL FINISHING:** Those are physical processes to modify the fabric surface such as extracting hair with raising, razor burn for shearing, shrinkage such as sanforized, shine or moiré effect with calendering, peach skin with sanding, etc.
- **COATED AND LAMINATED FABRICS:**
 - **Coating:** is the process of applying a resin, on one side of the fabric to make it water proofed and sealed.
 - **Laminating:** is the application of a membrane, on the underside of the fabric, to make it waterproof while maintaining breathability.

2. Finishing processes

2.1. Dyeing and printing

A fabric is dyed when it all has the same colour, and printed when the colour (normally a print) only affects one side of the fabric. In both cases, the knowledge on the concept of colour is very important, specifically its definition (hue, lightness and saturation values) and the corresponding representation.



Quality characteristics:

- Uniformity
- Repeatability
- Fastness

2. Finishing processes

2.2. Chemical and mechanical finishing

Mechanical finishing processes are those operations in cloth finishing which owe their effectiveness to the application of agencies such as heat, pressure and moisture and not to the interaction of chemicals with the constituent fibre of the fabric. These mechanical processes were formerly the most important means of modifying and improving the appearance of cleaned fabrics¹.



There are two types of chemical finishes:

- Finishes obtained by deposition of chemicals such as oil, fats and waxes, synthetic resins, rubber latex, cellulose acetate, cellulose ethers, optical bleaching agents and so on.
- Finishes obtained by chemical reactions with fibre, such as anti-soil, wrinkle free, wash & wear, flame retardant, deodorant & antimicrobial, ultraviolet protection, and many others.



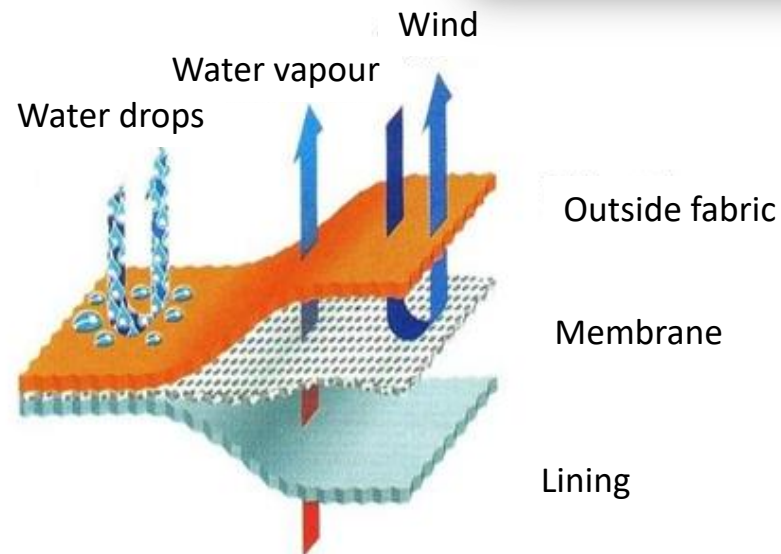
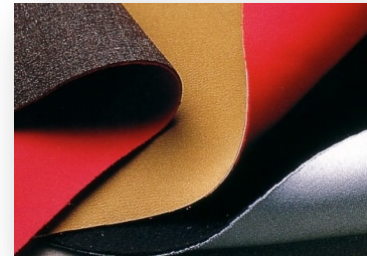
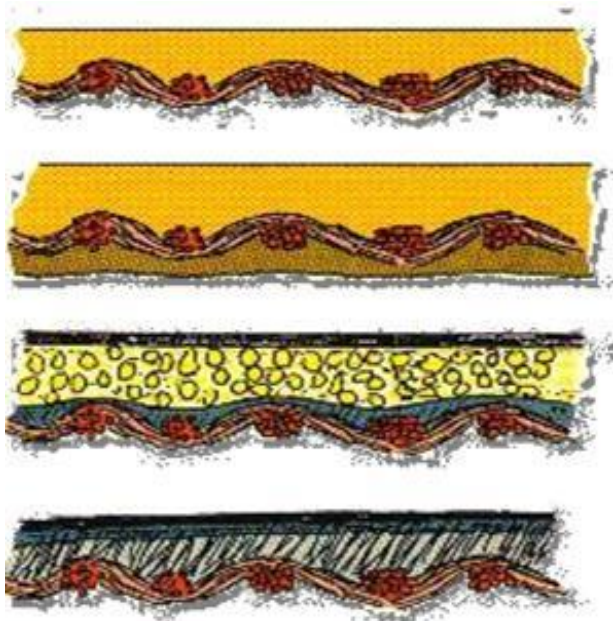
1. <https://www.tandfonline.com/doi/abs/10.1080/19447015108663865?needAccess=true&journalCode=jtip20>

2. Finishing processes

2.3. Coating and laminating

Lamination consists of bonding pre-prepared polymer film or membrane with one or more textile substrates using adhesives, heat, or pressure. Coating is the process of applying a viscous liquid (fluid) or formulated compound on a textile substrate.

Coating and lamination offer methods of improving and modifying the physical properties and appearance of fabrics and also the development of entirely new products by combining the benefits of fabrics, polymers and films.



3. Functionalities of the textile materials



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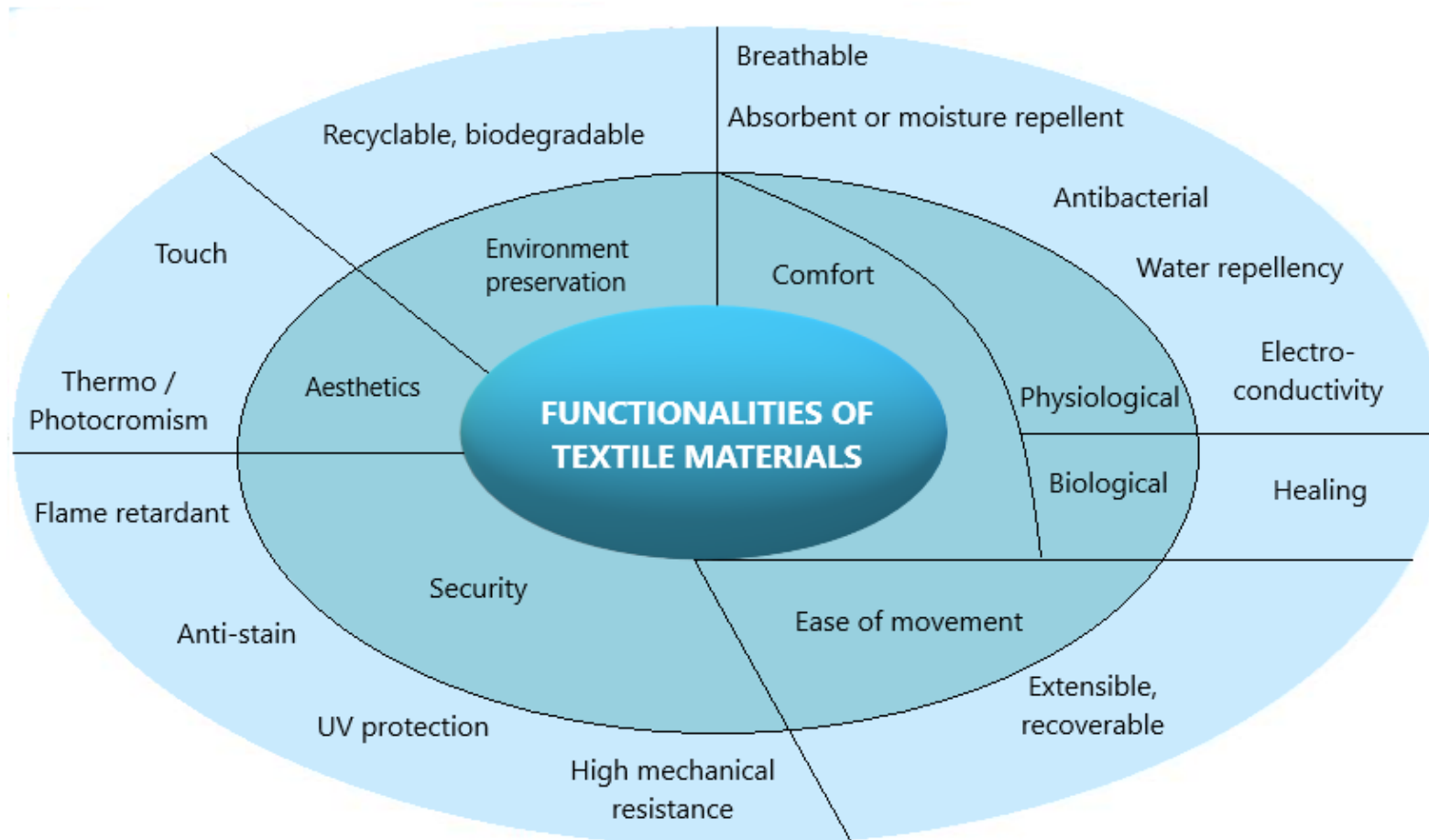


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3. Functionalities of the textile products

We can find textile materials everywhere, and this happens because the functionalities level of the fabrics is so high they can be found not only in fashion but in every industrial sector. Textile materials can be designed accomplishing aesthetics functions, but also security, comfort, environment preservation... Therefore, fabrics can be functionalized to meet the demand of different sectors, and this is achieved through technology and research.



4. Applications of the textile materials



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4. Applications of the textile materials

4.1. Clothing

When we chose our garments, we are choosing them for its aesthetics they describe ourselves) for its functions, depending on the weather, etc., and for its social expression.



PRAGMATIC

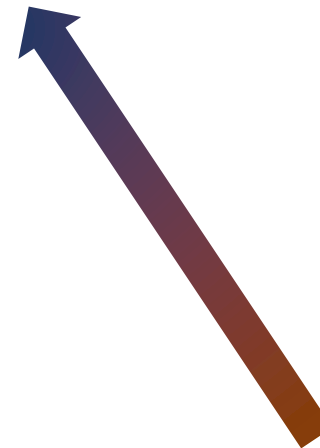


AESTHETICS



REPRESENTATIVE

Clothing
functions



4. Applications of the textile materials



4.1. Clothing

Nevertheless, a fourth statement is included nowadays on the described ones: ethics.

A part from being comfortable/functionalized, fashionable and describe yourself, a garment has a fabrication process and is made with materials that can harm (or not) the planet, socially and environmentally speaking. So, fabrics are acquiring new individual and collective needs and values.

New individual and collective needs and values

- BRAND
- NOVELTY, FASHION

AESTHETICS

PRAGMATIC

- HIGHER FUNCTIONALITY
- HIGHER CONFORT DEMAND

- CUSTOMIZED
- EPHEMERAL

SOCIAL

ETHICS

- ECOLOGIC
- SUSTAINABILITY

4. Applications of the textile materials



4.2. Home

Home textiles are another big market for the textile sector, being the fabric located in different parts of the houses, accomplishing a big variety of roles. In this case, the fashion function is not so important but functionality is.

• LINEN

- Bed: bed lining, blankets, duvet cover, cushions
- Hygiene: towels, wipes, bath curtain
- Table: table lining



• INTERIOR DESIGN AND DECORATION

- Enclosures: Curtains, net curtains, blinds, screens, etc.
- Floor and/or wall coverings: rugs, carpets, tapestries
- Furniture: Upholstered chairs and armchairs



• OUTDOOR

- Awnings, canopies, parasols
- Hammocks, deck chairs



4. Applications of the textile materials



4.3. Technical applications



4. Applications of the textile materials

4.3. Technical applications

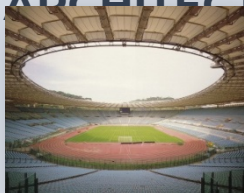
TEXTILES FOR CIVIL ENGINEERING



TEXTILES FOR AGRICULTURE AND FISHING



TEXTILES FOR BUILDING AND TEXTILE ARCHITECTURE



4. Applications of the textile materials



4.3. Technical applications

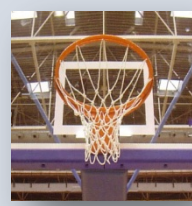
TEXTILES FOR THE AUTOMOTIVE AND PUBLIC TRANSPORTATION



TEXTILES FOR PACKAGING AND GOODS TRANSPORT



TEXTILES FOR SPORTS AND LEISURE

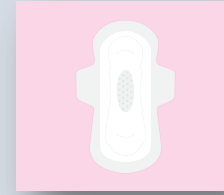


4. Applications of the textile materials



4.3. Technical fabrics

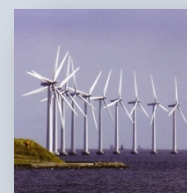
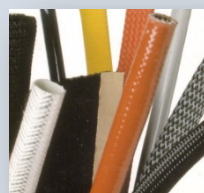
TEXTILES FOR THE MEDICAL, HYGIENIC AND SANITARY USES



TEXTILES FOR PERSONAL PROTECTION



TEXTILES FOR INDUSTRIAL USES



4. Applications of the textile materials



4.3. Technical applications

TEXTILES FOR ENVIRONMENTAL PROTECTION



TECHNICAL TEXTILES FOR HOME AND PUBLIC BUILDINGS



TECHNICAL TEXTILES FOR GARMENTS



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