MAN-MADE FIBRES

A Brief History

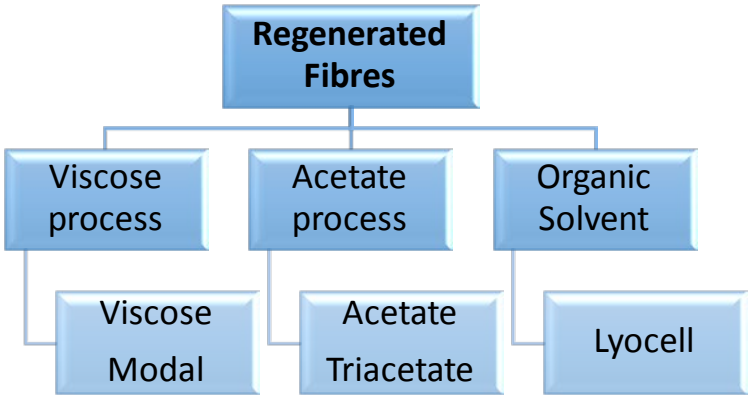
The first patent for the production of artificial fibres was granted in the late nineteenth century. Some years later the first artificial silk stockings were produced for sale in the 1920s. This innovation saw a change in fashion – the introduction of the shorter 'flapper style' dresses of the 'roaring twenties'. The introduction of synthetic and regenerated fibres revolutionised the fashion and textile industry.

MAN-MADE – Natural polymers

Man-Made Cellulosic Fibres or Regenerated Fibres

Definition: cellulosic fibres that have been made by chemically changing the natural material.

Man-made cellulosic fibres can be classed according to the process used to convert the raw cellulose into a spinnable solution.



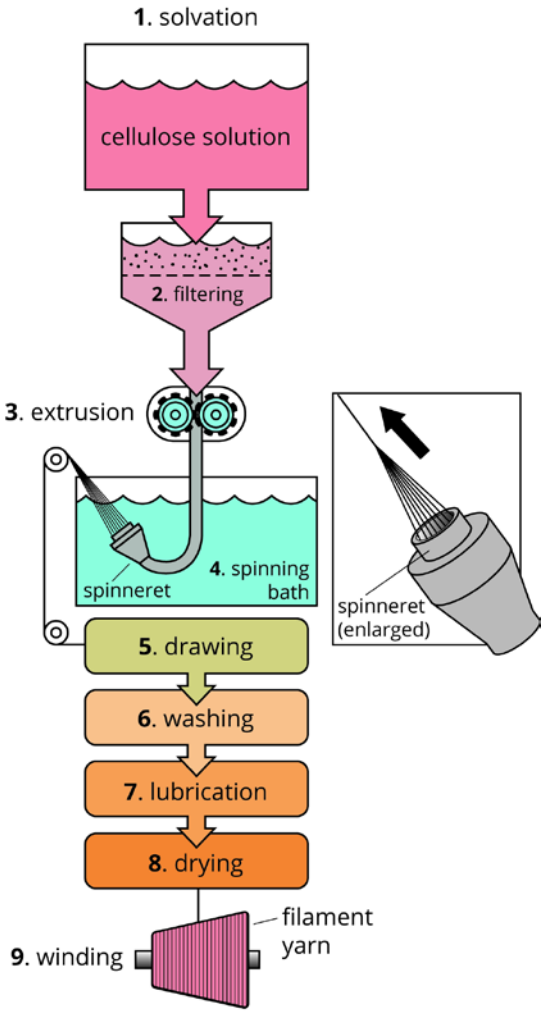
VISCOSE (RAYON)

Source

Viscose is one of the most important regenerated fibres. It comes from the wood pulp of the eucalyptus, pine or beech wood. It can also be made from short cotton fibres called cotton linters – a waste product from the cotton processing industry. It is processed to remove impurities and resins, leaving pure cellulose which is pressed into sheets.

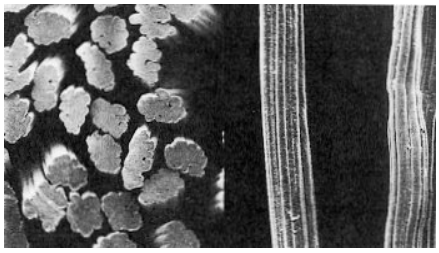
The sheets are dissolved in a solvent to form viscose solution which is then processed into a useable fibre.

This process is shown below:



Properties

Viscose fibres are produced as filament yarns and staple fibres. The viscose fibre has lengthwise lines called striations. The cross section is a circular shape with indents (as shown opposite).



Viscose is a versatile fibre that imitates the texture and feel of silk, cotton, wool and linen.

Viscose fibres:

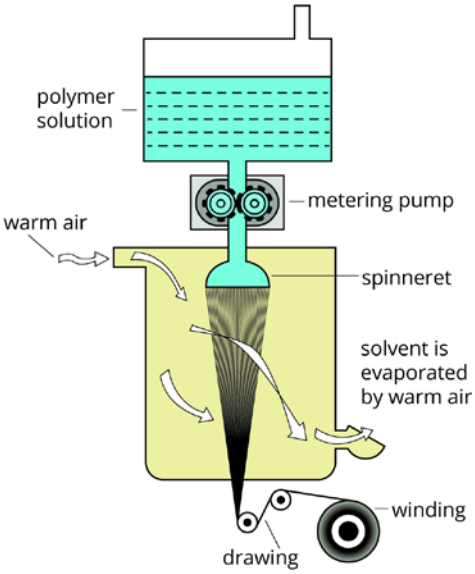
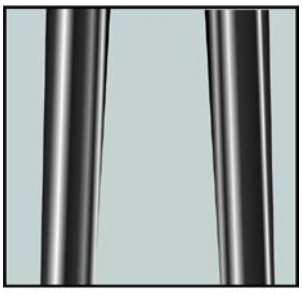
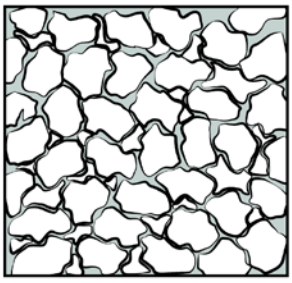
- are very absorbent and can absorb up to 14% water vapour
- are comfortable next to the skin as the fibres are fine and soft
- have a good handle and drape well
- are non-static as they always contain some moisture
- have poor elasticity; they wrinkle and crease easily
- are poor insulators as they do not trap air; this is due to the structure of the fibre
- are prone to damage by mildew and acid
- have poor resistance to abrasion because its fibres have poor elasticity
- have poor strength particularly when wet which can cause fibres to stretch

are biodegradable.

Finishes	Blends
Shrink resistance – improves creasing but reduces absorption. Other finishes include: texture, moiré, crimping.	Staple viscose are blended with many other fibres where their uniformity, lustre and absorption are helpful but mainly: cotton, linen, wool, polyester, elastane.

Viscose Fabrics	End uses	After care	Testing
Filament viscose: Lustrous crepe fabrics Staple viscose: Cotton Wool Linen types.	Blouses, dresses, lingerie. Ribbon and trims Curtains, lining.	Washable; Easy to iron; Can be dry cleaned; No bleach; Do not tumble dry.	**Burning**: rapid, bright flame with an afterglow.

ACETATE

Source	Properties
Cellulose acetate is a combination of cellulose from wood pulp and acetic acid. It is A dry, granular substance which can be dry spun when dissolved in acetone. This dry spinning process is shown below:  Acetate is produced as a continuous filament and can be manufactured to the required diameter staple, length and crimp. 	The properties associated with acetate are distinctly different from other regenerated fibres Very similar to viscose. Acetate is often referred to as a cheap alternative to silk because of its elegant drape and lustre. Acetate is produced as continuous filaments and microfibres. The fibres have a few indentations or   striations lengthways and the cross section indicates a more bulbous appearance. The cross section can look different depending on the manufacturing process, which can affect the appearance and handle of the finished fabric. Acetate fibres are: • prone to static – low absorbency but fast drying • smooth and soft with some lustre; they drape well • non-elastic therefore creases quite easily • thermoplastic and sensitive to dry heat • moth and mildew resistant • biodegradable.

Blends	End uses	After care	Testing
Wool Viscose Cotton, linen, silk Polyester Elastane	Blouses, dresses, lingerie, linings. Home furnishing. Upholstery. Personal hygiene products due to high absorbency.	Wash and iron carefully. Can be dry-cleaned. Do not bleach or dry clean.	**Burning**: melts in a flame burning rapidly. **Smell**: acidic smell. **Residue**: hard, black.

LYOCELL (Tencel®)

Source

Lyocell is the generic name for a new group of fibres derived from plant cellulose. One of the most important of these fibres is Tencel® developed by Courthauld.
Although the main source of lyocell is wood pulp, unlike viscose, the manufacturing process is quite different and has been developed to be more environmentally sensitive.


Forest

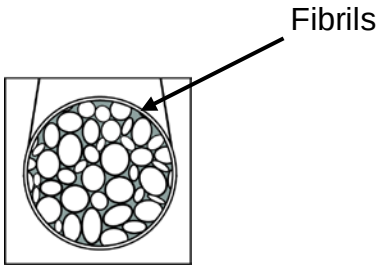

Wood


Pulp


Fibre

A closed loop system is used in manufacture which means that all the waste can be re-used in the production process. The whole process is considered eco-friendly.

The spun fibre consists of many microscopic fibres called fibrils shown in the cross section below:



The tiny fibrils inside the fibres can split which allows fabrics to be manufactured in a wide variety of appearances and for specific end uses.

Properties

Textiles made from Tencel® are considered more absorbent than cotton, cooler than linen and softer than silk. Lyocell shares many properties with other cellulosic fibres.
Lyocell is initially produced as long smooth continuous filaments as shown above.
Lyocell fibres are:

- absorbent and wick away moisture allowing them to appear breathable
- lightweight and comfortable next to the skin
- soft and supple with good draping qualities
- resistant to damage from bacteria and mould
- strong even when wet and do not stretch.
- easy care with low shrinkage
- biodegradable.

After care	Lyocell Blends
Washable; Moderate heat for ironing; Some items can be dry cleaned.	Linen Wool Cotton Cashmere Elastane Other synthetics

End uses

Clothing, workwear.
Nonwoven: Medical supplies, feminine hygiene products.
Sewing threads
Household linen

Points for Further Investigation and Discussion

- Compare and contrast the properties of regenerated fibres with traditional natural fibres.
- Investigate the environmental system for the manufacturing of lyocell. Assess and discuss its green credentials.

www.Youtube.com
Tencel® is the functional fibre from nature
Lenzing - Tencel® moisture management
The benefits of Tencel fabric

www.lenzing-fibers.com
www.madehow.com
www.slideshare.net
www.simplififabrics.com

MAN-MADE – synthetic polymers

Polyester

Source

Polyester is derived from oil in the form of petrochemicals, then processed into a polymer substance which is cut into chips. The chips are melted in the spinning process and extruded as polyester fibres. The fibres are either in the form of a flat filament, a textured filament or a staple fibre as shown below:

Polyester chips

Flat filaments

Textured filament

Staple fibre

As well as the texture being different, the thickness of polyester fibre varies too, from microfibre and extremely fine and soft to coarse and quite firm. During the manufacturing of polyester fabrics, fibre type is selected according to the intended end use.

Polyester is a non-renewable fibre and not biodegradable but can be recycled easily.

Properties

Polyester fibres can be engineered to suit specific end uses. For example flat filaments can be cool to wear as they do not trap air however textured filaments do trap air so can be warmer to wear.

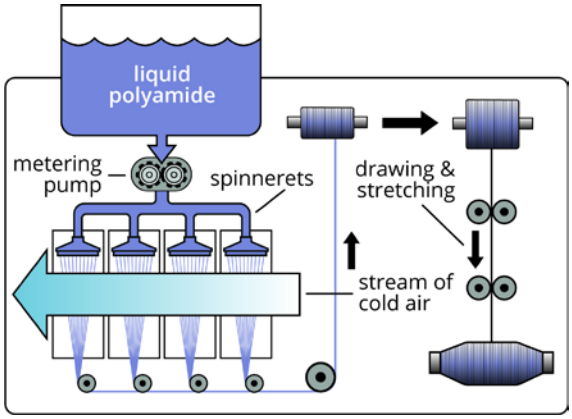
Polyester fibres:

- are not absorbent and prone to static although some textured filaments can wick away moisture. Polyester fibres can be engineered to add breathable comfort in clothing
- are strong, with excellent abrasion and tear resistance; durable
- are lightweight, hydrophobic and water repellent
- have good elasticity with good crease resistance
- are thermoplastic and can be permanently shaped using heat
- are resistant to alkalis, solvents, mould and mildew but not to acids
- are not resistant to prolonged exposure to sunlight; fibres can lose strength.

Finishes	Blends
Flame-resistant; anti-static treatment; other finishes can be applied specific to end-use.	Staple fibres: wool cotton viscose modal linen silk Common blend ratios: 70/30, 65/35, 55/45, 50/50

Polyester Fabrics	End uses	After care	Testing
Microfibre fabrics Trade names: Dacron®, Trevira® Hollofil	Clothing, ties, scarves, rainwear, lining, net curtains.	Machine washable, low temperatures, dries quickly, iron with care, can be dry cleaned and tumble dried. Do not bleach.	Burning: melts and shrinks away from the flame, forms a brownish mass which can drip. **Residue**: hard, solid.

NYLON, POLYAMIDE

Source	Properties
Nylon is made from polyamide and is extensively used in the textile industry. It is a thermoplastic and is made up of repeated units linked by a chemical bond. Polyamide is produced either as: • chips for future use, or • melted and extruded into continuous filaments immediately as shown in the diagram below.  Staple fibres are produced by cutting the filaments into the required length. The thickness of nylon fibre varies from microfibres to coarse fibres – fine and soft to quite firm and coarse.	The process of extrusion (stretching the liquid polyamide through spinnerets up to 3-4 times their original size) gives nylon its strength and resistance to wear. Some of nylon's properties are dependent on how the fibre has been formed: flat or textured filament or a staple yarn and will impact on end use. Nylon fibres: • are strong, with excellent abrasion resistance and tear resistance • are resilient with good elasticity, and crease resistance • have high extensibility – breaking extension is very high both wet and dry • lightweight, hydrophobic and water repellent • are prone to electro static charge unless a finish is used • are thermoplastic and can be permanently shaped using heat • are flammable • are resistant to alkalis, solvents, mould and mildew • have poor absorption although textured filaments can wick away moisture; can be engineered to add breathable comfort in clothing • not biodegradable.

End uses	After care	Blends
Clothing: tights, lingerie, swimwear, linings, sportswear, dresses, weather proof clothing. Carpets, tents, parachutes, ropes, seat belts, umbrellas. Industrial fabrics. Sewing threads	Washable. Quick drying. Iron with care.	Wool Cotton Silk Other synthetics

Nylon Fabrics	Finishes	Testing
Microfibre fabrics Trade names: Antron®, Tactel® Aramids: Kevlar® Nomex®	Anti-static treatment; lame resistant finish; other treatments depending on end-use.	**Burning**: shrinks and melts, fibre forming drips, away from the flame. **Residue**: hard, solid.

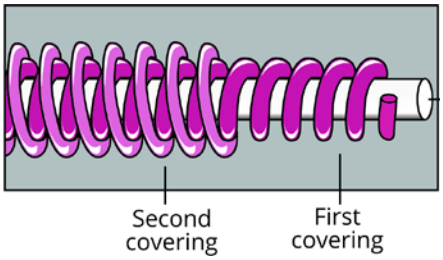
Points for Further Investigation and Discussion
• Compare the properties of nylon (polyamide) with those of polyester. Which is most versatile and why? • Discuss how the processing of nylon changes its properties and functionality in a wide range of textile products. • Polyester fibres are easily recycled. Investigate and discuss the environmental advantages of this fibre.

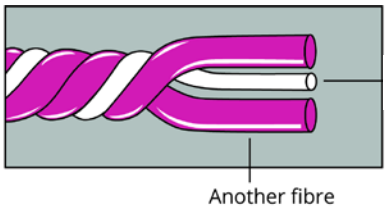
ELASTANE

Source

Elastane is derived from petrochemicals in the form of a continuous filament and is non-renewable. It is made up of a long chain molecule called polyurethane. The polymer is converted into a fibre using a spinning process. Flexible, soft segments are bonded with more rigid hard segments to form the yarn.

The elastane fibre is covered by another yarn as shown in the examples below:





The Dupont company gave the trade name Lycra® to its brand of elastane to distinguish it from other brands.

Properties

Elastane has very high extensibility – up to 7 times its original length – and has the capacity to spring back to the original size when tension is released. It can be stretched repeatedly and return to the original state.

It can be engineered to exact requirements: thickness, texture, brightness and performance to suit the end use of both fabric and product.

The elastane fibre:

- enhances the drape and softness of a fabric
- improves the fit and shape retention in products
- can decrease creasing in some fabrics such as linen
- is absorbent, dyes well and is easy care
- is stronger and more durable than rubber with a higher retractable force
- is resistant to deterioration from body oils, perspiration, detergents and lotions.

End Uses

Used in combination with other fibres – in clothing to improve comfort and fit, swimwear, underwear, hosiery, shoes, medical products, active clothing particularly where comfort and stretch are important. Textile components.

Blends

Combined with both natural and synthetic fibres for example:
20% for swimwear,
15% hosiery,
Up to 5% jersey,
2% woven fabrics,
1% flat knits

After Care

Hand wash or machine wash,
Can be boiled.
Can be dry cleaned.

Points for Further Investigation and Discussion

- Analyse the impact of the fibre elastane (Lycra®) on the functionality of contemporary clothing.
- Discuss the advantages of using elastane in high performance active sportswear.

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ARAMID

Source	Properties
Aramid is the generic name for a group of synthetic fibres developed from petro-chemicals. As aramid fibres can decompose before they melt. They are produced by both wet and dry spinning methods. The normal solvent used in the spinning process is sulphuric acid. In wet spinning the polymer solution is spun through a spinneret into weak acid or water.  Aramid products are available as filament yarn, staple fibre or pulp.	High tech aramid fibres can be engineered to make woven, knitted, non-woven and technical textiles providing strength and heat-resistance. Aramid fibres are five times stronger than nylon. Aramid fibres are: • resistant to abrasion, durable • resistant to organic solvents • heat and flame resistant with no melting point • prone to damage from acids and salts • sensitive to UV radiation • resistant to electrostatic charge and are non-conductive • resistant to solvents and chemicals low shrinkage, easy care and comfortable to wear.

Aramid Fabrics	End Uses
Kevlar® Nomex®	Flame resistant clothing, protective clothing and accessories, body armour. Geotextiles, car industry, aeronautical industry, ropes and cables, high risk sports equipment.

Points for Further Investigation and Discussion
• Investigate the use of aramid fibres to make fabrics that are used to make protective clothing in a wide variety of situations.

ACRYLIC, MODACRYLIC

Source

Acrylic is derived from petrochemicals that are inexpensive to manufacture. They were originally developed as a wool-like substitute.

Acrylic fibres are made from acrylonitrile; they are chopped into staple fibres during the extrusion process in the manufacture of acrylic yarns. They can also be spun as filament fibres and microfibres.

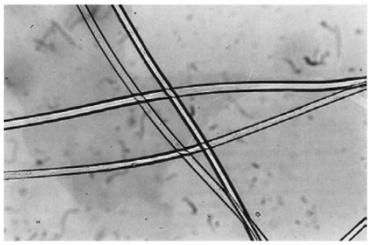
Raw white staple fibres ready for spinning.

There are 3 main types of acrylic:

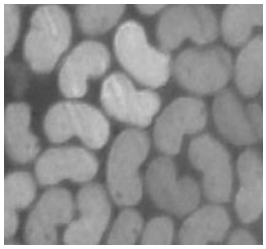
- Normal acrylic – sometimes blended with wool and knitted into fabric for coats, blankets, and furnishings fabrics.
- Modified acrylics or modacrylic – used for protective clothing, curtains and furnishing fabric as it is highly resistant to burning.
- Dunova – the highly porous micro-capillaries (shown below) allow good moisture absorption. Dunova is often used in warm underwear as it absorbs perspiration so well.

Properties

The short staple acrylic fibres are soft and warm and have a wool-like handle trapping air for good insulation.



(Magnified)



(Cross section)

Properties of Acrylic fibres:

- Low absorbency, fast drying but are prone to static
- Good strength
- Good elasticity with crease resistance - thermoplastic
- Soft wool-like handle (developed as wool substitute) with good drape
- Greater insulating power than wool – bulkier in appearance
- Warm to wear
- Easy care
- Resistant to some solvents and acid
- Resisatnt to mildew, mould, larvae and insects
- Thermoplastic – sensitive to heat and steam, can lead to shrinkage.

End uses	Blends	After care	Testing
Blankets, curtains, furnishing fabrics, carpets Micro-fibre performane fabrics Pile fabrics – fake fur, fleece Knitting yarns	Wool Cotton, linen, silk Viscose Polyester Elastane	Machine washable. Quick drying. May shrink – thermoplastic Iron with care – susceptible to heat.	**Burning:** shrinks, melts, burns with sooty smell and drips. **Residue:** sets hard.

Points for Further Investigation and Discussion

- Compare the structure and properties of wool and acrylic. Analyse the use of both fibres when used in clothing.
- Evaluate the use of modacrylic when used in protective clothing.
- List the aftercare symbols that would be included on the care label of a fashion garment made from acrylic.