

# Fiber Technology: Fiber spinning methods

# Basic concepts of textile fibers

It is defined as one of the delicate, hair portions of the tissues of a plant or animal or other substances that are very small in diameter in relation to their length.

**A fiber is a material which is several hundred times as long as its thick.**

- ***Textile fiber*** is a material mainly made from natural or synthetic sources. This material will be converted into the making of textile yarns and fabrics; woven, knitted, nonwoven, and carpets. It may be in a form of a applicable hair like strand or as the smallest visible unit of textile production.<sup>(1)</sup>

Textile fiber has some characteristics which differ between fiber to **textile fiber**.

Textile fiber can be spun into a yarn or made into a fabric by various methods including weaving, knitting, braiding, felting, and twisting.

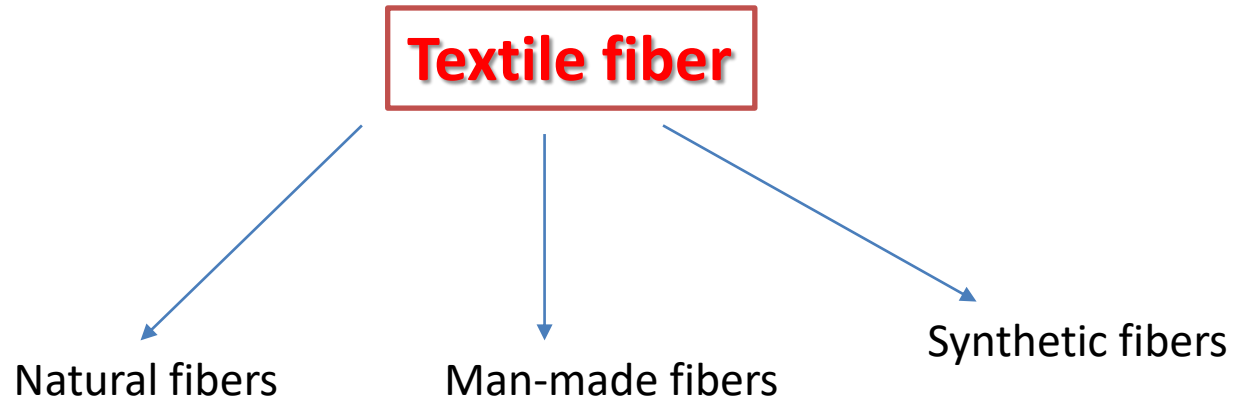
## Classification of Textile Fiber

Since from the past, there are many types of textile fiber that have been used or developed in textile production such as cloth, rope, household and etc. In textile industry, fiber can be classified into two different types based on their sources which are Natural fiber and Synthetic fibers.

**Classification of textile fibers can be done in many ways. Some of them are as follows:**

1. Classification according to their **nature and origin**.
2. Classification according to botanical/zoological/chemical name.
3. Classification according to the ability to attract water, i.e. moisture absorption.
4. Classification according to their thermoplasticity.
5. Classification according to their utility.

## Classification according to their nature and origin



**Natural fibers** are those fibers which are available from the natural sources, viz. plants, animals, minerals, etc. The mineral fibers are also referred as miscellaneous inorganic fibers.

**Manmade fibers** are those fibers which are developed by man. Man possesses a natural instinct of imitating nature and its products. Textiles are no exception to it. He does it either using some natural resources and/or chemicals to produce fibers, artificially.

## Natural fiber

It is a fiber made from a material originated from natural sources. There are three main sources that can be obtained to produce this kind of fiber. *Cellulosic fiber* (origin from plant), *Protein fiber* (origin from animal) and also *Mineral fiber*. This kind of fiber could only produce a staple yarn (short fibers) in terms length which is not too long compare with Synthetic fiber.

The dimensional structure of Natural fiber would be in hairiness surface because of their origin. Each kind of them has their own characteristic and end-use demands. [2] [4]

Unlike the other two sources, *Mineral fiber* is obtainable from varieties of rock source which is also known as *asbestos fiber*. It is a fibrous form of silicate made of magnesium and calcium. However, because of the risk of health problem may occur the production of asbestos in textile industry have been decline [5]

## Synthetic Fiber

The term *Synthetic fiber* refers to materials that is not originated in natural sources but are developed by human by using chemical and mechanical process. Thus, Synthetic fiber is well-known as the **Man-made fiber**. Unlike Natural fiber, the properties of this fiber can be determined or controlled early before the production occurs. Unlike natural, Synthetic fiber is produce in a filament yarn or filament staple yarn base on the end-use. The dimensional appearance can be varies according to the demands usage and in fact, it can be as same-like appearance and properties as the Natural fiber. <sup>[4]</sup>

“Synthetic based fiber” refers to a fiber that has been made totally by the man-made process by using chemical substance as the sources. The properties of it will be determined totally at the initial for their demands by the manufacturer.

Synthetic fibers can also be classified in two groups, viz. **(a)** Heterochain fibers, e.g., polyester, polyamide, polyurethane, polyurea fiber, etc., **(b)** Carbochain fibers, e.g. polyacrylonitrile, polyvinyl alcohol, polyvinyl chloride, polyolefin and special purpose fluorine, etc., containing fibres.

The macromolecules of heterochain fibres contain in their main chain carbon atoms and atoms of other elements, such as, oxygen and nitrogen. These polymers are usually obtained by polycondensation or polymerization of cyclic compounds.

The macromolecules of carbochain fibers have a carbon skeletal chain, i.e., they contain only carbon atoms in the main chain. Such polymers are obtained by polymerization.

# Spinneret

During synthetic fiber production, the polymer that will be used in the fiber preparation is transformed to “**polymer wires**” by passing through its melt or solutions from a mold. This process is called **fiber spinning**. **Spinneret** is a type of mold containing lots of very tiny pores/holes inside. It can be made up of metals or glass. The numbers of pores, its diameter and shape vary depending on the usage purpose.

## Filament



The polymer that is passed from spinneret rapidly formed into polymer wires in infinite/endless length. Each of these untreated wires are called **filament**. The filament concept also fulfills the requirements for the definition of textile fiber. If the filament is composed of one filament, then it's called as **monofil** ( sounds like monofilament), if it is composed of a few numbers of filaments, then it's called **multifil** (or yarn/thread).



- The fibers of toothbrushes, the fish line, and some thin socks are made up of monofilaments.

? Homework: which polymer materials can be used in the preparation of these products?

**staple** : these are the fibers whose lengths are not continuous.

E.g: wool, cotton

**continuous fiber**: the length of these fibers are accepted as infinite. Synthetic fibers

? Homework: Is there any example for continuous fiber in the natural fibers?

The length/diameter ratio of natural fibers varies between certain ranges in the natural fibers. E.g this ratio is between 1000-3000 for cotton and wool.

- Properties of fibers can be divided under three main topics:

A) Physical Properties

B) Mechanical Properties

C) Chemical Properties

- To define a material as a fiber, the basic property that should be taken into account is length/width ratio.
- Remind? What should be this ratio value?

- **Primary properties of textile fibers:**

- \*\*\*High length to width ratio

- Tenacity

- Flexibility

- Spinning quality (Cohesiveness)

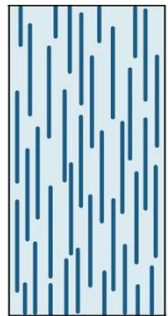
- Uniformity

## Orientation:

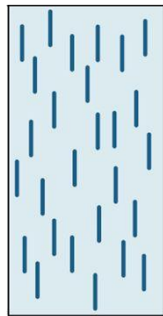
This concept is generally used for the assembly of the polymer chains horizontally (parallel). When the products obtained from polymers in the form of fiber, film, and etc. are exposed to tensile force in the any direction, the polymer chains are oriented in the tensile force direction.

With the help of these,

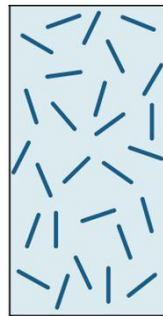
1. The polymer chains get closer,
2. The second interactions between polymer chains increase,
3. The mechanical properties of polymer such as breaking force improve,
- 4.the crystallinity of the polymer increases.



(a)



(b)



(c)

