TEXTILE FIBRES

Any substance, natural or manufactured, with a high length to width ratio and with suitable characteristics for being processed into fabric; the smallest component, hair like in nature, that can be separated from a fabric.

Properties of Textile Fibres:

Primary properties of textile fibres:

High length to width ratio
Tenacity
Flexibility
Spinning quality (Cohesiveness)
Uniformity

Secondary properties of textile fibres:

Physical shape
Elastic recovery and elongation
Resiliency
Flammability and other thermal reactions
Density
Lusture
Colour
Moisture regain

Primary properties of textile fibres:

High length-to-width ratio:

Fibrous materials must possess adequate staple (fibre length) and the length must be considerably greater than the diameter. The length is a very important fibre property. Natural fibres, except for silk, are mostly some millimeters up to several centimeters long. Synthetic fibres are actually filaments (indefinite length) or are chopped into (shorter) staple fibres, which can, in their turn, be spun.

Flexibility:

Flexibility is the property of bending without breaking that is the third necessary characteristic of textile fibre. In order to form yarns or fabrics that can be creased, that have the quality of drapability and the ability to move with the body and that permit general freedom of movement, the fibres must be bendable, pliable or flexible. The degree of flexibility determines the ease with which fibres, yarns and fabrics will bend and is important in fabric durability and general performance.

Spinning quality (Cohesiveness):

This characteristic refers to the ability of the fibre to stick together in yarn manufacturing processes. Cohesiveness indicates that fibres tend to hold together during yarn manufacturing as a result of the longitudinal contour of the fibre or the cross-section shape that enables the fibre to fit together and entangle sufficiently to adhere to one another.

Uniformity:

To minimize the irregularity in the final yarn, it is important that the fibres be somewhat similar in length and width i.e. be uniform. The inherent variability in the natural fibre can be averaged out by blending natural fibres from many different batches in order to produce yarn that are uniform.

Secondary properties of textile fibres:

Physical shape (fine structure and appearance):

The fibre shapes i.e. the surface structure is important for the fibre behaviour in a yarn and in a fabric. A rough scaly surface of wool fibres, for example, influences the felting and shrinkage properties of wool fabrics. The scales enable fibres to grip one another when a yarn is spun.

The smooth, glassy surface of a fibre such as the nylon fibre, affects the lustre of the fibre. A smooth surface will not cling to dirt so readily. The cross-sectional shape of a fibre influences the behaviour of the fabric. A circular or near-circular cross-section (wool) gives an attractive or comfortable feel as compared to a flat, ribbon-like cross-section (cotton). Circular fibres often have a poorer covering-power than the flatter or triangular ones. A flat or triangular cross-section gives more lustre. Serrated or indented cross-sections (viscose) give better colour absorption as a result of the larger area. More colour is also needed in the case of fine filaments. The latter also give a softer handle or feel.

Elastic recovery and elongation:

A fibre, which is subjected to a force, will stretch to a certain degree. This stretching can also be expressed as a percentage of the original fibre length, which is the elongation. The elongation of

a fibre may be measured at any specified load or as the elongation reached when the fibre breaks.

When a fibre is subjected to a small force (or stretched to a small degree), it may exhibit almost perfect elasticity. Elasticity is the property of a fibre to recover its original length after stretching caused by a load.

The term breaking elongation refers to the amount of stretch that occurs to the point where the fibre breaks. Elastic Recovery designates the percentage of return from elongation or stretch toward the original length or measurement. If a fibre returns to its original length from a specified amount of attenuation, it is said to have 100% elastic recovery at X% elongation.

Resiliency:

It is the ability of a fibre to return to shape following compression, bending or similar deformation. It is important in determining the crease recovery of a fibre or fabric, and it plays a significant role in the rapidity with which flattened carpet pile will regain its shape and restore its appearance.

Resilience is the property of a fibre which enables it to recover from a certain load or stretched position and flexibility is that property to resist repeated bending and folding. A supple fibre has a low resilience and is easily compressible. A stiff fibre has a high resilience and cannot be easily compressed.

Flammability and other thermal reactions:

Burning characteristics of the fibres are important in determining care and use, and they serve as helpful guidelines in the fibre identification. Federal legislation on textile inflammability is an important consumer issue and a variety of types of textile end-use products must meet a specified resistance to flames.

All fibres are affected in one-way or another as they are heated. Some, like wool, begin to decompose before melting; others, like polyethylene or acetate will soften and melt before decomposition sets in. The behaviour of fibres on heating and their ignition properties are of great practical importance. Indeed, fabrics should withstand the temperatures used in ironing, laundering (with water or solvent) etc. Since synthetic fibres are thermoplastic substances (i.e. they will soften as they are heated), this softening will largely determine their practical usefulness.

In the presence of air, most fibres will burn. In this context, the term LOI is used. It stands for Limiting Oxygen Index. The higher the value of LOI, the more difficult a substance will ignite since LOI is a measure of the amount of oxygen which has to be present in the air to let a substance (continue to) burn. On average, most substances have an LOI of about 20. Efforts are made to reduce the flammability of textile materials in order to limit accidents. These efforts are

The staple length of natural fibres is not an easy property to define because the fibre length can vary over a great area. A statistical interpretation of the data obtained on fibre length in a laboratory, makes it possible to determine the staple length (an average length). In order for a fibre to be spinnable, i.e. to be twistable, and therefore offer sufficient cohesion to the whole, a fibre must at least have a length of 5 to 15 millimetres. Fibres which are longer than 150 millimetres require specialized spinning machines which make the spinning process more expensive.

The most common natural fibres have a ratio length / thickness which equals one thousand or several thousands (cotton: 1500; wool: 3000; flax: 1200). Coarser fibres such as jute and sisal have ratios between 100 and 1000. When filaments of man-made fibres are chopped into shorter fibres, an effort is made to bring the ratios close to those of natural fibres, i.e. between 1000 and 4000.

Tenacity:

Second necessary property for a product to qualify for textile fibre is adequate strength, termed as tenacity. Tenacity is defined as the tensile stress expressed as force per unit linear density of the unstrained specimen.

The strength of a fibre is generally dependent on the length of the polymer chain, the degree of orientation of these polymer chains, the strength and types of the forces of attraction between the polymer chains (interpolymer forces). The longer a polymer chain is, the higher the degrees of orientation and crystallization and, hence, the stronger the interpolymer forces. Crystalline systems feel stiff and present less resistance to repeated bending or folding. Stronger fibres will lead to stronger yarns under the appropriate conditions of twist.

The tensile strength or breaking load is commonly described as the force required to reach break.

In the case of a fibre, the strength is described as tenacity (specific stress at break)

$$\text{Tenacity} = \frac{\textit{breaking load}}{\textit{mass per unit length}}$$

Tenacity is expressed in terms of (centi)newtons per tex (cN/tex or N/tex).

It is important to note that the fibre strength does not always indicate comparable yarn or fabric strength. Fibres with high strength are useful in seer and lightweight fabrics. Fabrics used in work cloths and various industrial applications are better from high tenacity fibres. Fibre tenacity does not always reflect the actual strength of textile yarn. It is possible for yarns to be made so that fibre slippage occurs; this does not make optimum use of the actual fibre tenacity.

made both in the field of synthesis of fibres (chemical modification) and, afterwards, by using substances which slow down or resist burning.

Chemically speaking, vegetable fibres have almost identical composition, and consist of cellulose, which is a combination of carbon, hydrogen and oxygen. They all burn as paper or wood, ignite readily, leave little or no ashes and release a distinctive fire smell of burnt paper.

Fibres of animal origin also have a similar chemical composition; they all contain nitrogen and will therefore not easily burn through. They shrivel and form charred ashes. They leave a fire smell of burnt feathers.

Exceptions are weighted natural silk (leaves ashes which keep the form of the yarn) and acetate where introducing acetate groups in the polymer chains makes the fibre melt before it can ignite.

Man-made fibres based on protein burn as fibres of animal origin. Fully synthetic fibres melt without ignition.

Density:

Fibres with different densities but of equal diameter will have different covering power that is the ability to cover a surface. Fabrics made with fibres of different densities will have difference in fabric appearance, flexibility, air permeability and cover.

The density, also called volumic mass or mass density, is the mass per unit volume and has ρ as its symbol. It is usually expressed in grams per cubic centimeter. Another term is specific gravity, which is the ratio of the mass of a fibre material and the mass of an equal volume of water (density $1g/cm^3$). The specific gravity of a substance vis-à-vis water equals the numerical value of the (absolute) density of this substance if it is expressed in g/cm^3. Every fibre is characterized by its density, which can be measured in various ways.

Measurement of density can be carried out with a gradient column, where the liquid in the tube has a density which varies in height. If a fibre is dropped in the tube, it will sink to the point at which the fibre density equals the liquid density, and remain suspended there.

This experiment is based on the fact that a fibre which is submerged in a liquid with the same density will sink nor drift but float, and that the density of a liquid can easily be measured. Treatments for finishing fibres, can influence the results. Foreign substances on or in the fibres must be removed before doing the experiment.

The list below gives an overview of the most important fibres and their densities.

Textile Fibres	Fibre densities in g/cm^3	Commercial name
Cotton	1.55	Raw
Cotton	1.54	Mercerized
Flax	1.50	
Jute	1.50	
Wool	1.30	No brand
Silk	1.33	Natural
Silk	1.60	Weighted
Silk	1.32	Tussah
Polyester	1.22	Kodel, vestan
Polyester	1.38	Teryleen, Dacron
Viscose	1.53	
Cuprammonium	1.53	
Polyurethane	1.15	Lycra
Polypropylene	0.90	Meraklon
Polyethylene	0.92	Courlene
Polyethylene	0.95	Courlene X3
Nylon 6	1.13	Perlon
Nylon 66	1.14	Tri-nylon
Acryl	1.14 – 1.17	Orlon (staple/filament)
Polyvinyl alcohol	1.30	Kuralon, vinal

Lusture:

It refers to the gloss, sheen or shine that a fibre has. It is the result of the amount of light reflected by a fibre, and it determines the fibre's natural brightness or dullness.

Colour:

Natural colour of fibres vary from pure white to deep gray, tan or black. Man-made fibres are usually white or off-white as they are produced.

Moisture regain or effect of moisture:

All fibres tend to absorb moisture when in contact with the atmosphere. The amount absorbed depends on the relative humidity of the air.

For absorption of moisture of a fibre, the term regain is used. This is the amount of moisture present in a textile material expressed as the percentage of the oven-dry weight (dry weight) of the textile. This dry mass is the constant weight of textile obtained after drying at a temperature of 105^{0}C to 110^{0}C. If B is the dry weight and A is the conditioned weight (the weight after being in a normalized atmosphere of 20^{0}C and 65% relative humidity), the regain expressed in percentage will be:

$$\text{Moisture Regain} = \frac{A-B}{B} \times 100$$

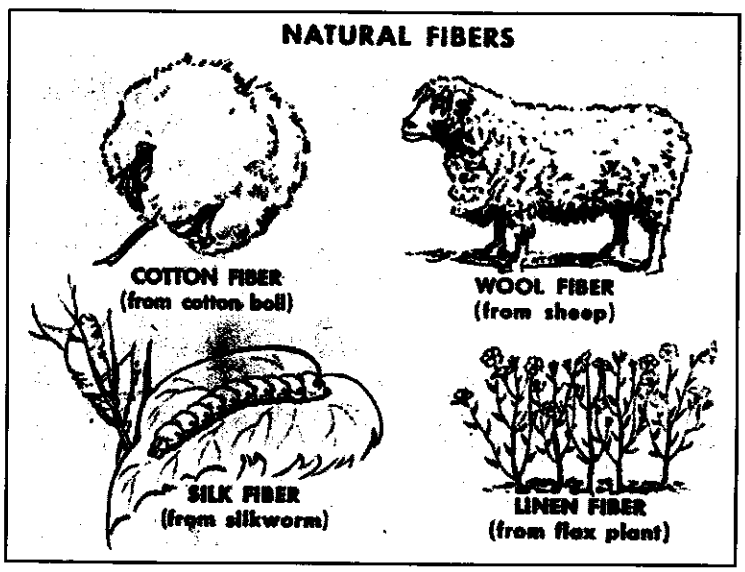
Another relevant term is moisture content and, expressed in percentage, is:

$$\text{Moisture content} = \frac{A-B}{A} \times 100$$

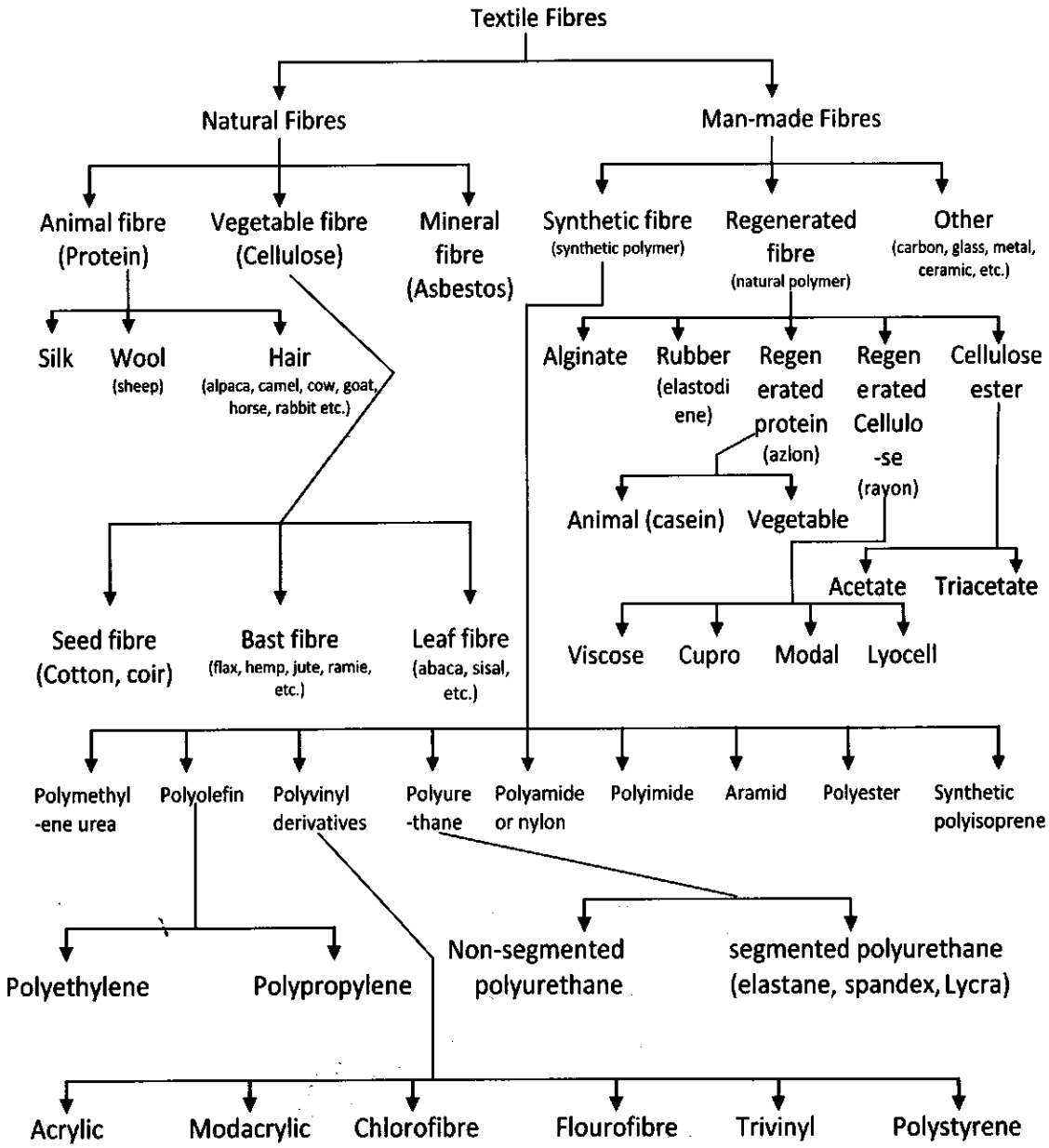
The moisture content is the mass of moisture in a fibre and is expressed as a percentage of the total weight. It is a measure of the amount of water held under any particular set of circumstances. The moisture content is always lower than the regain.

Fibres can present great variations in the amount of moisture they will absorb. Wool has a regain of 16%, cotton of 8.5%, acetate only of 6%. Fibres, which can absorb sufficient moisture, are most suitable for processing into clothing because they will absorb perspiration from the body and will hold considerable amounts of moisture without feeling clammy. The ability of a fibre to a bsorb moisture will also affect the processing and finishing of fibres. Fibres which easily absorb moisture, will therefore let dyestuffs penetrate more easily during the dyeing process. Synthetic fibres, which often absorb little moisture, are easily washed and dried by comparison with fibres, which absorb a lot of moisture. On the other hand, this entails the phenomenon of electrostatic charging.

The strength of a fibre is affected significantly by the water it absorbs. Fibres, which easily absorb moistu re, will usually be less strong when wet (except for flax an cotton) and will present increased elongation at break. One should also realize that absorption of moisture can also make the fibre swell to a considerable degree, which is important for fixating dyestuffs.



Classification of Textile Fibres:



Fibre Identification:

The identification of textile fibres is a very important part of the study of textile science. At one time, simple fibre identification was a relatively easy task; most consumers could tell by appearance and hand whether a fabric was cotton, wool, silk, or linen. Once the first manmade fibres were introduced, the process became a bit more difficult. Consumers usually could identify the fibre composition of fabrics made of 100 percent rayon or acetate, but blends of some fibres were difficult to identify. As more fibres were introduced, the task became progressively more difficult. Today, sophisticated techniques are usually required for accurate fibre identification.

The purpose of the Textile Fibre Products Identification Act was to provide information on fibre content of textiles at the point of sale. Consumers were at once relieved of the responsibility to identify fibre content of items they purchased; however, professionals working with textile products still must be able to identify fibres accurately. Such individuals include retailers who suspect some textile products they bought for resale have been labeled inaccurately; customs officials who must identify imported fibres; dry cleaners who must clean an item from which all the labels have been removed; extension home economists who are asked to help solve a consumer's problem with a textile product; and forensic scientists who must use a textile sample to help solve a crime.

For most individuals, the only information needed is a qualitative analysis of fibre content: what fibre or fibres are present in this product? For others, a quantitative analysis of the product is also important: in what percentages are the fibres present? With the numbers of fibres available today and the variety of blends being produced, neither analysis is easy.

Methods for qualitative identification of fibres include such procedures as burning tests, microscopy, density determination, moisture regain analysis, dye staining, chemical solubility, melting point determination, infrared spectroscopy, and chromatography. Simplified versions of the first six procedures are relatively easy to perform in most laboratories. They require the use of a drying oven, an analytical balance sensitive to 0.005 gram, a compound light microscope capable of 200 × magnification, laboratory glassware, and a supply of chemicals.

A. Burning Test:

The burning test is a good preliminary test for categorizing fibres. Observation of burning provides information on behavior in a flame, smoke generation, odor during burning, and ash or residue. It never should be used as the only method of identifying a fibre, but it provides valuable information that may be used with other evidence to make a positive identification of an unknown fibre.

Blends of fibres are difficult to test using this procedure. The reaction of the predominant fibre may mask the presence of a second fibre, which could have entirely different burning characteristics. Finishes, especially flameretardant finishes, can also give misleading information. Although the test is easy to perform, it does involve the use of an open flame, making it necessary to observe certain safety precautions. Use a small flame source in an area where there is no danger of igniting other materials. A candle in a stable base or a small alcohol lamp is preferable to a hand-held match. A nonflammable pad should be used under the burning material to provide protection from molten drip and smoldering ash. Do not touch ash or tweezers while they are still hot.

Procedure:

The sample to be tested should be in fibre form. A single yarn from a woven or knitted fabric should be untwisted to produce a tuft of fibres for testing. Use the following instructions, and observe the reactions of the burning fibre very carefully.

1. Hold the tuft of fibres with a pair of tweezers.
2. Move the tuft close to the side of the flame; do not place the fibres above or below the flame. Observe carefully to see if the fibres melt, shrink, or draw away from the flame.
3. Slowly move the fibre tuft into the flame to observe its burning behavior, and then slowly and carefully remove the tuft from the flame to observe the reaction once the flame source is no longer present. Careful observation provides an answer to these four questions: (a) When introduced to the flame, does the fibre burn rapidly or slowly, or does it show no sign of ignition? (b) Does the material begin to melt? (c) Does the material produce a sputtering flame, a steady flame, or no flame at all? (d) When the fibre is removed from the flame, does it continue to burn, or does it self extinguish?
4. If the material is still burning when it is removed from the flame, blow out the flame. Note the odor and colour of the smoke, or note that no smoke was produced when the fibre was removed from the flame.
5. Observe the residue remaining after burning. Does a residue drop from the tweezers? Does that residue continue to burn? How much residue is left? Does the residue remain red, indicating that it is still very hot? What colour is the ash that remains? Is the ash the shape of the fibre, light and fluffy, or is it bead-shaped?
6. After it cools off, touch the residue or ash. Is it soft or brittle? Can it be crushed easily between the fingers, or is it hard to crush?

Results:

Typical fibre reactions for the major natural and manmade fibre types are given in the following table. When interpreting results, remember:

1. It is difficult to detect the presence of blends with a burning test. One fibre in a blend may completely mask the proper ties of another fibre.
2. Dyes and finishes affect test results. Flame-retardant finishes are especially misleading.
3. Coloured fibres, especially those produced with pigments, may retain the colour in the ash or residue.

Table for burning characteristics of fibre:

Fibre	Approaching flame	In flame	Remove from flame	Odor	Residue
Cotton & flax	Does not shrink away; ignites on contact with flame	Burns quickly	Continues to burn; afterglow	Similar to burning paper	Light, feathery; light to charcoal gray in colour.
Rayon	Does not shrink away; ignites on contact with flame	Burns quickly	Continues to burn; afterglow	Similar to burning paper	Light, fluffy ash; very small amount
Polyester	Fuses; melts & shrinks away from flame	Burns slowly & continues to melt; drips	Self-extinguishes	Chemical odor	Hard, tough gray or tawny bead
Acrylic	Melts & fuses away from flame; ignites readily	Burns rapidly with hot flame & sputtering; drips, melts	Continues to burn; hot molten polymer drops off while burning	Acrid	Irregularly shaped, hard black bead
Nylon	Melts away from flame; shrinks, fuses	Burns slowly with melting, drips	Self-extinguishes	Cooking celery	Hard, tough gray or tan bead
Olefin	Fuses; shrinks & curls away from flame	Melts; burns slowly	Continues to burn	Chemical odor	Hard, tough tan bead
Wool	Curls away from flame	Burns slowly	Self-extinguishes	Similar to burning hair	Small, brittle black bead
Silk	Curls away from flame	Burns slowly & sputters	Usually self-extinguishes	Similar to singed hair	Crushable black bead(unweighted) Shape of fibre or fabric (weighted)
Spandex	Fuses but does not shrink away from flame	Burns with melting	Continues to burn with melting	Chemical odor	Soft, sticky, gummy mass

B. Light Microscopy Test:

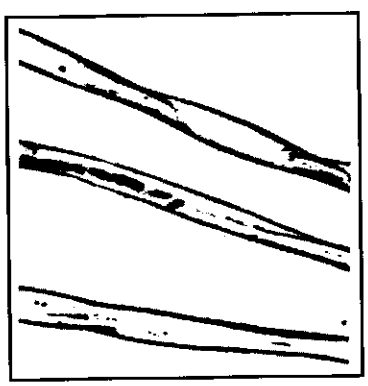
A compound microscope capable of at least 200× magnifications is required for fibre identification. A magnification of 200× may be adequate for tentative identification, especially of the natural fibres, but is not adequate for viewing the details of fibre structure. The lens and objectives of the microscope, as well as the slides and cover glasses, must be clean and free of scratches. The light source should be adjusted for maximum visibility prior to looking at prepared slides. Have materials at hand to sketch the fibres viewed, and have access to a source of photographs of known fibres to make comparisons for identification. The following figure shows the longitudinal and cross-sectional views of the most common fibres.

Longitudinal mounts:

It is possible to mount a single fibre, but it is less frustrating for most microscopists to use several fibres. A minimum of ten fibres is useful when the material to be studied is a blend. Too many fibres on a slide makes it difficult to focus on a single fibre to observe the details of its surface contour. When taking a sample from a yarn in a fabric, untwist the yarn completely to separate the fibres. The basic steps for making a longitudinal mount are as follows.

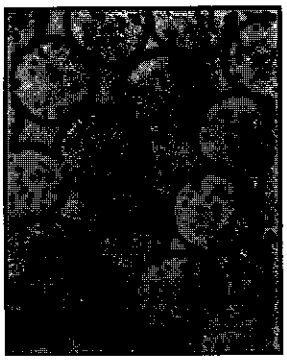
1. Place a single drop of water, glycerine, or mineral oil on the center of the glass slide. Mineral oil provides the best definition, but the other materials are adequate.
2. Carefully place the fibres in the drop of liquid with the length of the fibres parallel to the long dimension of the slide.
3. Place the cover glass lightly over the drop of liquid and the specimen. Tap the cover glass gently to remove air bubbles.
4. With the objective in its highest position, place the slide on the stage of the microscope. Lower the objective carefully before trying to focus the slide. It is very easy to damage the objective by scratching it or smearing it with oil.
5. Focus on low power and observe the fibre before focusing on high power. Note the general shape of the fibre, then look at it carefully for signs of scales, convolutions, pockmarks, striations, and other features. Look carefully to see if more than one type of fibre is present.
6. With the microscope focused on high power, move the fine adjustment very slowly to see if variations in surface contour are visible. Again, look carefully to see if more than one fibre type is present.
7. Sketch the fibres as seen through the microscope, then compare your sketch with standard photographs to conclude which fibres might be present.

Regular cotton (X-section)



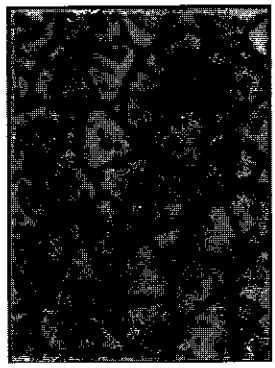
Regular cotton (longitudinal view)

Mercerized cotton (X-section)

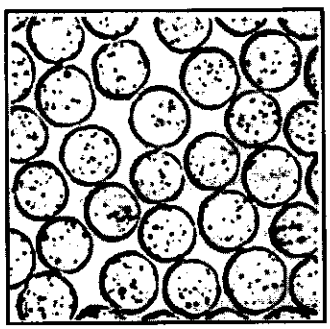


Regular polyester
(X-section)

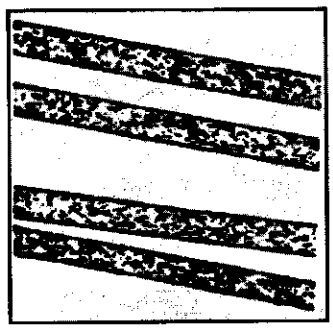
Regular polyester
(longitudinal view)



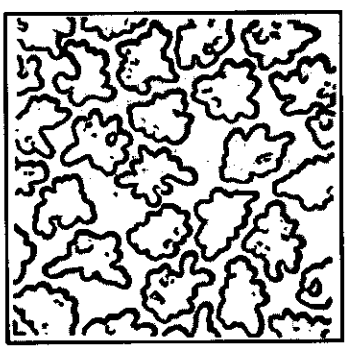
Trilobal polyester
(X-section)



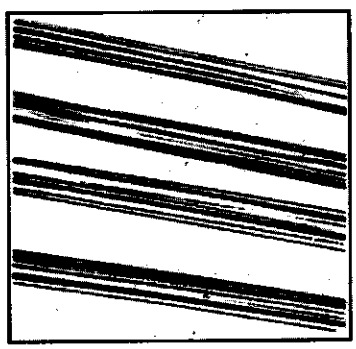
Delustered Nylon 6 (X-section)



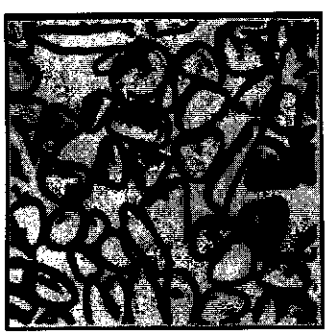
Delustered Nylon 6 (longitudinal view)



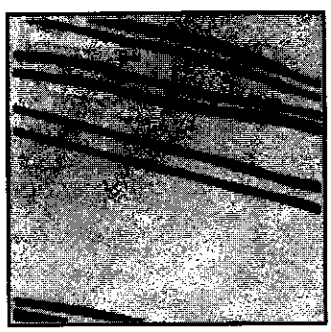
Regular viscose rayon (X-section)



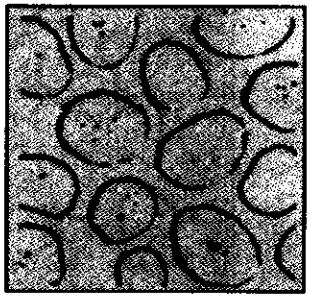
Regular viscose rayon (longitudinal view)



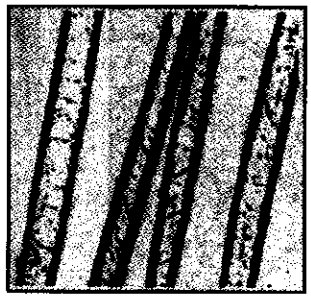
Silk (X-section)



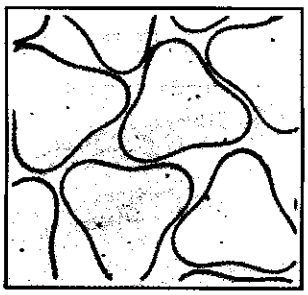
Silk (longitudinal view)



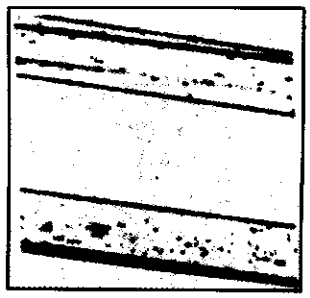
Merino wool (X-section)



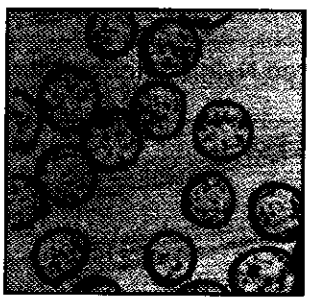
Merino wool (longitudinal view)



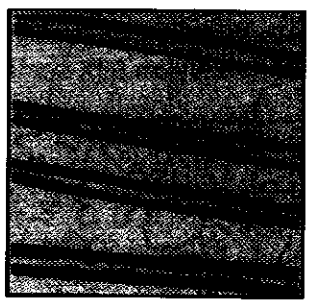
Trilobal nylon 6,6 (cross section)



Trilobal nylon 6,6 (longitudinal view)

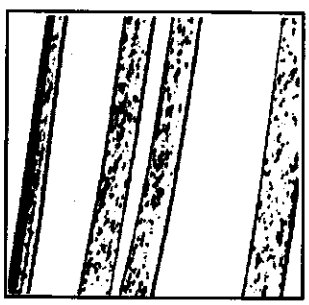


Polypropylene (cross section)



Polypropylene (longitudinal view)

Orlon Acrylic (cross section)



Orlon Acrylic (longitudinal view)

Cross-sectional mounts:

Special plastic and metal plates are available for making fibre cross-sections. Special fibre microtomes are used for more sophisticated work. Where such aids are not available, it is possible to make a section using a piece of cork, a threaded sewing machine needle, and a sharp single-edge razor blade. The instructions follow.

1. Use a small piece of fine-grain cork no more than 1 cm (0.5 inch) thick. Cut so that it is flat on one side. The cork wedge should be of a diameter small enough to slice easily.
2. Thread the sewing machine needle, and carefully force the point of the needle through the cork until a loop of thread can be formed.
3. Form a thread loop around your finger and pull the needle back through the cork. The needle may then be removed; it was needed just to push the thread through the cork to form the loop.
4. Make a small bundle of fibre ti fit through the thread loop. Then, using the free ends of the thread, carefully pull the looped fibre back through the cork. The fibre should be packed firmly in the hole of the cork, and fibre ends will be visible on both sides of the cork. After a little practice, estimation of the exact amount of fibre to use becomes easier
5. Place the flat side of the cork down on a cutting board and use the razor blade to cut a thin slice perpendicular to the fibre embedded in the cork. The slice should be no more than 0.5 mm thick. Make the cut with a single, continuous motion, not a sawing motion.
6. Place the cork slice on a glass slide. Do not use a mounting medium or cover glass. Focus the microscope and observe the cross sections of the fibres.

Results:

Look carefully at the shape of the fibre, and compare it with photomicrographs of known fibres. Most natural fibres can be identified by simple light microscopy, but positive identification of manufactured fibres is often difficult with this technique. When a fibre blend is present, it is possible to approximate the blend level by counting the fibres. Microscopy is also a good way to determine the number of fibres present in a blend.

C. Chemical Solubility Tests:

Chemical solubility tests are necessary to identify most manufactured fibres. They are usually performed after burning tests and microscopic examination of the fibres. Preliminary burning tests usually provide some information about the specific fibres that may be present or the fibres that are definitely not present, and microscopy provides information on the number of fibres to be identified and the predominant fibres in a blend.

The solubility procedure described in this section is based on the chemicals specified in the AATCC (American Association of Textile Chemists and Colourists) qualitative identification test method. In some instances, the term solubility is a misnomer as the material does not dissolve, but merely degrades. A material that dissolves in a solvent can be recovered from that solvent, whereas a material degraded by a solvent breaks apart but does not dissolve, and so cannot be recovered from the solvent. When observing solubility tests for fibres, it is not always possible to determine whether a fibre has actually dissolved or has merely disintegrated.

All chemical tests should be conducted in a room with proper ventilation and chemical safety protection devices. The required Material Safety Data Sheet (MSDS) for each chemical should be posted in areas where the chemical is used. Although only very small amounts of chemicals are needed for testing, accidents sometimes happen. Adhere to chemical safety rules in performing fibre identification tests. Wear protective eye goggles when using chemical solvents. Organic solvents and heated liquids should be used only in a fume hood! Follow local laboratory regulations for disposing of used solvents and fibres.

Procedure:

The following **Chemicals used for solubility test** table lists the chemicals and test conditions used in chemical solubility testing. When there is no prior knowledge of the fibres that may be present, the material should be tested in the solvents in the order presented in the table. Once a positive identification is made, solvent testing may be terminated. Where prior information indicates that certain fibres may be present, test the unknown fibre only in those solvents required for its identification. The general procedure for solvent identification follows.

1. When solvents are used at room temperature, the tests may be performed in a watch crystal, a 50-ml beaker, or a small test tube. Place a small amount of the fibre in the container and add the solvent. Use about 1 ml of solvent for 10 mg of fibre.

Chemicals used for solubility test:

Chemical	Concentration (%)	Temperature (°C)	Minutes
1. Acetic acid	100	Room	5
2. Acetone	100	Room	5
3. Sodium hypochlorite	5	Room	20
4.hydrochloric acid	20	Room	10
5. Formic acid	85	Room	5
6. 1,4-Dioxane[a]	100	101	5
7. m-Xylene[a]	100	139	5
8. Cyclahexanone[a]	100	156	5
9. Dimethylformamide[a]	100	90	10
10. Sulfuric acid[a]	59.5	20	20
11. Sulfuric acid[a]	70	38	20
12. m-Cresol[a]	100	139	5
13. Hydrofluoric acid[b]	50	Room	20

[a]Use in a fume hood.
[b]Use a nonglass beaker.

2. Tests performed at the boiling point of the solvent require the use of a ventilated fume hood. Pour the solvent into a small beaker and place the beaker on a hot plate inside the fume hood. Adjust the temperature of the hot plate to maintain a slow boil. Add the fibre to the boiling liquid. Watch the reaction carefully to make sure the solvent does not boil dry. Never add additional solvent to the heated beaker!
3. For tests conducted at intermediate temperatures, heat a beaker of water on a hot plate under the fume hood, and adjust the temperature using a thermometer. Place the fibre and solvent in a test tube, then set the test tube in the beaker of heated water.

4. Watch the fibre in the solvent carefully to observe the speed with which it breaks down and the amount of the material dissolved. Note whether the material actually dissolves, degrades into small pieces, or forms a plastic mass. If all fibres are not dissolved in a specific solvent, carefully remove the undissolved fibres. Rinse them in water, and attempt to dissolve them in another solvent.

Results:

The following **Solubility of Fibres** table provides fibre solubility test results. Compare the results to identify a fibre. Some of the chemicals in the table are commonly found in the home. Other household products containing similar solvents will also damage or dissolve fibres. Acetone is often a component of nail polish, nail polish remover, paint thinners, and paint removers. Amyl acetate, a similar chemical, may damage acetate, modacrylic, and vinyon fibres. Vinegar is a dilute solution of acetic acid; it does not dissolve fibres, but it may damage the same fibres that are dissolved by glacial acetic acid.

Solubility of Fibres (Chart for finding the solvent of a particular fibre)

Fiber	Acetic acid	Acetone	Sodium hypochlorite	Hydrochloric acid	Formic acid	1,4-Dioxane	m-Xylene	Cyclahexanone	Dimethylformamide	Sulfuric acid (59.5%)	Sulfuric acid (70%)	m-Cresol	Hydrofluoric acid
Acetate	S	S	I	I	S	S	I	S	S	S	S	S	—
Acrylic	I	I	I	I	I	I	I	I	S	I	I	P	I
Aramid	I	I	I	I	I	I	I	I	I	I	I	I	I
Cotton	I	I	I	I	I	I	I	I	I	I	S	I	I
Flax	I	I	I	I	I	I	I	I	I	I	S	I	I
Glass	I	I	I	I	I	I	I	I	I	I	I	I	S
Nylon	I	I	I	S	S	I	I	I	N	S	S	S	—
Olefin	I	I	I	I	I	I	S	I	I	I	I	I	—
Polyester	I	I	I	I	I	I	I	I	I	I	I	S	I
Rayon	I	I	I	I	I	I	I	I	I	S	S	I	I
Saran	I	I	I	I	I	S	S	S	S	I	I	I	I
Silk	I	I	S	I	I	I	I	I	I	S	S	I	—
Spandex	I	I	I	I	I	I	I	I	S	SP	SP	SP	—
Vinal				S	S	I	I	I	I	S	S	I	—
Vinyon	I	S	I	I	I	S	S	S	S	I	I	S	—
Wool	I	I	S	I	I	I	I	I	I	I	I	I	I

S = soluble. I = insoluble. SP = partially soluble. N = nylon 6, soluble; nylon 6,6, insoluble.

Sodium hypochlorite, which has about 5 percent available chlorine and a p^H of about 11, is the active ingredient in undiluted household chlorine laundry bleaches. Some laboratories use undiluted bleach as the chemical reagent in fibre solubility tests instead of mixing a 5 percent sodium hypochlorite solution.

Cresol is sometimes a component of household disinfectants and antiseptics. It is not present in a sufficiently high concentration to dissolve fibres, but it may damage acetate, acrylic, modacrylic, nylon, nytril, polyester, spandex, and vinyon fibres.