Chapter 1

Fibre, Yarn and Fabric

1.1 Text

What is a fibre

Fibres are the foundation of textile industry. All textiles are made up of fibres. All of the production flows and formulae in textiles wet processing stages including pre-treatment, dyeing, printing and final finishing are designed and conducted on the basis of the properties of the fibres from which the textiles are made. So it is necessary for us to review the fibre's definition and properties before we discuss the wet treatment of textiles.

What is a fibre? Fibre is the smallest visible unit of matter that has a high length to diameter ratio, fineness and flexibility.

The above definition for textile fibres is very broad. So many things are demanded of fibres in many different uses[1]. However, some characteristics can be identified which all textile fibres must have if they are to be commercially successful: a high length to diameter ratio, strength, extensibility and elasticity, resistance to chemicals, heat and sunlight, and ability to take colour[2].

1. Length to diameter ratio

Fibres generally have a small cross-sectional area and a length that greatly exceeds the diameter. For cotton and wool, the length to diameter ratio is in the region of 2000: 1 to 5000: 1. These fibres are produced naturally in short lengths, known as staple fibre. The fibre lengths vary from 10 to 50 millimeters for cotton and from 50 to 200 millimeters for wool[3]. Man-made fibres can be produced with many kilometers of yarn on a single package. The length to diameter ratio of the fibre is then infinite. This type of fibre is termed continuous filament. Silk is the only natural continuous filament fibre. Many man-made fibres are also produced as staple, so that they can be processed on the same machinery as the natural staple fibres.

2. Strength

The strength of a textile material ultimately depends on the strength of the individual fibres from which it is made. Consequently, fibres must have a certain level of strength if they are to be

useful. A high strength is clearly more important in fibres used for reinforcement of the rubber in a tire than for the fibres used in a knitted jumper.

3. Extensibility and elasticity

In use stresses will frequently be applied to textile materials. The materials need to extend under the stress and be flexible. The fibres in a pair of tights need to extend every time when the wearer bends her legs. But having extended, the fibres need to be elastic and return to their original length. If they do not, the tights will quickly become wrinkly at the knees and ankles. Tights are just one particular application, all fibres need to be extensible and elastic, but to different degree.

4. Resistance to chemicals, heat and sunlight

In normal use and during care procedures, fibres will be exposed to conditions that may damage them. These conditions may include chemicals such as acids, alkalis, bleachers, detergents, or organic solvents including dry cleaning fluid, and physical effects such as heat or sunlight. The extent to which fibres are exposed depends on the particular use. Resistance to sunlight is more important in curtains than it is in underwear. Almost all fibres are exposed to harmful conditions to some extent. Domestic washing powders are mildly alkali and contain bleachers. The temperature during normal ironing can easily reach 200 ℃. The effect of the high temperature on the fibres will be slow in most case and involve some weakening, with perhaps yellowing of white fibres and loss of brightness of coloured products.

5. Ability to be coloured

Most fibres are normally an off-white colour. Life would be very dull if all textile products were off-white[4]. Consequently, fibres need to be coloured ideally, they should be coloured by dyeing at a late stage of processing; this enables a quick response to customers' demands for the latest shade.

Fibres are usually grouped in order to research or discuss or apply them conveniently. Most of fibres are polymer. Based on their chemical composition, fibres can be classified into many groups such as cellulosic fibre, protein fibre, viscose fibre, polyamide fibre, polyester fibre and polycrylic fibre, etc.. But the most convenient grouping divides them into two basic groups according to their origins: i. e. natural and man-made fibres. Natural fibres refer to all fibres that occur in fibre form in nature, including cotton, linen, wool, silk, and so on, which have been known and used for thousands of years. As natural fibres cannot meet the requirement of people, many polymers that do not naturally exist in the form of fibre have been processed into the fibre form, usually by forcing the viscous polymers through a spinneret that consists of a series of tiny holes arranged in a circle, and used as fibres. These products are known as man-made fibres. Most of the man-made fibres have only been produced in the last 40 years, but they have made a great difference to present-day

society, in the types of clothes that we wear as well as the comfort and convenience of living.

The two basic groups can then be further subdivided. The natural fibres can be subdivided into the three types of cellulosic, protein and mineral fibres according to their origins. The cellulosic fibres come from plant materials, the protein fibres come from animal sources and there is a mineral fibre in nature, which is asbestos. Man-made fibres are usually subdivided into four groups: regenerated, modified, synthetic and mineral fibres, according to their polymer origins. The regenerated fibres are manufactured from natural polymers and can be divided into three types: rayon, acetate and protein. Modified fibres include diacetate and triacetate fibres, which are also made from cellulose, but the cellulose is modified chemically so that it can be dissolved in an organic solvent. Synthetic fibres are those fibres that are made synthetically from the raw materials none of which is previously polymer in nature. The term "synthetic" means that the polymer is entirely man-made. Mineral fibres in the category of synthetic fibres are glass, steel and carbon fibres, all of which are found in industrial end-uses. Table 1-1 shows the classifications of general fibres.

Table 1-1 The classifications of general fibres

Natural fibres			Man-made fibres			
Cellulosic	Protein	Mineral	Regenerated	Modified	Synthetic	Mineral
Cotton	Wool	Asbestos	Viscose rayon	diacetate	Polyamide	Glass
Flax	Silk		Cuprammonium rayon	triacetate	Polyeaster	Steel
Jute	Mohair		Protein regenerated fibre		Polycrylic	Carbon
Ramie	Cashmere				Polyolefin	
	Other animal hair				Polyvinyl	
					Elastane	

New words

1. fibre [ˈfaibə] *n.* 纤维,纤维制品
2. yarn [jɑːn] *n.* 纱,纱线
3. fabric [ˈfæbrik] *n.* 织物,布,织品
4. pre-treatment [ˈpriː-ˌtriːtmənt] *n.* 前处理
5. dyeing [ˈdaiiŋ] *n.* 染色,染色工艺,染色工程
6. printing [ˈprintiŋ] *n.* 印花,印花工艺
7. finishing [ˈfiniʃiŋ] *n.* 后整理,织物整理

8. fineness [ˈfainnis] *n.* 细度,纯度,光洁度,延伸率
9. flexibility [ˌfleksəbiliti] *n.* 柔软性,揉曲性,适应性,机动性
10. strength [streŋθ] *n.* 强力,强度,浓度
11. extensibility [iksˌtensəˈbiliti] *n.* 伸长性,延伸性,延展性
12. elasticity [ilæsˈtisiti] *n.* 弹性,弹性学,弹力,伸缩力
13. resistance [riˈzistəns] *n.* 阻拒性,抵抗,抵抗力,阻力
14. cross-sectional [ˈkrɔs-ˈsekʃənəl] *adj.* 横切面的
15. staple [ˈsteipl] *n.* 纤维,短纤维,毛束,纤维长度
16. filament [ˈfiləmənt] *n.* 丝,长丝
17. knitted [nitid] *adj.* 针织的
18. jumper [ˈdʒʌmpə] *n.* 妇女穿的套头外衣,连兜头帽的皮外衣
19. stress [stres] *n.* 应力
20. tights [taits] *n.* 紧身衣裤
21. wrinkle [ˈriŋkl] *n.* 皱纹,褶皱
22. acid [ˈæsid] *n.* 酸
23. alkali [ˈælkəlai] *n.* 碱
24. bleacher [ˈbliːtʃə] *n.* 漂白剂,漂白坯布,漂白工厂,漂白工人
25. detergent [diˈtəːdʒənt] *n.* 洗涤剂,净洗剂
26. weakening [ˈwiːkəniŋ] *n.* 变弱,弱化
27. yellowing [ˈjeləuiŋ] *n.* 泛黄,变黄
28. brightness [ˈbraitnis] *n.* 明亮,鲜艳,鲜艳度,(色彩)明度
29. off-white [ˈɔːf-wait] *adj.* 灰白,黄白色,奶白
30. shade [ʃeid] *n.* 颜色,色调,色泽,色光 明暗的程度
31. polymer [ˈpɔlimə] *n.* 聚合物
32. cellulosic [ˌseljuˈləusik] *adj.* 纤维素的
33. protein [ˈprəutiːn] *n.* 蛋白质 *adj.* 蛋白质的
34. viscose [ˈviskəus] *n.* 粘胶液,粘胶纤维
35. polyamide [pɔliˈæmaid] *n.* 聚酰胺
36. polyester [ˈpɔliestə] *n.* 聚酯
37. polycrylic [ˌpɔliˈsaiklik] *n.* 聚丙烯酸化合物,腈纶
38. cotton [ˈkɔtn] *n.* 棉,棉花,棉线
39. linen [ˈlinin] *n.* 亚麻,亚麻纺织品 *adj.* 亚麻的,亚麻布的
40. viscous [ˈviskəs] *adj.* 黏性的

41. mineral [ˈminərəl] *n.* 矿物,矿石
42. spinneret [ˈspinəret] *n.* 纺丝头,喷丝头
43. asbestos [æzˈbestɔs] *n.* 石棉
44. regenerate [riˈdʒenərit] *vt.* 使新生 *vi.* 新生,再生 *adj.* 新生的,更新的
45. modified [ˈmɔdifaid] *adj.* 改性的,改良的,改进的
46. synthetic [sinˈθetik] *adj.* 合成的,人造的
47. rayon [ˈreiɔn] *n.* 人造丝,人造纤维
48. acetate [ˈæsi,teit] *n.* 醋酸盐,醋酯,醋酯纤维
49. flax [flæks] *n.* 亚麻,麻布
50. cellulose [ˈseljuləus] *n.* 纤维素
51. jute [dʒuːt] *n.* 黄麻
52. ramie [ˈræmi] *n.* 苎麻,苎麻纤维
53. mohair [ˈməuhɛə] *n.* 马海毛,安哥拉山羊毛 *adj.* 马海毛制的
54. cashmere [kæʃˈmiə] *n.* [纺]开司米,山羊绒,羊绒
55. cuprammonium [ˌkjuːprəˈməuniəm] *n.* 铜氨液,铜氨纤维
56. polyolefin [ˌpɔliˈəuləfin] *n.* 聚烯烃
57. polyvinyl [ˌpɔliˈvainil] *n.* 聚乙烯
58. elastane [iˈlæstein] *n.* 聚氨酯弹性纤维,简称氨纶;(德)伊莱斯坦(商标名)

Phrases and expressions

1. wet process 湿加工
2. length to diameter ratio 长径比
3. diacetate fibre 二醋酯纤维
4. triacetate fibre 三醋酯纤维

Notes

[1] So many things are demanded of fibres in many different uses.

这里,"So many things "指"非常多的东西","demand of "为"需求、需要"。

[2] However ...they are to be...to take colour.

"are to"表示"必须"的意思,常用于条件从句。

[3] The fibre lengths vary from 10 to 50 millimeters for cotton and from 50 to 200 millimeters for wool.

此句是一种并列句的简略结构。后一句省略主谓语，即" The fibre lengths vary"。

[4] Life would be very dull if all textile products were off-white.

虚拟语气,主句为 would ＋动词原形结构,从句为 if ＋主语＋动词过去式结构，表示与现在事实相反。

Translated text

什么是纤维

纤维是纺织工业的基础，所有的纺织品都是由纤维制造的。纺织品湿加工过程包括前处理、染色、印花和后整理等工序。其生产流程和配方都是根据组成纺织品纤维的性质进行设计和实施的。因此，在讨论纺织品的湿加工之前，有必要回顾一下纤维的定义及其性质。

什么是纤维？纤维是最小的可见物质单元，它具有较高的长径比、细度和柔韧性。

上述定义对纺织纤维来讲太宽泛了。不同的用途对纤维的要求不同,然而作为商品化的纺织纤维必须具有以下特性 高的长径比、强度、延伸性和弹性、耐化学药品、耐热和耐日晒以及着色性。

1. 长径比

纤维通常横切面积较小，其长度远远超过直径。棉和羊毛的长径比为 2000∶1 ~ 5000∶1。这些纤维天生较短，称为短纤维。例如，棉纤维长度为 10 ~ 50 mm ,而羊毛纤维长度为 50 ~ 200 mm。一个纱卷的人造纤维就是一根长达数千米的长丝，这类纤维的长径比趋近于无穷大。因此，这种类型的纤维被称作连续长丝。真丝是唯一的天然连续长丝纤维。许多人造纤维也以短纤形式生产，以便它们能在加工天然短纤的设备上进行加工。

2. 强度

纺织材料的强度主要取决于构成它的单纤的强度。因此，有用的纤维必须具有一定的强度。显然，高强力对于在轮胎中作为橡胶增强材料的纤维比作为针织外衣的纤维更重要。

3. 延伸性和弹性

纺织材料在使用中常被施加应力。在应力的作用下，材料要延伸和变形。紧身裤中的纤维会随着穿着者的每一次腿部的弯曲而伸展。然而延长之后，纤维还需要有弹性，才能回到它们原始的长度。如果纤维没有弹性，那么这条紧身裤很快就会在膝和脚踝部起皱。紧身裤仅仅是一个特殊的使用情况，所有的纤维都需具有延伸性和弹性，只是程度不同而已。

4. 耐化学药品、耐热和耐日晒

在正常的使用和护理期间，纤维会受到很多因素的损害，这些因素包括化学品（如酸、碱、漂白剂、清洁剂),有机溶剂(如干洗剂),以及热和日光的物理作用。纤维暴露的程度取决于特定的用途。耐日光性在窗帘中比在内衣裤中显得更加重要。几乎所有的纤维都在某种程度上暴露在有害的条件下。家用洗衣粉是弱碱性的并含有漂白剂。一般熨烫过程中温度很容易达

到 200 ℃。高温对纤维的影响在大多数情况下是缓慢的，包括使纤维的某些性能弱化，同时伴随有使白色的纤维泛黄和使有色产品的色彩鲜艳度降低的情况。

5. 可着色性

大多数的纤维通常是灰白色的。如果所有的纺织品都是灰白色的，我们的生活会变得非常暗淡。若想纤维被理想地、完美地着色，就应该在加工处理的后阶段进行染色，这样才能对消费者提出的最新颜色要求给出一个快速的响应。

为了便于研究、讨论或应用，通常将纤维分类。大多数的纤维是聚合物。按其化学组成，纤维可被分为许多类型，如 纤维素纤维、蛋白质纤维、粘胶纤维、聚酰胺纤维、聚酯纤维和聚丙烯腈纤维等。最方便的分类方法是根据纤维的来源把它们分成两种基本类型，即天然纤维和人造纤维。天然纤维指所有以纤维形式从自然界中产生的纤维，包括棉、亚麻、羊毛和蚕丝等等，这些纤维已被人们认识并使用了数千年。当天然纤维不能够满足人们的需求时，许多并不是以纤维形式天然存在的聚合物被加工成纤维形状。通常，这些黏性的聚合物经挤压通过由一系列呈圆形排列的微孔所组成的纺丝头而被加工成纤维形状，并且作为纤维使用，这些产品叫做人造纤维。大部分人造纤维在最近 40 年才被生产出来，但是它们使现代社会发生了很大的改变，如我们穿着的衣服类型、生活的舒适性和方便性。

这两种基本类型可以进一步细分。天然纤维根据其来源可再分为纤维素纤维、蛋白质纤维和矿物纤维三种类型。纤维素纤维来自植物原料，蛋白质纤维来自动物，在自然界中还有一种矿物纤维即石棉。根据聚合物的来源，人造纤维通常再分为四种类型 再生纤维、改性纤维、合成纤维和矿物纤维。再生纤维由天然的聚合物制造，分为三种类型 粘胶纤维、醋酯纤维和蛋白质纤维。改性纤维包括二醋酯纤维和三醋酯纤维，它们都由纤维素制造，这些纤维素通过化学改性而能溶解于有机溶剂中。合成纤维是通过合成非天然存在的聚合物原料而制得的。“合成”一词表明聚合物完全是人造的。在合成纤维范畴中的矿物纤维有玻璃纤维、钢纤维和碳纤维，它们全部用于工业。表 1-1 列举了常见纤维的分类。

表 1-1　常见纤维的分类

天　然　纤　维			人　造　纤　维			
纤维素纤维	蛋白质纤维	矿物纤维	再生纤维	改性纤维	合成纤维	矿物纤维
棉花	羊毛	石棉	粘胶人造丝	二醋酯纤维	聚酰胺纤维	玻璃
亚麻	丝		铜氨纤维	三醋酯纤维	聚酯纤维	钢
黄麻	马海毛		蛋白质再生纤维		聚丙烯腈纤维	碳
苎麻	羊绒				聚烯烃纤维	
	其他动物毛发				聚乙烯纤维	
					聚氨酯弹性纤维	

Reading material

Fine structure of fibre

Fibre structure can be viewed at three different levels: i. e. gross morphology, fine structure and chemical structure. The gross morphology of a fibre is normally defined as the shape and appearance of the fibre under an optical microscope. The fine structure of a fibre is concerned with the arrangement of the polymer molecules within the fibre. The chemical structure of a fibre is concerned with the characteristics of the molecules which make up the fibre.

Unlike microscopic examinations where difference in fibre surface and characteristic shapes can be identified and appropriately labeled, fine structure cannot be observed even by the most powerful microscopes. The information that exists in this field comes from X-ray studies and other equally elaborate techniques.

The pattern of molecular arrangement within any fibre varies widely. The molecules may be highly oriented, which means that they run parallel to each other and to the longitudinal axis of the fibre. Alternatively, they may be of low orientation, in which case they mostly lie at an angle to one another, crossing over at various points.

Linear polymer molecules cannot be completely ordered along their entire lengths. They tend to pass through alternating regions of order and disorder. Where several molecules converge and follow the same path for a fraction of their entire length, they give rise to crystallization — parallel arrangements of molecules held together by strong intermolecular forces. Where they fail to come together in the manner described, they form non-crystalline or amorphous regions.

Many attempts have been made to illustrate this phenomenon by simulation and model making. The fringed micelle is one such model which was first proposed in the 1930s and to a large extent still remains fundamentally appropriate.

1.2 Text

Natural cellulosic fibres

The basis of the chemical composition of all vegetable fibres is cellulose, which is present to a greater or lesser extent. Apart from these vegetable fibres, some man-made fibres, such as viscose and cuprammonium rayon fibres also consist of cellulose. In order to distinguish them from the

man-made cellulosic fibres, the vegetable fibres are called natural cellulosic fibres.

Natural cellulosic fibres are usually divided into four types: seed fibres (such as cotton and kapok), bast fibres (flax, jute and ramie), leaf fibres (sisal and pina) and fruit fibres (coir).

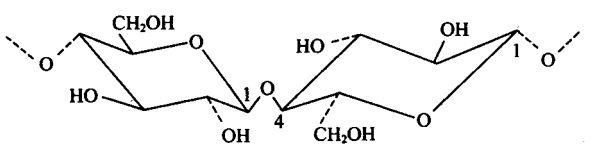
1. Cotton

Cotton is by far the most important textile fibre and makes up nearly 50 percent of the total weight of fibres used in the world[1]. Cotton is obtained from the cotton plant that grows in warm climates in most part of the world. Cotton is single cell fibre and develops from the epidermis of the cotton seed. Cotton consists of cellulose and non-cellulosic materials. Non-cellulosic materials in cotton fibre include protein, wax, pectin, mineral substances, etc. They can range from 4% to 12% together and are referred to as impurities by the manufacturer of cotton goods. Table 1-2 shows the composition of mature cotton fibres.

Table 1-2 Composition of mature cotton fibres

Constituents	Percentage by dry weight(%)
Cellulose	88.0—96.5
Protein	1.0—1.9
Wax	0.4—1.2
Ash	0.7—1.6
Pectin	0.4—1.2
Others	0.5—0.8

Cellulose can be considered to be a condensation polymer formed from the glucose units. Initially, two glucose units combine to form a cellobiose molecule with the elimination of water; and these polymerize further to form a chain of cellobiose. The molecular structure of cellulose is shown as followed:



The molecular structure of cellulose

The helical reversal structure of natural cellulose shows the constantly recurring cellobiose unit,

consisting of two glucose units each with six carbon atoms. The length of the cellobiose unit along the fibre axis is 1.03 nm. There are 3000—5000 C_6 or glucose units joined together in natural cellulosic fibres. This corresponds to a molecular weight of 300000—500000.

A morphological structure of the cotton fibre is described as follows. The outer most layer of the cotton fibre is the cuticle covered by waxes and pectins, and these surround as a primary wall, built of cellulose, pectins and proteinic material. The inner part of the cotton fibre comprises the secondary wall, subdivided into several layers of parallel cellulose fibrillae, and the lumen. The non-cellulosic material is mainly situated in the primary wall and the secondary wall mainly composed of cellulose. The smallest unit of the fibrillae is the elementary fibril, consisting of densely packed bundles of cellulose chains, for which highly ordered (crystalline) regions alternate with less ordered (amorphous) regions in a longitudinal direction. Inside the microfibrils a microcapillary system is developed. The capillary system is responsible for swelling and absorption process which are important for the wet treatment of cotton. When cotton fibres dry from their initial fully swollen state, the cell wall collapse to give a typical kidney-shaped cross-section. Due to its chemical composition and structure, cotton is hydrophilic.

2. Flax (linen)

Flax is a bast fibre obtained from the flax plant by a complicated process to separate fibre from the woody core. This process is known as retting. After retting is complete, the stack is bundled together and passed between fluttering rollers that break the outer woody covering into small particles. It is then subjected to scutching process, which separates the outer covering from the fibre. Flax fibres are multicellular, with each cell having tapering end and a narrow lumen[2]. The fibres show longitudinal striations and nodes. The ultimate fibres are composed of elementary fibrillae, which are spirally arranged. The fibrillae are held together by a binding or gummy substances. Flax is an assembly of the fibrillae cemented together within the fibres and an assembly of these fibres into bundles[3]. Due to the existence of the gummy substances, flax is prone to discoloration.

Cellulose is the main ingredient of flax fibre. The unretted flax contains about 78% cellulose, 16.7% hemicellulose, 1.8% pectins, 2% lignin and 1.5% fats and waxes. The polymer of flax consists with a degree of polymerization of about 18000 cellobiose units.

Flax has relatively high strength. It is resistant to alkalis but is easily damaged by acids. Flax is considered to be the oldest textile fibre in the western world. It had been used traditionally in the manufacture of cloths, tent fabric, sewing thread, fishing lines, table cloth for a long time, but today it is often used as a component of blends.

3. Ramie

Ramie is also a bast fibre. Ramie plant has been grown in China for centuries, so ramie fibre is often referred to as China grass. The ribbons of ramie fibre are removed from the stalks of the ramie plant by the process of decortication. Due to the presence of a large quantity of gum, the ribbons must be treated to separate them into fibres for spinning by a degumming process. Commercial degumming is carried out by treating the fibres with caustic soda solution for several hours. The use of mixed bacterial cultures and enzymes is also reported to remove the gum from ramie fibre[4].

Like other vegetable fibres, the main component of the purified ramie fibre is still cellulose, but ramie has high degree of both polymerization and orientation. The crystalline degree of ramie fibre is high, which impart a low molecular accessibility to the fibre. So ramie fibre is highly resistant to alkalis, microorganisms and insects. It is not easy to be damaged by cold acid and to be dyed[5]. The cell of the fibre is long and the cross-section is irregular in shape. The lumen narrows and disappears towards the end of the cell. Ramie fibre is white, lustrous, stiff and fairly coarse like canvas. It has high strength. This is attributed to its highly ordered structure. Ramie fibre is often blended with cotton for the use in clothing such as shirts, suitings, sweaters and blouses. The ramie adds strength and the cotton introduces softness. Ramie fibre absorbs water rapidly and fabrics made from it will launder easily and dry quickly.

4. Jute

Jute is a lignocellulosic bast fibre. Jute tends to be brown in colour due to about 20% lignin present in the fibre. The individual jute fibres are very short and they cannot be used for spinning. So Jute fibres are processed into the form of bundles of fibrous material held together by a gummy substance. The removal of the gummy substance causes massive loss of strength.

Jute is mainly grown in Bangladesh and India. It is herbaceous annual plant, which grows as high as 20 feet. Jute fibres are extracted from the stem of the plant by retting which usually consists of physical stage and microbial stage. The function of the physical stage is to swell and break down the outer cuticle layer of the stem; the microbial stage is to partially destroy some impurity components by fermentation through bacterial action and remove them from the jute fibres.

The cross-section of jute fibre is polygonal, usually with five or six sides. It has thick walls and a broad lumen of oval cross-section. Chemically, jute fibres are composed of mainly polysaccharides and lignin, although a number of minor components, such as waxes, pectins, inorganic salts, nitrogenous substances, coloring matter etc., are found. It is a low-cost fibre

but rather intensive labor. It has been used traditionally for clothes, carpet backing and packaging.

New words

1. kapok [ˈkeipɔk] *n.* 木棉
2. sisal [ˈsisəl] *n.* 剑麻,西沙尔麻
3. pina [ˈpiːnə] *n.* 同 pineapple ,菠萝(纤维)
4. coir [ˈkɔiə] *n.* 椰壳纤维
5. non-cellulosic [nɔn-ˌseljuˈləusik] *adj.* 非纤维素的
6. glucose [ˈgluːkəus] *n.* 葡萄糖
7. cellobiose [ˌseləˈbaiəus] *n.* 纤维二糖
8. morphological [ˌmɔːfəˈlɔdʒikəl] *adj.* 形态上的
9. lumen [ˈljuːmin] *n.* 中腔,腔管
10. crystalline [ˈkristəlain] *adj.* 结晶的
11. amorphous [əˈmɔːfəs] *adj.* 无定形的
12. microfibril [ˌmaikrəuˈfɑibril] *n.* 微纤维
13. microcapillary [ˈmaikrəukəˈpiləri] *n.* 微型毛细管
14. capillary [kəˈpiləri] *n.* 毛细管 *adj.* 毛细管的,毛细作用的
15. kidney-shaped [ˈkidni-ʃeipt] *adj.* 肾形的
16. hydrophilic [ˌhaidrəuˈfilik] *adj.* 亲水的,吸水的
17. retting [ˈretiŋ] *n.* 沤麻,浸解
18. multicellular [ˌmʌltiˈseljulə] *adj.* 多细胞的
19. striation [straiˈeiʃən] *n.* 条痕,条花,沟纹,缝隙
20. unretted [ˌʌnretid] *adj.* 未浸解的
21. hemicellulose [ˌhemiˈseljuləus] *n.* 半纤维素
22. ribbon [ˈribən] *n.* 带状物,纤维条
23. decortication [diˈkɔːtikeiʃən] *n.* 剥皮
24. enzyme [ˈenzaim] *n.* 酶
25. accessibility [ˌækəsesiˈbiliti] *n.* 接受性
26. canvas [ˈkænvəs] *n.* 帆布
27. sweater [ˈswetə] *n.* 厚运动衫,毛线衫
28. blouse [blauz] *n.* 宽松上衣,女装衬衫
29. lignocellulosic [ˌlignəuˈseljuˈləusik] *adj.* 木质纤维素的

30. Bangladesh [ˌbɑːŋgləˈdeʃ] *n.* 孟加拉国
31. herbaceous [həːˈbeiʃəs] *adj.* 草本的
32. microbial [maiˈkrəubiəl] *adj.* 微生物的
33. fermentation [ˌfəːmenˈteiʃən] *n.* 发酵
34. polygonal [ˈpɔliɡənl] *adj.* 多角形的,多边形的
35. polysaccharide [pɔliˈsækəraid] *n.* 多糖,聚糖,多聚糖
36. low-cost [ləu-kɔst] *adj.* 低廉的,低成本的

Phrases and expressions

1. primary wall 初生层
2. secondary wall 次生层
3. fluttering roller 抖动式滚筒
4. scutching process 打麻工艺
5. degumming process 脱胶工艺,精练工艺
6. caustic soda 烧碱,苛性钠,氢氧化钠

Notes

[1] Cotton is by far the most important textile fibre and makes up nearly 50 percent of the total weight of fibres used in the world.

by far用于表示程度,意为"到目前为止、迄今为止"。

[2] Flax fibres are multicellular, with each cell having tapering ends and a narrow lumen.

这里,with 后面加宾语,说明附带情况。

[3] Flax is an assembly of the fibrillae cemented together within the fibres and an assembly of these fibres into bundles.

这里,说明了亚麻纤维的两个特点,即单纤维由基原纤组成,纺织纤维为纤维束状。

[4] The use of mixed bacterial cultures and enzymes is also reported to remove the gum from ramie fibre.

这一句等同于"The use of mixed bacterial cultures and enzymes to remove the gum from ramie fibre is also reported".

[5] It is not easy to be damaged by cold acid and to be dyed.

此为两个并列句,后一句省略主语。完整形式是:It is not easy to be damaged by cold acid and it is not easy to be dyed。

Translated text

天然纤维素纤维

所有植物纤维的基本化学成分是纤维素，只是存在多少不同而已。除了这些植物纤维之外,一些人造纤维,例如粘纤维胶和铜氨纤维,也由纤维素组成。为了将植物纤维和人造纤维素纤维区别开来，人们把植物纤维叫做天然纤维素纤维。

天然纤维素纤维通常分为四种类型 种子纤维(例如棉花和木棉)、韧皮纤维(亚麻、黄麻和苎麻)、叶纤维(剑麻和菠萝纤维)和果实纤维(椰壳纤维)。

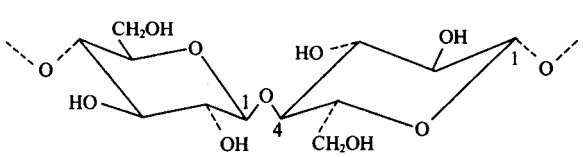
1. 棉花

棉花是迄今为止最重要的纺织纤维，占全世界所用纤维总重量的近一半。棉花产自棉株，生长在温暖气候条件下，分布于世界大部分地区。棉花是单细胞纤维，由棉籽的表皮发育而成。棉花由纤维素和非纤维素组成。非纤维素包括蛋白质、蜡、胶质和矿物质等，其总含量为 4% ~ 12%,被棉制品商认为是杂质。表 1-2 显示了成熟棉纤维的组成。

表 1-2　成熟棉纤维的组成

成　　分	干重百分比(%)
纤维素	88.0 ~ 96.5
蛋白质	1.0 ~ 1.9
蜡	0.4 ~ 1.2
灰	0.7 ~ 1.6
胶质	0.4 ~ 1.2
其他	0.5 ~ 0.8

纤维素是由葡萄糖单元形成的缩聚物。最初，两个葡萄糖单元通过脱水形成一个纤维二糖分子；进一步聚合形成由纤维二糖分子所组成的长链。纤维素分子的结构如下图所示。



纤维素分子的结构

天然纤维素的螺旋状的翻转结构表明，它由恒定不变的重复的纤维二糖单元组成，纤维二

糖由两个葡萄糖单元组成，每一个葡萄糖单位含有六个碳原子。沿着纤维轴的纤维二糖单元长度是 1.03 nm。在天然纤维素纤维中有 3000～5000 个六碳或葡萄糖单元连接在一起，其相对分子质量相应达到 300000～500000。

下面描述棉花纤维的形态结构。外层是初生层，由纤维素、胶质和蛋白质构成，初生层的外面由被蜡和胶质覆盖的表皮构成。棉花纤维的内部由次生层构成，它又可细分为几个平行的纤维素原纤层以及中腔。非纤维素物质大部分分布在主要由纤维素构成的初生层和次生层。原纤的最小单位是基原纤。基原纤由密集成束状的纤维素长链组成。在基原纤中，高度有序区（结晶区）和低度有序区（非结晶区）纵向交替排列。在微纤维的内部形成一个微毛细管体系，毛细管体系担负着在棉花的湿加工中有重要意义的膨胀和吸收作用的责任。当棉纤维从完全膨胀的状态变干燥的时候，细胞壁会萎缩成典型的肾形切面。由棉纤维的化学组成的结构，决定着它是亲水性的。

2.亚麻

亚麻是一种从亚麻植物获得的韧皮纤维。它通过一种复杂的工艺与木质芯分离而制得，这个工艺叫做沤麻。在沤麻结束之后，麻堆被结成束状，并通过抖动滚筒将外层的木质覆盖物打碎成小颗粒，然后经打麻工序处理，将外层覆盖物与纤维分离。亚麻纤维是多细胞纤维，每个细胞有渐细的末端和一个狭窄的包腔。纤维纵向有条纹和节点。最终的纤维由呈螺旋形排列的基原纤组成，基原纤由黏性物或胶质联结在一起。在亚麻中，原纤胶结成纤维，纤维胶结成束。由于胶质的存在，亚麻不易脱色。

纤维素是亚麻纤维的主要成分。未经沤麻处理的亚麻含有约 78% 纤维素、16.7% 半纤维素、1.8%胶质、2%木质素和 1.5%脂肪和蜡质。亚麻的聚合体由聚合度大约为 18000 的纤维二糖单元构成。

亚麻有相当高的强力，耐碱但容易被酸损害。亚麻被认为是西方世界最古老的纺织纤维。在很长一段时间，它曾传统地被用于面料、帐篷、缝纫线、钓鱼线的生产，但今天它却时常用作混纺织物中的一个成分。

3. 苎麻

苎麻也是韧皮纤维。苎麻植物在中国已种植了数世纪之久，因此苎麻纤维也被称为中国草。苎麻纤维的麻条通过剥皮工艺从苎麻植物的茎秆上剥下。由于存在大量的胶质，麻条必须通过脱胶工艺处理才能用于纺纱。工业规模的脱胶是采用烧碱溶液溶解数小时而完成，也有报道采用培养细菌和酶的混合物来脱胶。

像其他植物纤维那样，除杂后的苎麻纤维的主要成分仍然是纤维素，但是苎麻纤维有很高的聚合度和取向度。苎麻纤维的结晶度高，使得纤维分子亲和性较低。因此，苎麻纤维对碱、微生物和昆虫有较高的抵抗力。不易被冷的酸破坏，也不易被染色。苎麻纤维细胞很长，其横切面呈不规则形状。中腔狭窄，并在细胞末端消失。苎麻纤维呈白色、有光泽、坚硬，像帆布一样

相当粗糙。苎麻纤维的强度高,源于其高度有序的结构。苎麻纤维常和棉花混纺,用作衬衫、制服、汗衫和休闲服的面料。苎麻纤维用于增加强力，而棉花用于提供柔软性。苎麻纤维吸水迅速，用苎麻纤维制造的织物易洗快干。

4. 黄麻

黄麻是木质纤维素韧皮纤维。由于约 20%木质素的存在，黄麻大多呈棕色。单个黄麻纤维非常短,不能够用于纺纱。所以,黄麻纤维通过胶质将其加工成纤维束的形式,胶质的去除会引起纤维强力的大量损失。

黄麻主要产于孟加拉国和印度，黄麻纤维属于一年生草本植物，成熟时达 20 ft(6.10 m)高。黄麻纤维通过沤麻工序从植物茎秆上分离出来，沤麻工序一般包含物理阶段和微生物阶段。物理阶段的作用是膨胀并剥离植物茎秆上的外表皮层；微生物阶段的作用是通过细菌的发酵作用部分地破坏某些杂质成分并将它们从黄麻纤维上脱去。

黄麻纤维的横切面呈多角形，通常有五个边或六个边。有一个横切面呈椭圆形的明显的中腔,细胞壁厚。黄麻纤维的化学组成主要有多聚糖和木质素,还发现有少量的蜡状物、胶质、无机盐、含氮物质和色素等组分。黄麻纤维价格低廉,但获取相当不易。传统上用于服装、地毯底布和包装材料。

Reading material

Degradation of cellulose

Cellulose can be degraded by the action of acids, alkalis, oxidizing agents, enzymes, heat or radiation. The study of degradation of cellulose has important implications for satisfactory dyeing and finishing, since even slight degradation during processing may be accompanied by unacceptable loss of strength and other undesirable effects.

Most of cellulosic fibres have poor resistance to aqueous acids. For example, when cotton is treated with a dilute solution of hydrogen chloride, the rate of hydrolysis is very rapid and the strength loss of the cotton is great. So it is not usually allowed to treat cellulosic fibres with acids, especially with strong acids and at high temperatures.

The glycosidic linkages in cellulose are not attacked by alkali at temperature lower than about 170 ℃. However, the preparation of cellulosic textiles for dyeing frequently includes hot alkaline treatments that cause greater weight loss than be accounted for by the removal of non-cellulosic substances. In this case degradation of cellulose is present.

Since each intermediate unit in a cellulose molecule contains three hydroxy groups, the number

of possible oxidation products is considerable. These oxidations may damage textiles, it is, therefore, necessary to choose safe bleaching agent and maintain proper conditions.

Biodeterioration of cellulosic textiles is a serious problem and many efforts have gone into methods of prevention. If damp cotton is exposed to air, mildew may gradually develop on it, accompanied by staining that is difficult or impossible to remove. Prolonged exposure also causes a serious loss of tensile strength. In the biodeterioration process, enzymes play an important role.

Cellulose can be heated for many hours up to about 120 ℃ without any serious deleterious effect. In dry air at high temperatures, however, considerable depolymerization takes place, accompanied by the formation of carbonyl and carboxyl groups in the solid material, the evolution of water, carbon monoxide, and carbon dioxide, and a loss of tensile strength.

1.3 Text

Natural protein fibres

Natural protein fibres such as wool and silk are obtained from animal hairs and animal secretions. All of these fibres are composed of protein in which the repeated unit is amino acid. The amino acids are linked to each other by the peptide bond (—CO—NH—) to form the protein polymer. Some of man-made fibres are also made from amino acids, but only animal fibres are the natural protein fibre. Natural protein fibres have higher moisture regain and warmth than natural cellulosic fibres. Natural protein fibres have good resiliency and good elastic recovery but have poor resistance to alkalis.

1. Wool

In the category of animal hair fibres, wool is the most important fibre and produced in the largest amount; other animal hair fibres such as mohair, cashmere and vicuna are only produced on a small scale. Wool is the fur-like covering of sheep that are raised in many countries around the world. It is obtained by shearing the fibrous covering from the sheep. The shorn-off wool is dirty and about 50% of its weight consists of natural and other impurities such as grease, suint, sand, dirt, vegetable matter, etc. So the raw wool should be treated through a series of processes including sorting, scouring and carbonization before it is used in spinning. The ultimate quality of wool relating to the fineness, length, physical strength, handle, luster, absorbency, etc. depends on many factors including the processes mentioned above. It is also affected by the species of sheep, climatic condition under which the animal is raised, the health of the animal, and so on.