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On the Basis of Fibers and Textiles

Fibers are substances composed of continuous or discontinuous filaments. They are mainly used in making textiles for human wear, thus called textile fibers. Traditionally, textile fibers can be classified as nature fibers, chemical fibers, and functional fibers.

Nature fibers are textile fibers directly obtained from plants or animals that are originally natural or artificially cultivated. Their advantages are that they can be directly obtained from nature and have good moisture absorption, air permeability, and extensibility. Nevertheless, the wide application of nature fibers is restricted by its limited source, low yield, poor chemical stability, and low abrasion resistance, thus their inability to supply the fast-growing needs of human beings.

Chemical fibers refer to the fibrous object manufactured by artificial processing, which can be divided into synthetic fiber and regenerated fiber. Compared with nature fibers, chemical fibers exhibit superior light resistance, abrasion resistance, mildew resistance, and mothproof ability. Besides, their length, thickness, whiteness, and luster can be conveniently adjusted during the production process. Therefore, they can be an important complementary for nature fibers.

Furthermore, functional fibers refer to new types of fibers that have some special functions such as flame retardant, antistatic, anti-ultraviolet, etc., in addition to common physical and mechanical properties of ordinary fibers. Nowadays, functional fibers have been developed in order to endow chemical fibers with special functions such as antiflaming, hydrophile, and antistatic.

Textiles are products made by processing and interweaving textile fibers. These can be made into clothes, which can be utilized for covering the ugliness, adorning the beauty, keeping out cold wind, and protecting the body from insects. In addition to these basic functionalities of traditional textiles, people have been exploring functional textiles by weaving with functional fibers to endow clothes with more functions, like better skin protection, body temperature maintenance, decoration and aestheticism, etc.

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Xing Fan, Nannan Zhang, and Yi Wang.

This chapter mainly discusses the basis (such as definition, classification, and application) of fibers and textiles and the evolution process from classical functional fibers to intelligent fibers and textiles.

1.1 On the Basis of Fibers

Fibers usually refer to a soft slender body with a length-to-width ratio above 10^3 and thickness of several microns to hundreds of microns. Since fibers are mostly used to make textiles, they are also called textile fibers [1]. Traditionally, textile fibers are divided into nature fibers and chemical fibers, according to their sources of raw materials. In recent years, textile fibers with some special functions (such as flame retardant, hydrophilic, antistatic, anti-ultraviolet, etc.) have emerged, which are called functional fibers. The following section will mainly introduce the definitions, classifications, characteristics, and applications of nature fibers, chemical fibers, and functional fibers.

1.1.1 Nature Fibers

Nature fibers can be directly obtained from planted plants or animal hair and secretions. They are important material sources for the textile industry, of which the history can be dated back to the prehistoric times. Humans have begun to use nature fibers even since the Neolithic. They have been used in making clothings and life production equipment (such as ropes, nets, bags, etc.). According to the source of raw materials, nature fibers can be divided into cotton fiber, hemp fiber, wool fiber, and silk fiber [1].

The first type of nature fiber is cotton fibers. They are single-cell material that grow on cotton seeds and lengthen first and then thicken deposits to mature (Figure 1.1a).[1] In addition, Figure 1.1b shows the scanning electron microscope (SEM) of cotton fibers.[2] The advantages of cotton fibers are that they have slender and soft texture and good moisture absorption, strong alkali resistance, organic solvent resistance, and heat resistance. Therefore, the applications of cotton fibers are suitable for making all kinds of clothes as shown in Figure 1.1c, furniture cloths and industrial cloths (https://site.douban.com/108216/widget/notes/181120/note/146893919).

The second type of nature fiber is hemp fibers. They refer to fibers that are obtained from a variety of hemp plants, including phloem fibers in the cortex of annual or perennial herbs, dicotyledonous plants, and leaf fibers in monocotyledonous plants (Figure 1.2a).[3] Also, Figure 1.2b shows the SEM of hemp fibers [2]. The advantages of hemp fibers are that they have good hygroscopicity, high strength, and low denaturation ability, as well as being very pleasantly cool. The applications of hemp fibers are that they can be used as textile materials to woven into various

1 http://www.xjxnw.com/c/2017-06-15/1215397.shtml
2 https://www.meipian.cn/h8g0qnf
3 http://baike.jc001.cn/words/56558.html#

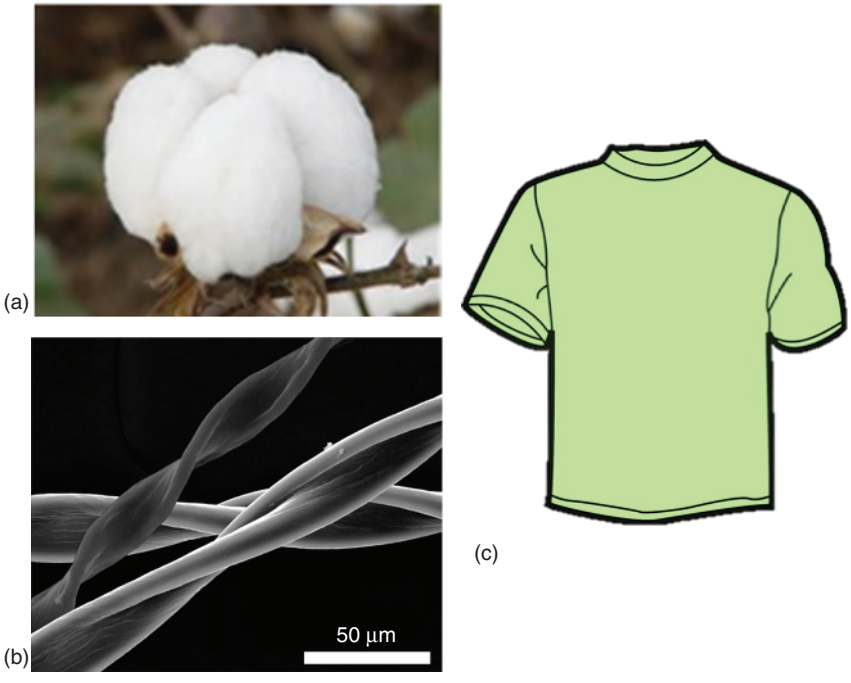

Figure 1.1 Cotton fibers. (a) Photographs of cotton fibers. (b) The SEM of cotton fibers. (c) Fashion clothing made of cotton fibers. Source: From Glenn Morrison et al. (2015), Figure 00 (p.149)/with permission of Elsevier. https://doi.org/10.1016/j.atmosenv.2015.05.051.

cool linen cloths, summer cloths, spinning ropes, and sacks for packaging as shown in Figure 1.2c.[4]

The third type of nature fiber is wool fibers that are developed from cells on sheep skin (Figure 1.3a).[5] Therefore, sheep wool is the most important textile wool fibers. Figure 1.3b shows the SEM of wool fibers [3]. The advantages of wool fibers are that they have soft and flexible texture and excellent warmth retention, so the applications of these are that they can be used in making woolen cloths, woolen yarns, blankets, felts, and other textiles. In addition, because wool fibers have the characteristics of good warmth retention and comfortable wearing, they are mostly used in autumn and winter clothings as shown in Figure 1.3c.

The fourth type of nature fiber is silk. It is a kind of continuous long fiber, which is solidified by silk liquid secreted by mature silkworm (Figure 1.4a).[6] In addition, Figure 1.4b shows the SEM of silk [4]. The advantages of silk are that it is light, fit, soft, smooth, and breathable and has gorgeous color, luster, elegance, and comfort. Additionally, silk is the mildest, softest, and thinnest nature fiber. The applications of silk are that it is used for silk weaving and then processed into a variety of silk

4 http://www.pibu.com/news/show-17833.html
5 http://www.czeps.cn/nongyechangshi/10387.html
6 https://baike.baidu.com/tashuo/browse/content?id=69510a16e826351b68c4ec14&fr=vipping

Figure 1.2 Hemp fibers. (a) Photographs of hemp fibers. (b) The SEM of hemp fibers. Source: Mwaikambo and Ansell [2]. (c) Photographs of spinning ropes and sacks for packaging.

textiles with different styles and finally made into silk products, clothing as shown in (Figure 1.4c), bedding, and other commodities (http://art.cfw.cn/news/153346-1.html).

1.1.2 Chemical Fibers

With the increase of human population and clothing requirements, limited natural resources are far from meeting with people's needs. As complementary to nature fibers, people have begun to consider the use of chemical fiber to address the shortage issue of cotton, silk, and wool. As a matter of fact, the use of chemical fibers has been started from the end of the nineteenth century. In addition, the period from the end of the nineteenth century to the 1930s of the twentieth century was a fast developing stage for the innovation of chemical fibers.

Chemical fibers are fibers made from natural or synthetic polymer compounds through chemical processing. According to the different sources of raw materials and processing methods, they can be divided into synthetic fibers and regenerated fibers.