GAODENG XUEXIAO ZHUANYE JIAOCAI

• 高等学校专业教材 •

ENGLISH FOR SYNTHETIC LEATHER TECHNOLOGY

合成革专业英语

任龙芳◎编著

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前　言

随着我国经济与世界的接轨，合成革生产、销售和贸易的日益全球化，要求合成革行业的从业人员掌握专业英语。正是在这种要求下，许多就业者，特别是刚走上工作岗位的年轻人，以及大专院校非织造、合成革专业方向的学生，深感专业英语教材的缺乏（目前合成革专业没有相关专业英语教材）。因此，急需要一批专业内容比较系统、技术内容新、便于自学的教材和参考书。本书正是应上述需要，在参考了大量英语书籍和期刊的基础上，按照合成革原材料和生产过程编写而成的。愿这本书能对非织造和合成革专业技术同行，特别是年轻同行的学习有所帮助。

本书共有8章，内容包括合成革工业介绍、聚氨酯材料、无纺布加工技术、合成革湿法加工技术、合成革干法加工技术、合成革整饰技术、海岛型超细纤维合成革加工技术、合成革的缺陷辨析和性能检测。为了便于读者的理解，在有关描述加工工程的章节还插入了机械加工原理示意图。本书既是一本非织造、合成革专业教材，又是一本专业英语学习参考书。

本书内容系统，单词覆盖面广，易读易懂，便于自学，实用性很强。同时为了便于学生学习和自学者阅读，每节都对相关的专业词汇、部分通用词汇及表达方式进行了汉语注释。

本书的编写酝酿多年，在编写过程中，陕西科技大学硕士研究生贺齐齐、陈婷、高翔、高鑫参与了部分翻译、资料整理工作；合成革专业的马兴元教授、罗晓民教授、王海军副教授、冯见艳博士、徐娜博士以及皮革专业的王学川教授、强涛涛副教授也非常支持本书的出版。在此一并表示衷心的感谢。由于本人水平有限，难免有疏漏和不足之处，敬请读者批评指正。

任龙芳
2015年2月14日于陕西科技大学

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1.1 Classification of artificial leather

At present, there is no unanimous rule about the classification of artificial leather and synthetic leather. Generally speaking, in the manufacturing process of artificial leather, the woven fabrics in which the warp and weft interweave are as substrate, while for the synthetic leather, the nonwoven fabrics are as substrate.

In China, people call the artificial leather which is produced by PVC resin as PVC artificial leather; while those produced by PU resin are named as PU leather. In detail, the synthetic leather which is produced by using PU resin and ordinary nonwovens is called PU synthetic leather. If the synthetic leather is produced with microfiber nonwoven fabrics and PU, it is called microfiber PU synthetic leather.

1.2 The development history of products

Because the supply of natural leather and the increasing demand to leather becomes unbalanced, the artificial leather and synthetic leather gradually develop. In the 1930s, people began to study the substitutes of leather by using different chemicals and methods. The artificial leather coated with PVC polymer appeared in the 1930s, which realized the large - scale industrialization in the replacement of leather. This is the first generation product of artificial leather.

PVC artificial leather is a kind of imitative leather product in which the woven or knitted fabrics are as substrate and polyvinyl chloride resin is as coating. The purpose is to make the appearance of PVC artificial leather is similar to that of leather. Its characteristics are bright appearance, soft texture, wear resistance, folding resistance, acid and alkali resistance, etc. Because it is cheap, has strong surface strength and is easy to be processed, it is widely used in vehicles, furniture and decoration. PVC artificial leather which is as the substitute of leathers has obvious shortcomings, such as poor adhesion with base, weather resistance, handle and softness. The addition of plasticizer can improve the softness of products, but the smell is worse.

Since 1970s, through the development of 30 years, PVC artificial leather in China has been developed into a large scale. However, the development of PVC artificial leather in recent years has been restricted because of its weaknesses in performance and technics. At present, the application of PVC artificial leather has been reduced. With the development of PU synthetic leather, especially the appearing of the third generation artificial leather which is the microfiber leather, the development of artificial leather moves to newer level. So the market position of PVC artificial leather is gradually being replaced.

On the other hand, in recent years, the human realized the harm caused by the destroying to environment, so they increasingly pay attention to environmental protection. PVC is very harmful to human health and the environment, which attracts the attention of international environmental organizations and relevant person to PVC. Some ecologists and International Greenpeace believes that the chlorine industry, especially the PVC industry, is the main source of dioxin in the environment. In PVC production process highly toxic dioxin will be produced, toxic additives in PVC products also can pollute the environment. These toxic materials will enter the human body which has carcinogenic effect. Meantime, the treatment of PVC wastes is more difficult. Whether these wastes are burned or buried, they will produce and release dioxins and chlorinated compounds which can cause the land and water pollution. The recycling of PVC also is very difficult.

In the data provided by Greenpeace, the animal tests show that chemical additives phthalein which can make the PVC more flexible, has large effect on the kidney, liver and testis of human body. That is to say, it can cause cancer, damage to kidney and the function reconstruction system of human body. In recent years, some experiments suggest that the children may inhale toxic chemicals from PVC toys. Therefore, in recent years, Greenpeace, ecological organizations, the Greens or "green" politicians who come from European countries and cities continue to put the pressure on government, as a result, some governments adopt the policy to limit the use of PVC products. For example, Netherland has prohibited using PVC as packaging and Belgium had levied "ecological tax" to PVC water bottle.

In the 1960s, with the application and development of polyurethane and nonwovens technology in the artificial leather, the second generation synthetic leather was born.

PU instead of PVC is used in the artificial leather. In 1937 Professor Bayer successfully developed a polyurethane resin which lay a good foundation for the development of PU artificial leather and synthetic leather. Polyurethane resin is rapidly developed in the manufacturing process of natural rubber substitute. PU film is elastic, soft and has high breaking strength, excellent abrasion resistance, moisture permeability and solvent resistance. It has not only good physical and mechanical properties, but also has processing performance, so it can be as the best material of artificial leather and synthetic leather. The first patent about PU synthetic leather is obtained by Germany in 1953, and then Japan introduced the patent from Germany in 1962. In this year a Japanese Industrial Chemical Company also produce the polyurethane leather.

Subsequently, some new processes of nonwovens which are produced by synthetic fiber appear, which makes the substrates have lotus - shaped cross - section or hollow shape. The multiporous structure is obtained which can accord with the reticular structure of leather. At that time, the surface of synthetic leather has achieved microporous structure which is equivalent to the grain of leather. So the appearance and internal structure of PU synthetic leather is gradually close to that of leather and other physical properties are also close to that of leather. However, the color of synthetic leather is brighter than that of leather. Its folding resistance at normal temperature can reach to more than one million, while that at low temperature also can achieve the level of leather. PU synthetic leather has natural and soft handle, excellent adhesion properties, folding resistance and anti-wear.

Synthetic leather belongs to higher grade products in "chemically coated leather" and it has more than 40 years history. The Corfam product which is initiated by DuPont Company in 1963 is a composite which is prepared by polyester staple fiber with multiporous PU. It has excellent air permeability and can be used as footwear. The "Corfam" no longer continued to be produced after 8 years because of the quality and American industrial policy. Later European countries began to develop wet polyurethane synthetic leather. For example, Dow Company produced TPU leather. In addition, German Enkagrastoff and English Porvair both tried to do it, but they did not succeed because of various reasons. Quite a number of manufacturers had to withdraw because of the quality. However, a product which is developed by Kuraray Company in 1965 is put on sale as Japanese first synthetic leather. It is mainly used as a material for the men's shoes and is praised by all people. Thereafter, the fiber manufacturers involved. At present, the production of chemically coated leather almost becomes the only industry in Asia.

The microfiber PU synthetic leather is the third generation of artificial leather. Its base is nonwoven fabrics with three-dimensional structure, which creates the condition to catch up with the leather in terms of the substrate. The product combined with the newly developed processing technology, such as multiporous PU dipping and the composite coating. The huge surface area and strong water absorption of microfiber is brought into play, which makes the PU synthetic leather have similar hygroscopic properties with leather. Whether in terms of the internal microstructure, appearance, physical characteristics or wearing comfort, the microfiber PU synthetic leather also can be comparable with the high-quality leather. In addition, the chemical resistance, uniformity, processing adaptability, waterproof and mildew resistance of microfiber synthetic leather is better than that of leather.

The emergence of microfiber synthetic leather and the development of new materials are inseparable, especially the development of polyurethane and new synthetic fiber. Meantime, the formation of microfiber synthetic leather by several materials largely attribute to the effort in terms of the microscopic study on leather and the imitation to the microscopic structure of leather.

The development of microfiber brought a new revolution to artificial leather industry. Toray Industries introduced scanning electron microscope (SEM) in 1966 and used it to observe the microstructure of different fibers and textiles. This technology played a very important role. SEM observation revealed the microstructure of chamois. As shown from macroscopic and microscopic perspective, this fiber can be imitated with microfiber. Toray Industries decided to develop new products within two years to make a comeback. In 1968, the polyester microfiber synthetic leather was born. In the same year, another Japanese artificial leather enterprise which is Kuraray Company developed the nylon microfiber synthetic leather by using different method. Although the separation methods and materials used by the two companies are different, the design concept and idea are the same. Firstly, they were made up of the microfiber. Secondly, after the unnecessary components were removed, the fiber component was simple. Meantime, the resin which is used is polyurethane.

1.3 The current situation of microfiber PU synthetic leather in China

Before the 1970s, the polyurethane synthetic leather industry is still blank in China, but the artificial leather in Japan has been booming. Our country was still in the stage of material shortage, but it still decided to introduce the production technology and complete sets of equipment of polyurethane synthetic leather from Japan. As a national key project, the first polyurethane synthetic leather factory is built in 1983 and put into operation in Yantai, Shandong Province. It introduced wet production technology of Japanese Kuraray Co., Ltd, and its annual yield of lotus-shaped polyurethane synthetic leather 3 million square meters and liquid polyurethane is 25000 tons, which terminates the history which our country can not produce high-grade artificial leather. Meantime, it also marked the birth of industrial base of polyurethane in China. Since 1981 our country began to introduce dry production technology of PU artificial leather. At that time, there only have Guangzhou artificial leather factory. Subsequently artificial leather factory in Dongguan and plastic factory in Wuhan have also been put into production.

At the end of the 20th century, the dry and wet production lines of synthetic leather which are introduced and constructed by our own have reached to thousands. The technics of these production lines is relatively simple. It is mainly with ordinary chemical fiber fabric as base and the yield is large, which fills the shortage of insufficient leather supply. But the artificial leather produced in China basically is low and middle added-value leather. Every factory only simply repeats the technics, so they fall into vicious competition in the market because of similar products.

In the 21st century, with the rapid development of the national economy, people's living standard has been greatly improved. So people have not satisfied with original low-end products and accordingly they put forward higher requirements for the artificial leather industry. It is an inevitable trend to research and develop artificial leather with better performances. The domestic artificial leather industry also falls into the trough. In order to survive, companies research and develop new products according to their own situation. Wanhua Group Co., Ltd. firstly invests much money to develop microfiber synthetic leather. In 1996, Wanhua possessed independent intellectual property right about the production technology of unfigured sea-island PA6 microfiber synthetic leather, and in 1998, it formed the production capacity of 3 million square meters per year.

Currently microfiber synthetic leather mainly includes two categories: figured sea-island fiber and unfigured sea-island fiber. For the unfigured sea-island fiber, PA6 is as material and the figured sea-island fiber is with polyester as material. The development of microfiber is very rapid in the past two years. Many synthetic leather factories, chemical fiber and nonwoven companies invest in it. At present, it is mainly dominated by Shandong, Zhejiang, Jiangsu, Fujian and Shanghai.

Words and expressions

unanimous	*adj.*	一致的
bran-new	*adj.*	全新的
bring into play		发挥
carcinogenic	*adj.*	致癌的
chamois	*n.*	麂皮
chlorinated compounds		含氯化合物
Corfam	*n.*	科芬(一种合成革的产品名称)
dioxin	*n.*	二噁英
function reconstruction system		功能再造系统
Greenpeace	*n.*	绿色和平组织
imitative leather product		仿革制品
Kuraray Company		可乐丽公司
levy "ecological tax"		征收"生态税"
make a comeback		东山再起
phthalein	*n.*	酞
plasticizer	*n.*	增塑剂
polyester staple fiber		涤纶短纤或聚酯短纤
reticular structure		网状结构
substitute	*v./n.*	代替，代用品
Toray Industries		东丽公司

Notes to the text

1. The artificial leather coated with PVC polymer appeared in the 1930s, which realized the large-scale industrialization in the replacement of leather. 30 年代出现了以 PVC 高分子材料涂敷的人造革，在天然革的替代工作上实现了大规模工业化的实际应用。
2. The PVC artificial leather is a kind of imitative leather product in which the woven or knitted fabrics are as substrate and polyvinyl chloride resin is as coating. PVC 人造革，是以纺织或针织材料为底基、聚氯乙烯树脂为涂层的仿革制品。
3. which makes the substrates have lotus-shaped cross-section or hollow shape. 使基材具有藕状断面、空心纤维状。
4. The multiporous structure is obtained which can accord with the reticular structure of leather. 多孔结构符合天然革的网状结构要求。
5. a composite which is prepared by polyester staple fiber with multiporous PU 涤纶短纤织物上浸涂有多孔性聚合物 PU 的一种复合产品。
6. includes two categories: figured sea-island fiber and unfigured sea-island fiber. 包括两大类：即定岛纤维和不定岛纤维。

Chapter 2 Polyurethanes

Lesson 1 Introduction

Coating, bonding and sealing are techniques that humankind has used for many thousands of years. For a long time, only natural resins, oils and fats were used for these purposes.

Shellac, a natural resin secreted by the scaly lac insect, has been used in India for centuries as a weather-resistant coating for surfaces. The word lacquer in English is derived from the Sanskrit word laksha, which means one hundred thousand and describes the unimaginably large number of insects required to produce shellac lacquers. Later it was learned that lacquer resins could also be obtained from other sources, e. g. by boiling down wood oil.

Animal products, especially bones and hide, were the basis for glues and adhesives for many centuries. The makers of high-quality glues were called Kellepsos in ancient Greece. During the middle Ages, development was largely static. The invention of the printing press by Jnhannes Gutenberg then led to a new and rapidly growing need for adhesives in the emerging bookbinding industry.

The development of synthetic resins began in the early 20th century and made possible the production of coatings and adhesives of vastly improved quality. Polyurethanes were discovered in 1937 when Heinrich Rinke produced 1, 6-hexamethylene diisocyanate (HDI) and Otto Bayer developed the diisocyanate polyaddition process. Initial research in this new field of polymer chemistry in the 1940s focused on polyurethane fibers, while the first polyurethane foams were produced a little later.

Fifty years ago, the first polyurethane coatings were developed. Otto Bayer and his team discovered that the technical properties of alkyd resins could be improved through modification with diisocyanates. However, the real conquest of the coatings sector by polyurethanes only began with the development and industrial use of low-monomer polyisocyanates. The first products were based on toluene diisocyanate. Because of the aromatic nature of the base isocyanate, these tend to yellow on exposure to light and can therefore only be used for interior applications or in primers.

The range of applications was broadened later with the introduction of products based on aliphatic diisocyanates, initially hexamethylene diisocyanate. Gradually the two component coatings made by combining polyisocyanates with polyols replaced the traditional alkyd coatings, first in the field of large vehicle production. The driving force was the quality of the coatings which, even when dried under mild conditions, matched the performance of coatings which had been baked. This is important when coating large vehicles (air planes, rail wagons and buses) as their size makes baking impossible.

In the 1970s, it was found that the quality of automotive refinish coatings could be substantially improved with the help of polyurethane chemistry. By adding polyisocyanates based on isophorone diisocyanate (IPDI) to the medium-oil alkyd resins mainly used at that time, the hardness, overcoatability and gasoline resistance of the resulting coatings could be improved significantly. Today, two-component polyurethane coatings have almost completely replaced alkyd resin chemistry in this segment.

The broad range of applications for polyurethanes in coatings was quickly recognized. Other examples of applications include wood finishing, corrosion protection and construction, as well as textile coating. Another advance has been the development of two-component metering technology. Since the mid-1980s, plastic coatings have become a farther domain for polyurethanes.

Polyurethane adhesives came onto the market in the 1950s with the development of the hydroxyl polyurethanes and the first trifunctional isocyanate crosslinker. The early 1960s also saw the development of plasticizer-resistant hydroxyl polyurethanes, which laid cc foundation for the success of these products in shoe manufacture.

Solvent-free polyurethane reactive adhesives have been used since the 1970s, first in automotive production, and then in the manufacture oflaminated films and sandwich elements. They were later joined by reactive sealants. Since the 1990s, polyurethane-based reactive and aqueous dispersion adhesives have gained market shore in furniture manufacture, bookbinding and shoe sole production.

The process of substituting traditional technologies in coatings, adhesives and sealants with polyurethane is still incomplete, and can be observed occurring around the world. Against a background of increasingly demanding quality requirements, ever more stringent environmental legislation, and cost optimization of the end-product manufacturing processes, there has been growth in the use of low-solvent, solvent-Free, waterborne and radiation-curing formulations of one-and two-component polyurethane systems. Bearing in mind concomitant developments, e. g. nanotechnology, polyurethanes will continue to gain further importance. Their spectrum of use will thus expand beyond the established applications into other new areas.

The distribution of world coating raw material consumption is fairly balanced, with one third going to Europe, the Middle East and Africa, just under a third going to the Americas, and slightly more than a third going to Asia-Pacific (APAC). It should be emphasized here that APAC's share of global coating raw materials consumption has grown.

Words and expressions

aliphatic	*adj.*	脂肪族的
aromatic	*adj.*	芳香族的
Asia-Pacific		亚太地区
concomitant	*adj.*	共存的，伴随的
conquest	*v.*	征服
dispersion	*n.*	分散
ethyl	*n.*	乙基
Far East	*n.*	远东

hexamethylene diisocyanate		己二异氰酸酯
hydroxyl	*n.*	羟基
isophorone diisocyanate		异佛尔酮二异氰酸酯
lacquer	*n.*	油漆
legislation	*n.*	法规
methyl	*n.*	甲基
optimization	*n.*	优化
overcoatability	*n.*	再涂性
sealant	*n.*	密封剂
toluene	*n.*	甲苯
trifunctional	*adj.*	三官能度的

Notes to the text

1. diisocyanate 二异氰酸酯，triisocyanate 三异氰酸酯，polyisocyanate 多异氰酸酯。常用的化学名称的前缀表达方式为：mono-单，di-二，tri-三，tetra-四，penta-五，hexa-六，poly-多，聚。
2. their spectrum of use，译为它们的使用范围，此处的 spectrum 是范围的意思，还有光谱的意思，例如，FTIR spectrum 红外光谱。
3. Solvent-free polyurethane reactive adhesives 无溶剂反应型聚氨酯胶黏剂。此处的 free 是无……的意思，另外还有游离的意思，例如，free formaldehyde 游离的甲醛。
4. laminated films and sandwich elements 多层膜，sandwich 原意为三明治，此处是比喻成膜像三明治一样由几层叠加在一起形成。

Lesson 2　Chemical principles and raw materials

2.2.1　Isocyanates

As a rule, isocyanates are obtained by the phosgenation of the corresponding primary amines (Fig. 2 - 1).

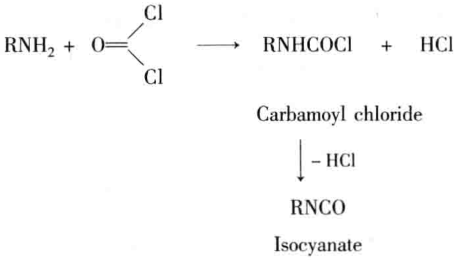


Fig. 2 - 1　Manufacture of isocyanates by phosgenation of primary amines

Alternatively, phosgene - free manufacturing processes have been developed. One such process involves reacting an amine with urea and alcohol to form a urethane that can then be split thermally to yield an isocyanate. This process is also used in the industrial production of some diisocyanates. Fig. 2 - 2 shows the principle of this synthetic route. The standard commercial polyisocyanates used in coatings and adhesives are all derived from just a few diisocyanates with aliphatic, cycloaliphatic or aromatic isocyanate groups. The most important diisocyanates are summarized in Tab. 2 - 1.

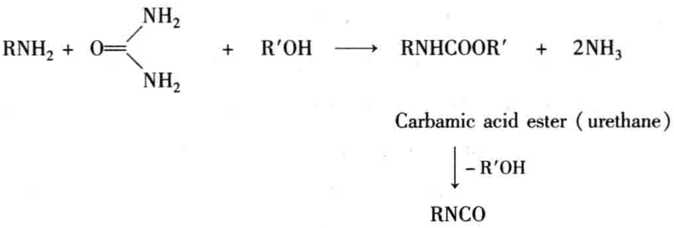
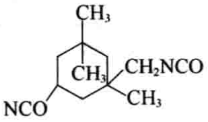
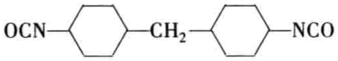
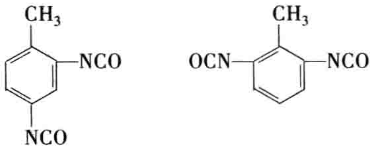
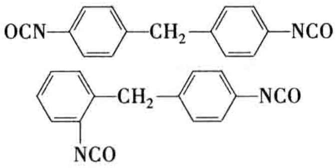
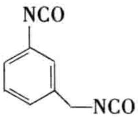
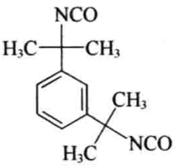


Fig. 2 – 2 Manufacture of isocyanates via the urea route

Tab. 2 – 1 The name and chemical formula of commonly used diisocyanates

name	chemical formula
Hexamethylene diisocyanate (HDI)	OCN $(CH_2)_6NCO$
Isophorone diisocyanate (IPDI) (3-Isocyanatomethyl-3, 5, 5-trimethylcyclohexylisocyanate)	
Bis-(4-isocyanatocyclohexyl) methane (H_{12}MDI)	
2, 4-and 2, 6-Toluene diisocyanate (TDI)	
Diphenylmethane-4, 4′-and/or -2, 4′-diisocyanate (MDI)	
Xylylene diisocyanate (XDI)	
Tetramethylxylene diisocyanate (TMXDI), 1, 3-Bis (1-isocyanato-1-methylethyl) benzene	
Triisocyanatononane (TIN)