教育部高职高专规划教材

高分子材料专业英语

第二版

刘琼琼 主编

English

English

化学工业出版社

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·北京·

本书是《高分子材料专业英语》的第二版，是高职高专高分子材料专业的专业英语教材。全书共分为六大部分（PART A～PART F），内容包括高分子材料的基本知识（Introduction），塑料添加剂（Plastics Additives）和各种树脂（Resins），橡胶配合剂（Rubber Compounding Ingredients）和各种生胶（Raw Rubbers）以及高分子材料的成型加工（Polymer Processing）。书后附有合成橡胶的命名（The Nomenclature of Synthetic Elastomers），高聚物缩写（Acronyms of Polymers）和高分子科学术语的词汇表（Glossary of Polymer Engineering）。

本书为高职高专院校高分子材料类专业师生使用教材，也可供从事高分子材料加工及应用的专业技术人员参考。

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高职高专高分子材料加工技术专业规划教材
编审委员会

前　言

本书第一版自出版以来，得到了广大师生的肯定，并多次重印。大家普遍反映此教材区别于一般的高等学校专业英语教材，具有系统性强，篇幅较短，注释详尽的特点。

在征求使用者意见和建议的基础上，第二版保留了第一版的特色，更换了部分难以理解的篇章，修订了部分注释内容。

第二版改动最大的是在课文正文侧边的空白处给出了专业单词和词组的注释。改动的初衷来源于学生上课时通常将课后单词和词组注释忙于写在书中。采用此种方式可以将词汇的学习融入文章的理解之中，并且针对性较强，有利于文章的阅读。

本书的修订工作由第一版的编写人员共同完成，主要由刘琼琼执笔。

虽然在第二版编写时尽了最大的努力，工作量较大，但书中一定还存在一些不足之处，敬请大家将使用中发现的一些问题及时反馈，以便使教材进一步完善。

编者

2010 年 4 月

第一版前言

本书是教育部高职高专规划教材，是按照教育部对高职高专人才培养工作的指导思想，在广泛吸取了多年来专业英语教学经验的基础上编写的。

全国各高职高专学校的高分子材料专业都开设了“专业英语”课程。这门课为完成基础英语向专业英语的过渡，提高学生阅读高分子材料专业文献资料的能力发挥了重要作用，但一直以来没有相应的教材，本教材的出版将对教学起到重要的作用。

全书共分为六大部分（PART A～PART F），内容包括高分子材料的基本知识（Introduction），塑料加工中的助剂（Plastics Additives）和各种树脂（Resins），橡胶加工中的配合剂（Rubber Compounding Ingredients）和各种生胶（Raw Rubbers）以及高分子材料的成型加工（Polymer Processing）。每课均由课文（Text），单词和词组（Words and Expressions，包括音标及解释），注释（Notes），练习（Exercises）和阅读材料（Reading Material）组成。每课的课文和阅读材料均可独立成篇，取自各种不同风格的专业文献资料。具有词汇量适中、覆盖面广的特点。另外，在附录部分专列了高分子材料专业名词术语表（Glossary of Polymer Engineering）以利于学生查阅。本书主要作为高职高专教材，也可为从事高分子材料加工及应用的专业技术人员参考。

本书编写分工情况为：PART A 和 PART B 由刘晓侠编写；PART C，PART F 的 Unit 1 和 Unit 2 由高炜斌编写；PART D，PART E 和 PART F 的 Unit 3 及附录和词汇表由刘琼琼编写。全书刘琼琼主编，李永芳主审。在编写过程中得到了徐州工业职业技术学院材料工程系的各位老师给予的帮助，在此深表谢意。

限于编者水平，书中的不妥之处在所难免，希望能得到读者的批评指正以利于进一步的完善和改进。

编者

2005 年 3 月

CONTENTS

PART A Introduction

Unit 1 Polymer

聚合物

A polymer is a large molecule built up from numerous smaller molecules. These large molecules may be linear, slightly branched, or highly interconnected. In the later case the structure develops into a large three-dimensional network.

分子
线型的/支化的
交联的
三维网状结构

The small molecules used as the basic building blocks for these large molecules are known as monomers. For example poly(vinyl chloride) is made from the monomer vinyl chloride.[1]The repeat unit in the polymer usually corresponds to the monomer from which the polymer was made. There are exceptions to this, though. Poly(vinyl alcohol) is formally considered to be made of vinyl alcohol repeat units but there is, in fact, no such monomer as vinyl alcohol. [2]To make this polymer, it is necessary first to prepare poly(vinyl acetate) from the monomer vinyl acetate, and then to hydrolyse the product to yield the polymeric alcohol.

单体/聚氯乙烯（PVC）
重复单元
聚乙烯醇（PVA）
聚乙酸乙烯酯（PVAc）
水解

The size of a polymer molecule may be defined either by its mass or by the number of repeat units in molecule. This later indicator of size is called the degree of polymerization, DP. The relative molar mass of the polymer is thus the product of the relative molar mass of the repeat unit and the DP.

聚合度（DP）/相对分子质量

[3]There is no clear cut boundary between polymer chemistry and the rest of chemistry. As a very rough guide, molecules of relative molar mass of at least 10000 or a DP of at least 1000 are considered to fall into the domain of polymer chemistry.

The vast majority of polymers in commercial use are organic in nature, that is, they are based on covalent compounds of carbon. The other elements involved in polymer chemistry most commonly include hydrogen, oxygen, nitrogen, chlorine, fluorine, phosphorus, sulfur and silicon, i.e. those elements which are able to form covalent bonds with carbon.

有机的
共价化合物/碳
氢/氧
氮/氯/氟/磷/硫/硅
共价键

New Words

polymer	['pɔlimə]	*n.*	聚合物
molecule	['mɔlikju:l, 'məu-]	*n.*	分子
linear	['liniə]	*adj.*	线型的
branch	[brɑ:ntʃ]	*vt.*	分支
interconnect	[ˌintə(:)kə'nekt]	*vt.*	使互相连接
network	['netwə:k]	*n.*	网状物
monomer	['mɔnəmə]	*n.*	单体
vinyl	['vainil, 'vinil]	*n.*	乙烯基
chloride	['klɔ:raid]	*n.*	氯化物
alcohol	['ælkəhɔl]	*n.*	醇，乙醇
acetate	['æsiˌteit]	*n.*	醋酸酯、乙酸酯，醋酸盐
hydrolyse	['haidrəlaiz]	*v.*	水解
product	['prɔdʌkt]	*n.*	产品，产物，乘积
mass	[mæs]	*n.*	质量
indicator	['indikeitə]	*n.*	指标
polymerization	[ˌpɔlimərai'zeiʃən]	*n.*	聚合
molar	['məulə]	*adj.*	摩尔的
boundary	['baundəri]	*n.*	分界线
domain	[dəu'mein]	*n.*	范围，领域
organic	[ɔ:'gænik]	*adj.*	有机的
covalent	[kəu'veilənt]	*adj.*	共价的
element	['eliмənt]	*n.*	元素，成分
carbon	['kɑ:bən]	*n.*	碳
hydrogen	['haidrəudʒən]	*n.*	氢
oxygen	['ɔksidʒən]	*n.*	氧
nitrogen	['naitrədʒən]	*n.*	氮
chlorine	['klɔ:ri:n]	*n.*	氯
fluorine	['flu(:)əri:n]	*n.*	氟
phosphorus	['fɔsfərəs]	*n.*	磷
sulfur	['sʌlfə]	*n.*	硫黄
silicon	['silikən]	*n.*	硅

Notes

[1] The repeat unit in the polymer usually corresponds to the monomer from which the polymer was made. There are exceptions to this, though. Poly(vinyl alcohol) is formally considered to be made of vinyl alcohol repeat units but there is, in fact, no such monomer as vinyl alcohol. 聚合物的重复结构单元一般与用于制备此聚合物的单体相对应，然而，也有例外，如聚乙烯醇通常看成是由乙烯醇重复单元组成的，但实际上不存在乙烯醇这种单体。

[2] To make this polymer, it is necessary first to prepare poly(vinyl acetate) from the monomer vinyl acetate, and then to hydrolyse the product to yield the polymeric alcohol. 要制备聚乙烯醇这种聚合物，首先从单体乙酸乙烯酯制备聚乙酸乙烯酯，然后将聚乙酸乙烯酯水解得到聚乙烯醇。

[3] There is no clear cut boundary between polymer chemistry and the rest of chemistry. As a very rough guide, molecules of relative molar mass of at least 10000 or a DP of at least 1000 are considered to fall into the domain of polymer chemistry. 聚合物与其他化合物之间并无明显的界线，一般大致将相对分子质量超过 10000（聚合度超过 1000）的分子划为聚合物。

Exercises

1.Translate the following into Chinese

Polymers are substances containing a large number of structural units joined by the same type of linkage. The key characteristic that distinguishes polymers from other materials is their chain-like molecular structure. This structure is also responsible for the unique properties and processing behavior of polymers. Polymers in the natural world have been around since the beginning of time. Starch, cellulose, and rubber all possess polymeric properties. Man-made polymers have been studied since 1832. Today, the polymer industry has grown to be larger than the aluminum, copper and steel industries combined.

2. Give a definition for each following word

(1) polymer (2) monomer

[Reading Material]

The Rise of Polymer Science

Since most chemists and chemical engineers are now involved in some phase of polymer science or technology, some have called this the polymer age. Actually, we have always lived in a polymer age.

Polymer is derived from the Greek *poly* and *meros*, meaning many and parts, respectively. Some scientists prefer to use the word *macromolecule,* or large molecule, instead of polymer. Others maintain that naturally occurring polymers, or *biopolymers*, and synthetic polymers should be studied in different courses. However, the same principles apply to all polymers. If one discounts the end uses, the differences between all polymers, including plastics, fibers and elastomers or rubbers, are determined primarily by the intermolecular and intramolecular forces between the molecules and within the individual molecule, respectively, and by the functional group present.

Since ancient times, naturally occurring polymers have been used by mankind for various purposes. Proteins from meat and polysaccharides from grain are important sources of food. In addition to being the basis of life itself, protein, which was the first polymer, was (and is) used as a source of amino acids and energy. The ancients degraded or depolymerized the protein in tough meat by aging and cooking and denatured egg albumin by heating or adding vinegar to the eggs.

Wool and silk, both proteins, serve as clothing. Wood, the main component of which is cellulose, a polysaccharide, is used for building and fire-making. The use of asphalt as an adhesive is mentioned in the Bible. Amber, a high-molar mass resin, was worn by the Greeks as a jewel.

Early humans learned how to process, dye, and weave the natural proteinaceous fibers of wool and silk and the carbohydrate fibers of flax and cotton. Early South American civilizations used natural rubber for making elastic articles and for waterproofing of fabrics.

Nobel laureate Hermann Staudinger laid the groundwork for modern polymer science in the 1920s. The development of polymer technology since 1940s has been extremely rapid. The world production of synthetic rubber has for a long time (in 1960s) exceeded that of natural rubber and that the world production of synthetic fibers equaled to that of the natural fibers in 1970s. The volume production of plastics in the world already exceeded that of steel in the end of 20th century.

New Words and Expressions

macromolecule	[ˌmækrəu'mɔlikju:l]	*n.*	高分子，大分子
principle	['prinsəpl]	*n.*	原理，法则，原则
elastomer	[i'læstəmə(r)]	*n.*	弹性体
intermolecular	[ˌintrəmə'lekjulə]		分子间的
intramolecular	[ˌintrəmə'lekjulə]	*adj.*	分子内的
functional group			官能团
polysaccharide	[pɔli'sækəraid]	*n.*	多糖，聚糖，多聚糖
degrade	[di'greid]	*v.*	(使)降级
depolymerize	[di:'pɔliməraiz]	*v.*	(使)解聚
denature	[di:'neitʃə]	*vt.*	使变性
albumin	[æl'bjumin]	*n.*	白蛋白
vinegar	['vinigə]	*n.*	醋
cellulose	['seljuləus]	*n.*	纤维素
asphalt	['æsfælt]	*n.*	沥青
adhesive	[əd'hi:siv]	*n.*	胶黏剂
		adj.	黏性的
amber	['æmbə]	*n.*	琥珀
resin	['rezin]	*n.*	树脂
dye	[dai]	*n.*	染料，染色
proteinaceous	[ˌprəuti:'neiʃəs,-ti:i-]	*adj.*	蛋白质的，似蛋白质的
carbohydrate	['kɑ:bəu'haidreit]	*n.*	碳水化合物，糖类
flax	[flæks]	*n.*	亚麻，麻布，亚麻织品
laureate	['lɔ:riit]	*adj.*	佩戴桂冠的
		n.	戴桂冠的人

Unit 2 Classification of Polymers

聚合物的分类

There are a number of methods of classifying polymers. [1]One is to adopt the approach of using their response to thermal treatment and to divide them into thermoplastics and thermosets. Thermoplastics are polymers which melt when heated and resolidify when cooled, while thermosets are those which do not melt when heated but, at sufficiently high temperatures, decompose irreversibly. This system has the benefit that there is a useful chemical distinction between the two groups. [2]Thermoplastics comprise essentially linear or lightly branched polymer molecules, while thermosets are substantially crosslinked materials, consisting of an extensive three-dimensional network of covalent chemical bonding.

热处理
热塑性/热固性聚合物
熔化/加热/再固化/冷却
分解
交联
共价键

Another classification system, first suggested by Carothers in 1929, is based on the nature of the chemical reactions employed in the polymerization. Here the two major groups are the condensation and the addition polymers. [3]Condensation polymers are those prepared from monomers where reaction is accompanied by the loss of a small molecule, usually of water. By contrast, addition polymers are those formed by the addition reaction of an unsaturated monomer, such as takes place in the polymerization of vinyl chloride.

化学反应
聚合/缩聚物
加聚物
加成反应/不饱和单体
氯乙烯

This system was slightly modified by P. J. Flory, who placed the emphasis on the mechanisms of the polymerization reactions. He reclassified polymerizations as step reactions or chain reactions corresponding approximately to condensations or addition in Carother's scheme, but not completely. [4]A notable exception occurs with the synthesis of polyurethanes, which are formed by reaction of isocyanates with hydroxyl compounds and follow "step" kinetics, but without the elimination of a small molecule.

聚合反应历程
逐步反应/连锁反应
合成/聚氨酯/异氰酸酯
羟基化合物/逐步动力学

[5]In the first of these, the kinetics are such that there is a gradual built up of high relative molar mass material as reaction proceeds, with the highest molar mass material not appearing until the very end of the reaction. [6]On the other hand, chain reactions, which occur only at a relatively few activated sites within the reaction medium, occur with rapid build up of a few high relative molar mass molecules while the rest of the monomer remains unreacted. When formed, such macromolecules stay essentially unchanged while the rest of the monomer undergoes conversion. [7]This means that large molecules

活性中心/反应介质
大分子
转化

appear very early in the polymerization reaction, which is charactered by having both high relative molar mass and monomer molecules present for most of the duration of the reaction.

New Words

classify	['klæsifai]	*vt.*	分类，分等
thermal	['θə:məl]	*adj.*	热的，热量的
thermoplastics	[ˌθə:mə'plæstiks]	*n.*	热塑性材料，热塑性塑料
thermoset	['θə:məset]	*n.*	热固性材料，热固性塑料
		adj.	热固的
melt	[melt]	*v.*	(使)熔化
solidify	[sə'lidifai]	*v.*	(使)凝固
decompose	[ˌdi:kəm'pəuz]	*v.*	分解
comprise	[kəm'praiz]	*v.*	包含，由…组成
crosslink	['krɔsliŋk]	*v/n.*	交联
polymerization	[ˌpɔlimərai'zeiʃən]	*n.*	聚合
condensation	[kɔnden'seiʃən]	*n.*	浓缩
addition	[ə'diʃən]	*n.*	加成
unsaturated	['ʌn'sætʃəreitid]	*adj.*	不饱和的
mechanism	['mekənizəm]	*n.*	机理，历程
scheme	[ski:m]	*n.*	方案
synthesis	['sinθisis]	*n.*	合成
polyurethane	[ˌpɔli'juəriθein]	*n.*	聚氨酯
isocyanate	[ˌaisəu'saiəneit]	*n.*	异氰酸酯
hydroxyl	[hai'drɔksil]	*n.*	羟基
kinetics	[kai'netiks]	*n.*	动力学
elimination	[iˌlimi'neiʃən]	*n.*	除去，消除
activated	['æktiveitid]	*adj.*	有活性的
medium	['mi:djəm]	*n.*	介质
unreacted	['ʌnri'æktid]	*adj.*	未反应的
undergo	[ˌʌndə'gəu]	*vt.*	经历
conversion	[kən'və:ʃən]	*n.*	转化
duration	[djuə'reiʃən]	*n.*	持续时间，为期

Notes

[1] One is to adopt the approach of using their response to thermal treatment and to divide them into thermoplastics and thermosets. Thermoplastics are polymers which melt when heated and resolidify when cooled, while thermosets are those which do not melt when heated but, at sufficiently high temperatures, decompose irreversibly. 一种是根据热行为将聚合物分成热塑性和热固性。热塑性聚合物加热熔化，冷却固化，而热固性聚合物加热不会熔化，在温度

特别高时则会发生不可逆分解。

[2] Thermoplastics comprise essentially linear or lightly branched polymer molecules, while thermosets are substantially crosslinked materials, consisting of an extensive three-dimensional network of covalent chemical bonding. 热塑性聚合物基本上是由线性的或支化的高分子组成；固性聚合物则是完全交联的，它是通过共价键连接而成的三维网状结构材料。

[3] Condensation polymers are those prepared from monomers where reaction is accompanied by the loss of a small molecule, usually of water. By contrast, addition polymers are those formed by the addition reaction of an unsaturated monomer, such as takes place in the polymerization of vinyl chloride. 缩聚物是由单体通过缩合反应形成，反应过程中有小分子生成，通常是水。与缩聚物不同，加聚物是由不饱和单体通过加聚反应形成，例如氯乙烯单体的聚合。

[4] A notable exception occurs with the synthesis of polyurethanes, which are formed by reaction of isocyanates with hydroxyl compounds and follow "step" kinetics, but without the elimination of a small molecule. （上述两种分类方法不一致）在聚氨酯的合成表现明显，聚氨酯是由异氰酸酯与羟基化合物反应，遵循逐步反应机理，但反应过程中却没有小分子生成。

[5] In the first of these, the kinetics are such that there is a gradual built up of high relative molar mass material as reaction proceeds, with the highest molar mass material not appearing until the very end of the reaction. 第一类聚合（逐步聚合）的机理是随着反应的进行，分子量逐步增加，直到反应结束才有高分子生成。

[6] On the other hand, chain reactions, which occur only at a relatively few activated sites within the reaction medium, occur with rapid build up of a few high relative molar mass molecules while the rest of the monomer remains unreacted. 另一类连锁聚合反应只是在少量活性中心上进行，反应体系中迅速生成高分子，同时体系中还存有未反应的单体。

[7] This means that large molecules appear very early in the polymerization reaction, which is charactered by having both high relative molar mass and monomer molecules present for most of the duration of the reaction. 这意味着高分子在聚合反应一开始就会形成，表现为几乎在整个聚合反应期间高分子和单体分子同时存在。

Exercises

Read the following short article and comprehend the classificaiton of polymers:

1) **Natural – Synthetic**

Based on the origin of the material, whether natural or synthesized.

2) **Organic – Inorganic**

Organic polymers have carbon backbone. PE, PP, PS etc.

Inorganic polymers do not contain carbon backbone. Glass, Silicone polymers.

3) **Thermoplastic – Thermosetting**

Thermoplastics soften on heating.

Thermosets do not soften or melt on heating. Cross-linked chains.

4) **Plastics, elastomers, fibers, resins**

Classified as per the use of polymeric material.

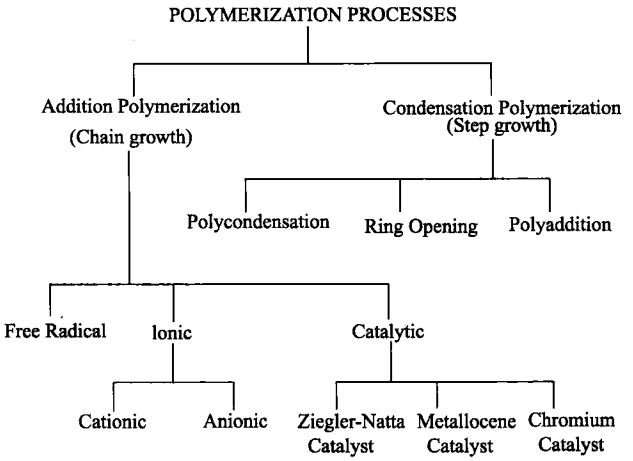
5) **Addition polymers – Condensation polymers**

Based on manufacturing process.

The classification based on manufacturing process is important for the course, "Industrial Polymerization".

Addition Polymerization: Also called as *Chain Polymerization, Chain growth Polymerization, Chain Reaction Polymerization.*

Condensation Polymerization: Also called as *Step Polymerization, Step Growth Polymerization, Step Reaction Polymerization.*



Examples:

Addition polymers: Polyethylene, Polypropylene, PVC, Polystyrene.

Condensation polymers: Polyesters, Nylon 66, Polycarbonates, Polyurethanes, Epoxy resins.

[Reading Material]

Polymer Architecture

An important microstructural feature determining polymer properties is the polymer architecture. The simplest polymer architecture is a linear chain: a single backbone with no branches. A related unbranching architecture is a ring polymer. A branched polymer molecule is composed of a main chain with one or more substituent side chains or branches. Special types of branched polymers include star polymers, comb polymers, brush polymers, dendronized polymers, ladders, and dendrimers.

Branching of polymer chains affects the ability of chains to slide past one another by altering intermolecular forces, in turn affecting bulk physical polymer properties. Long chain branches may increase polymer strength, toughness, and the glass transition temperature due to an increase in the number of entanglements per chain. The effect of such long-chain branches on the size of the polymer in solution is characterized by the branching index. Random length and atactic short chains, on the other hand, may reduce polymer strength due to disruption of organization and may likewise reduce the crystallinity of the polymer.

A good example of this effect is related to the range of physical attributes of polyethylene. High-density polyethylene (HDPE) has a very low degree of branching, is quite stiff, and is used in

applications such as milk jugs. Low-density polyethylene (LDPE), on the other hand, has significant numbers of both long and short branches, is quite flexible, and is used in applications such as plastic films.

Dendrimers are a special case of polymer where every monomer unit is branched. This tends to reduce intermolecular chain entanglement and crystallization. Alternatively, dendritic polymers are not perfectly branched but share similar properties to dendrimers due to their high degree of branching.

The architecture of the polymer is often physically determined by the functionality of the monomers from which it is formed. This property of a monomer is defined as the number of reaction sites at which may form chemical covalent bonds. The basic functionality required for forming even a linear chain is two bonding sites. Higher functionality yields branched or even crosslinked or networked polymer chains.

An effect related to branching is chemical crosslinking - the formation of covalent bonds between chains. Crosslinking tends to increase T_g and increase strength and toughness. Among other applications, this process is used to strengthen rubbers in a process known as vulcanization, which is based on crosslinking by sulfur. Car tires, for example, are highly crosslinked in order to reduce the leaking of air out of the tire and to toughen their durability. Eraser rubber, on the other hand, is not crosslinked to allow flaking of the rubber and prevent damage to the paper.

A crosslink suggests a branch point from which four or more distinct chains emanate. A polymer molecule with a high degree of crosslinking is referred to as a polymer network. Sufficiently high crosslink concentrations may lead to the formation of an infinite network, also known as a gel, in which networks of chains are of unlimited extent-essentially all chains have linked into one molecule.

Words and Expressions

architecture	['ɑ:kitekʧə]	*n.*	构造
ring	[riŋ]	*n.*	链状
side chain			侧链，支链
star polymer			星形高聚物
comb polymer			梳型高聚物
dendronized polymer			树形高分子
ladder	['lædə]	*n.*	梯形高分子
dendrimer		*n.*	超支化高分子
strength	[streŋθ]	*n.*	强度
toughness	['tʌfnis]	*n.*	韧性
entanglement	[in'tæŋglmənt]	*n.*	缠结
crystallinity	[ˌkristə'liniti]	*n.*	结晶度
high-density polyethylene (HDPE)			高密度聚乙烯
degree of branching			支化度
milk jug		*n.*	奶壶