

· 高等学校专业教材 ·

ENGLISH FOR POLYMER  
ENGINEERING SPECIALITY

# 高分子材料工程专业英语

· 揣成智 主 编 ·



ENGLISH



中国轻工业出版社


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# 前 言

本教材根据全国高等院校塑料工程专业教材委员会计划要求而编写的大学本科教材。全书共 72 课：第 1 课和第 2 课介绍聚合物科学历史和基本概念，第 3 课至第 18 课介绍高分子化学和高分子物理方面的知识，第 19 课至第 21 课介绍塑料工业方面的知识，第 22 课至第 35 课介绍常用的塑料材料，第 36 课至第 38 课介绍树脂性能分析，第 39 课至第 52 课介绍塑料成型加工，第 53 课介绍橡胶的发展史，第 54 课至第 64 课介绍橡胶材料、橡胶配方设计和橡胶成型加工，第 65 课和第 66 课介绍合成纤维的一些基本概念，第 67 课和第 68 课分别介绍美国化学文摘中的论文和专利文摘，第 69 课和第 70 课介绍中英文摘要翻译，第 71 课和第 72 课分别介绍国际论文和专利阅读。

全书每课除正文外，还附有词汇、词组、课文注释、补充资料和课后练习。单词用国际音符标注，补充资料有构词法、科技英语翻译理论与技巧、英文摘要写作等。书末安排附录和总词汇表，以利读者查阅。本书可作为高等院校高分子材料与工程专业的专业英语教材，也可作为从事聚合物工程及有关科技人员自修专业英语的参考书。

本教材编写分工如下：第 1 课至第 18 课、第 65 课和第 66 课由北京轻工业学院项爱民编写，第 19 课至第 52 课由天津轻工业学院揣成智编写，第 53 课至第 64 课、第 67 课至第 72 课、附录及词汇表由天津轻工业学院李树编写，第 1 课至第 72 课中的补充材料 (Additional Information) 及与之有关的少量练习由天津轻工业学院邬素华编写。全书由天津轻工业学院揣成智主编并负责统稿，由天津轻工业学院王保清教授负责主审。

在本书编写过程中，得到原国家轻工总会人教部、中国轻工业出版社、天津轻工业学院、北京轻工业学院及兄弟院校有关领导和同仁的帮助与支持，谨此表示由衷的感谢。

由于本教材为国内第一本高分子材料与工程专业适用的专业英语统编教材，加上编者水平所限，书中不足和错误在所难免，恳请读者不吝指正。

编者

1999 年 3 月

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## Lesson 1 History of Macromolecular Science

Natural polymers have been utilized throughout the ages. Since his beginning man has been dependent upon animal and vegetable matter for sustenance, shelter, warmth, and other requirements and desires. Natural resins and gums have been used for thousands of years. Asphalt was utilized in pre-Biblical times; amber was known to the ancient Greeks; and gum mastic was used by the Romans.

In the search by the early organic chemists for pure compounds in high yields, many polymeric substances were discovered and as quickly discarded as oils, tars, or undistillable residues. A few of these materials, however, attracted interest. Poly (ethylene glycol) was prepared about 1860; the individual polymers with degree of polymerization up to 6 were isolated and their structures correctly assigned. The concept of extending the structure to very high molecular weights by continued condensation was understood.

Other condensation polymers were prepared in succeeding decades. As the molecular aggregation theories gained in popularity, structures involving small rings held together by secondary bond forces were often assigned to these products<sup>(1)</sup>.

Some vinyl polymers were also discovered. Styrene was polymerized as early as 1839, isoprene in 1879, and methacrylic acid in 1880. Again cyclic structures held together by "partial valences" were assigned.

Acceptance of the macromolecular hypothesis came about in the 1920's, largely because of the efforts of Staudinger, who received the Nobel prize in 1953 for his championship of this viewpoint<sup>(2)</sup>. In 1920 he proposed long-chain formulas for polystyrene, rubber, and polyoxymethylene. His extensive investigations of the latter polymers left no doubt as to their long-chain nature. More careful molecular weight measurements substantiated Staudinger's conclusions, as did x-ray studies showing structures for cellulose and other polymers which were compatible with chain formulas. The outstanding series of investigations by Carothers beginning in 1929 supplied quantitative evidence substantiating the macromolecular viewpoint.

One deterrent to the acceptance of the macromolecular theory was the problem of the ends of the long-chain molecules. Since the degree of polymerization of a typical polymer is several hundred, chemical methods for detecting end groups were at first not successful. Staudinger suggested that no end groups were needed to saturate terminal valences of the long chains; they were considered to be unreactive because of the size of the molecules. Large ring structures were also hypothesized; and this concept was po-

pular for many years. Not until Flory elucidated the mechanism for chain-reaction polymerization did it become clear that the ends of long-chain molecules consist of normal, satisfied valence structures<sup>(3)</sup>. The presence and nature of end groups have since been investigated in detail by chemical methods.

Staudinger was among the first to recognize the large size of polymer molecules, and to utilize the dependence on molecular weight of a physical property, such as dilute solution viscosity, for determining polymer molecular weights. He also understood clearly that synthetic polymers are polydisperse. A few years later, Lansing and Kraemer distinguished unmistakably among the various average molecular weights obtainable experimentally.

Staudinger's name is also associated with the first studies of the configuration of polymer chain atoms. He showed that the phenyl groups in polystyrene are attached to alternate chain carbon atoms. This regular head-to-tail configuration has since been established for most vinyl polymers. The mechanism for producing branches in normally linear vinyl polymers was introduced by Flory but such branches were not adequately identified and characterized for another decade. Natta first recognized the presence of stereospecific regularity in vinyl polymers.

## 1. New words

gum [gʌm] *n.* 胶

asphalt ['æsfælt] *n.* 沥青, 柏油

amber ['æmbə] *n.* 琥珀

tar [tɑ:] *n.* 焦油

polyethylene [ˌpɒli'eθili:n] *n.* 聚乙烯

vinyl ['vainil] *n.* 乙烯基

styrene ['staiəri:n] *n.* 苯乙烯

glycol ['glai kəl] *n.* 乙二醇

polymerization [ˌpɒliməri'zeɪʃən] *n.* 聚合作用

isoprene [ai'səʊpri:n] *n.* 异戊二烯

methacrylic [ˌmeθə'krilik] *n.* 甲基丙烯类的

polystyrene [ˌpɒli'staiəri:n] *n.* 聚苯乙烯

polyoxymethylene [ˌpɒli,ɒksi'meθili:n] *n.* 聚  
甲醛

cellulose ['seljʊləʊs] *n.* 纤维素

deterrent [di'terənt] *n.* 阻碍物

viscosity [vis'kɒsiti] *n.* 粘度

polydisperse [ˌpɒlɪdɪs'pɜ:s] *a.* 多分散性的

phenyl ['fenil] *n.* 苯基

configuration [kən'figjʊ'reɪʃən] *n.* 构型

stereospecific [ˌstiəriəʊspə'sɪfɪk] *n.* 有规立构  
定向的

elucidate [i'ljʊ:sideɪt] *vt.* 阐明

## 2. Useful words and expressions

ethylene glycol 乙二醇

degree of polymerization 聚合度

molecular weight 分子量

secondary bond 次价键

methacrylic acid 甲基丙烯酸, 丙烯酸

long-chain 长链

end group 端基

chain-reaction 链式反应

dilute solution viscosity 稀溶液粘度

head-to-tail configuration 头尾构型

### 3. Notes to the text

(1) As the molecular aggregation theories gained in popularity, structures involving small rings held together by secondary bond forces were often assigned to these products. 由于分子缔合理论当时很盛行, 人们把这些产品的结构看成是由次价键力结合起来的小环。

(2) Acceptance of the macromolecular hypothesis came about in the 1920's, largely because of the efforts of Staudinger, who received the Nobel Prize in 1953 for his championship of this viewpoint. 主要由于施陶丁格(Staudinger)的努力, 20世纪20年代高分子概念才被人们接受, 正是由于这个观点, 1953年他被授予诺贝尔奖。

(3) Not until Flory elucidated the mechanism for chain-reaction polymerization did it become clear that the ends of long-chain molecules consist of normal, satisfied valence structures. 直到Flory (1937)澄清链式反应聚合机理以后, 长链分子反应末端是正常的价键结构的看法才被接受。

### 4. Additional information

#### 科技英语翻译的一般知识 I

**翻译的任务:** 翻译是一种语言表达法。其任务就是“把一种语言文字的意义用另一种语言文字表达出来。”与文学英语翻译有所不同的是, 科技英语翻译要注重逻辑思维, 讲究语言上的规范、表达上的妥协和译文的流畅。

**翻译的标准:** 概括地说: “确切性”是翻译的总的标准。而“信、达、雅”常作为一般翻译的质量标准。“信”谓之忠实原文; “达”谓之通顺, 译文通俗易懂; “雅”谓之修辞, 译文辞藻优美, 语言精练。

对科技翻译而言, 还须做到明确、通顺、简练。所谓明确, 有两方面的含义。一是确切, 即在技术内容上要忠实于原文。二是明白, 就是表达原文, 不应有模糊不清, 模棱两可之处。通顺: 就是说译文应当合乎中文的语法要求, 读起来易懂, 顺口。简练: 就是译文要尽可能简短、精练, 没有冗词废字, 不重复啰嗦, 力求作到简洁明快, 精练流畅。

### 5. Exercises

- (1) Early investigations of macromolecular structures showed that \_\_\_\_\_ .  
a. it was a long-chain structure    b. it was a cyclic structure  
c. it was a colloidal structure
- (2) When did experimental methods of molecular weights become available?  
a. 1826    b. 1880    c. 1920    d. 1929
- (3) Whose investigations were considered very import in acceptance of the existence of macromolecules?  
a. Raoult    b. Van't Hoff    c. Staudinger    d. Flory.
- (4) The degree of polymerization of a typical polymer is \_\_\_\_\_ .  
a. only several    b. several hundred    c. several ten
- (5) Staudinger suggested that no end groups were needed to saturate terminal valences of the long chains. Do you think so?  
a. Yes    b. No

- (6) Who found experiment methods to obtain molecular weight for such substance as rubber starch?
- a. Raoult and Van't Hoff.      b. Raoult and Standinger  
c. Standinger and Carother.      d. Carother and Raoult.
- (7) When was the first synthetic polymer prepared?
- a. 1860      b. 1826      c. 1920      d. 1880

## Lesson 2 Basic Concepts of Polymer Science

Almost half a century ago, Wolfgang Ostwald coined the phrase "the land of neglected dimensions" to describe the range of sizes between molecular and macroscopic within which occur most colloidal particles. The term "neglected dimensions" might have been applied equally well to the world of polymer molecules, the high-molecular-weight compounds so important to man and his modern technology. It was not until the third decade of this century that the science of high polymers began to emerge, and the major growth of the technology of these materials came even later. Yet today polymer dimensions are neglected no more, for industries associated with polymeric materials employ more than a third of all American chemists and chemical engineers.

The science of macromolecules is divided between biological and nonbiological materials. Each is of great importance. Biological polymers form the very foundation of life and intelligence, and provide much of the food on which man exists. This book, however, is concerned with the chemistry, physics, and technology of nonbiological polymers. These are primarily the synthetic materials used for plastics, fibers, and elastomers, but a few naturally occurring polymers, such as rubber, wool, and cellulose, are included. Today, these substances are truly indispensable to mankind, being essential to his clothing, shelter, transportation, and communication, as well as to the conveniences of modern living.

A polymer is a large molecule built up by the repetition of small, simple chemical units. In some cases the repetition is linear, much as a chain is built up from its links. In other cases the chains are branched or interconnected to form three-dimensional networks<sup>(1)</sup>. The repeat unit of the polymer is usually equivalent or nearly equivalent to the monomer, or starting material from which the polymer is formed. Thus the repeat unit of poly (vinyl chloride) is  $-\text{CH}_2\text{CHCl}-$ ; its monomer is vinyl chloride,  $\text{CH}_2=\text{CHCl}$ .

The length of the polymer chain is specified by the number of repeat units in the chain. This is called the degree of polymerization. The molecular weight of the polymer is the product of the molecular weight of the repeat unit and the degree of polymerization<sup>(2)</sup>. Using poly (vinyl chloride) as an example, a polymer of degree of polymerization 1000 has a molecular weight of  $63 \times 1000 = 63000$ . Most high polymers useful for plastics, rubbers, or fibers have molecular weights between 10,000 and 1,000,000.

Unlike many products whose structure and reactions were well known before their industrial application, some polymers were produced on an industrial scale long before

their chemistry or physics was studied. Empiricism in recipes, processes, and control tests was usual.

Gradually the study of polymer properties began. Almost all were first called anomalous because they were so different from the properties of low-molecular-weight compounds. It was soon realized, however, that polymer molecules are many times larger than those of ordinary substances. The presumably anomalous properties of polymers were shown to be normal for such materials, as the consequences of their size were included in the theoretical treatments of their properties.

Primary chemical bonds along polymer chains are entirely satisfied. The only forces between molecules are secondary bond forces of attraction, which are weak relative to primary bond forces<sup>(3)</sup>. The high molecular weight of polymers allows these forces to build up enough to impart excellent strength, dimensional stability, and other mechanical properties to the substances<sup>(4)</sup>.

### 1. New words

coin [kɔɪn] *vt.* 制造 (字句), 杜撰  
elastomer [i'læstəʊmə] *n.* 弹性体  
monomer ['mɒnəmə] *n.* 单体  
recipe ['resipi] *n.* 配方

indispensable [ɪndɪ'spensəbl] *a.* 不可缺少的  
empiricism [em'pɪrɪsɪzəm] *n.* 经验主义  
anomalous [ə'nɒmələs] *a.* 反常的, 不规则的

### 2. Useful words and expression

build up 组成, 形成, 聚集  
three dimensional network 三维网状结构  
repeat unit 重复单元

poly (vinyl chloride) 聚氯乙烯  
primary bond 主价键  
dimensional stability 尺寸稳定性

### 3. Notes to the text

(1) In some cases the repetition is linear, much as a chain is built up from its links. In other cases the chains are branched or interconnected to form three-dimensional networks. 这些重复单元有的形成线型的, 很像一条链; 有的形成支化的; 有的相互连接形成三维网状结构。

(2) The molecular weight of the polymer is the product of the molecular weight of the repeat unit and the degree of polymerization. 聚合物的分子量是重复单元的分子量与聚合度的乘积。

(3) The only forces between molecules are secondary bond forces of attraction, which are weak relative to primary bond forces. 分子间唯一能有的力是次价键的引力, 这种引力比主价键的力要小。

(4) The high molecular weight of polymers allows these forces to build up enough to impart excellent strength, dimensional stability and other mechanical properties to the substances. 由于聚合物的分子量大, 这些力可以累加得很大, 使这些物质具有非常好的强度、尺寸稳定性和其他力学性能。

## 4. Additional information

### 科技英语翻译的一般知识 I

**翻译过程：**为使译文达到上述标准，在翻译过程中要注意理解、表达和校核三个阶段。

(1) 深刻理解原文：要想深刻理解原文，译者必须精通专业知识。理解科技文献中的每一名称术语的特定含义。例如：yield 一般译作“产量”，而在林业中译作“收获量”，造纸业中译作“得率”，塑料工业中译作“屈服”或“挤出量”。gate 一般译作“大门”或“闸门”，而在塑料工业中译作“浇口”等。即使译者具有一定的专业知识，也要在翻译前通读全文，首先了解这篇文章说的是哪方面的内容，然后再着手翻译，否则会铸成大错，或笑话百出。

(2) 确切表达译文：在深刻、完全地理解了原文的意思之后，就要力求确切地表达译文，将原文所表达的事物概念不折不扣、恰如其分、明确通顺地表达成译文，要在深刻理解原文的基础上准确选词和恰当造句，并在造句时注意避免歧义并力求文字简练。

(3) 校核阶段：是理解与表达的进一步深化，是对原文内容进一步核实以及对译文语言进一步推敲的阶段。通过对译文的校阅，看它是否通顺流畅，同时进行必要的润色加工，尽量删去那些可有可无的字，并在必要时进行适当的增补，以避免繁琐或消除歧义。

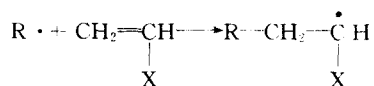
## 5. Exercises

- (1) What phrase did Wolfgang Ostwald coin to describe the macromolecules almost half a century ago?
- (2) What is the science of macromolecules divided? What is this book concerned with?
- (3) What is the definition of a polymer?
- (4) Why were almost polymers, first called anomalous in the study of polymer properties?
- (5) How much is its molecular weight if a polyethylene has the degree of polymerization 1000?



## Lesson 3 The Inherent Reactivity of Radicals

At one time it was believed that one could assess the reactivity of radicals, and the converse order for monomers, by considering the change in stabilization energy for the following process:



According to this view, the most reactive monomer will yield the least reactive radical, and so on, because of their structural relationship. To some extent this view is supported by data which generally indicate that vinyl acetate is one of the least reactive of monomers while yielding one of the most reactive radicals, precisely the reverse being the case for styrene. Unfortunately, for substances of intermediate reactivity the situation is far less clear cut and it is here that one is forced to conclude that different factors prove dominant in determining reactivity in different reactions<sup>(1)</sup>. With the more strongly polar transfer agents, such as CBr<sub>4</sub> or FeCl<sub>3</sub>, the intrusion of polar factors is particularly strong and the concept of a unique order of reactivity cannot possibly be maintained.

A conclusive demonstration of the failure of the unique order of reactivity concept is afforded by an examination of the relative reactivity of polystyrene (S ·) and polyacrylonitrile (AN ·) radicals towards a variety of substrates across the polarity spectrum<sup>(2)</sup>. The data in Table 3.1 indicate that, judged by the standard of transfer with ferric chloride, the S · radical is one hundred times as reactive as the AN ·, although transfer with triethylamine leads to the conclusion that the AN · radical is five thousand times as reactive as the S ·. In fact, one can obtain almost any apparent ratio of reactivities by suitable substrate selection so that bald statements that one radical is more reactive than another are seen to be without meaning<sup>(3)</sup>.

**Table 3.1 Relative rate constants for polystyrene and polyacrylonitrile radicals**

Substrate	Ratio of rate constants S · / AN ·
FeCl <sub>3</sub>	100
CH <sub>2</sub> =CH · CN	2
CH <sub>2</sub> =CH · Cl	0.05
CH <sub>2</sub> =CH · Φ	0.002
N (C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub>	0.0002