Unit 1 What are polymers?

What are polymers? For one thing, they are complex and giant molecules and are different from low molecular weight compounds like, say, common salt.

什么是高聚物？首先，他们是合成物和大分子，并且不一样于低分子化合物，譬如说一般的盐。

To contrast the difference, the molecular weight of common salt is only 58.5, while that of a polymer can be as high as several hundred thousand, even more than thousand thousands.

与低分子化合物不一样的是，一般盐的分子量仅仅是**58.5**，而高聚物的分子量高于**10 5**，甚至不小于**106**。

These big molecules or 'macro-molecules' are made up of much smaller molecules, can be of one or more chemical compounds.

这些大分子或“高分子”由许多小分子构成。小分子互相结合形成大分子，大分子可以是一种或多种化合物。

To illustrate, imagine that a set of rings has the same size and is made of the same material. When these things are interlinked, the chain formed can be considered as representing a polymer from molecules of the same compound.

举例阐明，想象一组大小相似并由相似的材料制成的环。当这些环互相连接起来，可以把形成的链当作是具有同种化合物构成的高聚物。

Alternatively, individual rings could be of different sizes and materials, and interlinked to represent a polymer from molecules of different compounds.

另首先，环可以大小不一样、材料不一样,

相连接后形成具有不一样化合物构成的聚合物。

This interlinking of many units has given the polymer its name, poly meaning 'many' and

mer meaning ‘part’ (in Greek).

聚合物的名称来自于许多单元相连接，**poly**意味着“多、聚、反复”，**mer**意味着“链节、基体”（希腊语中）。

As an example, a gaseous compound called butadiene, with a molecular weight of 54, combines nearly 4000 times and gives a polymer known as polybutadiene (a synthetic rubber) with about 200 000molecular weight.

例如：气态化合物丁二烯的分子量为**54**，连接**4000**次可得到分子量大概为**202300**的聚丁二烯（合成橡胶）高聚物。

The low molecular weight compounds from which the polymers form are known as monomers. The picture is simply as follows:

形成高聚物的低分子化合物称为单体。下面简朴地描述一下形成过程：

butadiene + butadiene + … + butadiene--→polybutadiene(4 000 time)

丁二烯 ＋丁二烯＋…＋丁二烯——→聚丁二烯（**4000**次）

One can thus see how a substance (monomer) with as small a molecule weight as 54 grow to become a giant molecule (polymer) of (54×4 000≈)200 000 molecular weight.

可以懂得分子量仅为**54**的小分子物质（单体）怎样逐渐形成分子量为**202300**的大分子（高聚物）。

It is essentially the “giantness” of the size of the polymer molecule that makes its behavior (different from that of a commonly known chemical compound such as benzene.)

实质上正是由于聚合物的巨大分子尺寸才使其性能不一样于像苯这样的一般化合物（的性能）

Solid benzene, for instance, melts to become liquid benzene at 5.5℃ and , on further

heating, boils into gaseous benzene.

例如固态苯在**5.5**℃熔融成液态苯，深入加热，煮沸成气态苯。

As against this well-defined behavior of a simple chemical compound, a polymer like polyethylene does not melt sharply at one particular temperature into clean liquid.

与此类简朴化合物明确的行为相比，像聚乙烯这样的聚合物不能在某一特定的温度迅速地熔融成纯净的液体。

Instead, it becomes increasingly softer and, ultimately, turns into a very viscous, tacky molten mass. Further heating of this hot, viscous, molten polymer does convert it into various gases but it is no longer polyethylene. (Fig. 1.1) .

而聚合物变得越来越软，最终变成十分粘稠的聚合物熔融体。将这种热而粘稠的聚合物熔融体深入加热，它会转变成不一样气体，但它不再是聚乙烯（如图**1.1**）

Another striking difference with respect to the behavior of a polymer and that of a low molecular weight compound concerns the dissolution process.

聚合物行为和低分子量化合物另一不一样的行为为溶解过程。

Let us take, for example, sodium chloride and add it slowly to fixed quantity of water. The salt, which represents a low molecular weight compound, dissolves in water up to a point (called saturation point) but, thereafter, any further quantity added does not go into solution but settles at the bottom and just remains there as solid.

例如，将氯化钠慢慢地添加到定量的水中。盐作为一种低分子量化合物，在水中溶解直到某一点（叫饱和点），但深入添加,

盐不进入溶液中却沉究竟部而保持原有的固体状态

The viscosity of the saturated salt solution is not very much different from that of water. But if we take a polymer instead, say, polyvinyl alcohol, and add it to a fixed quantity of water, the polymer does not go into solution immediately.

饱和盐溶液旳粘度与水旳粘度靠近.不过，假如我们用聚合物，如聚乙烯醇添加到定量水中，聚合物不是立即进入到溶液中。

The globules of polyvinyl alcohol first absorb water, swell and get distorted in shape and after a long time go into solution.

聚乙烯醇颗粒首先吸水溶胀，发生变形，通过很长时间后，（聚乙烯醇分子）进入到溶液中。

Also, we can add a very large quantity of the polymer to the same quantity of water without the saturation point ever being reached.

同样地，我们可以将大量旳聚合物加入到同样量旳水中，不存在饱和点。

As more and more quantity of polymer is added to water, the time taken for the dissolution of the polymer obviously increases and the mix ultimately assumes a soft, dough-like consistency.

将越来越多旳聚合物加入水中，认为聚合物溶解旳时间明显地增长，最终展现柔软像面团同样粘稠旳混合物。

Another peculiarity is that, in water, polyvinyl alcohol never retains its original powdery nature [as the excess sodium chloride does] [in a saturated salt solution].

另一种特点是，在水中聚乙烯醇不会像过量旳氯化钠在饱和盐溶液中那样能保持其初始旳粉末状态。

In conclusion, we can say that (1) the long time taken by polyvinyl alcohol for dissolution, (2) the absence of a saturation point, and (3) the increase in the viscosity are all characteristics of a typical polymer being dissolved in a solvent and these characteristics are attributed mainly to the large molecular size of the polymer.

总之，我们可以讲（1）聚乙烯醇的溶解需要很长时间，（2）不存在饱和点，（3）粘度的增长是聚合物溶于溶液中的经典特性，这些特性重要归因于聚合物大分子的尺寸。

The behavior of a low molecular weight compound and that of a polymer on dissolution are illustrated in Fig.1.2.

总如图1.2阐明了低分子量化合物和聚合物的溶解行为。

Polymer: 高分子,聚合物.**(repeat units) polymeric polymerization** **“poly-”:** 多的,聚合的. **Polygon,** 聚醚？聚酯？聚酰胺？聚乙烯？多官能团？**polyfunctional** **“-mer”: part. Isomer,** 同分异构体 **Macromolecule:** 大分子,高分子**Macro-:** 大（反义词？） **Molecule,** 分子 **--------- Atom,** 原子 **Molecular Weight,** 分子量 **Micro-:** 显微的。显微镜？**Microscope. Microsoft** **Monomer:** 单体 **“mono-”:** 单个 . **Monocrystalline，monodisperse，monofunction** **“di-, bi-”:** 双. **“tri-”:** 三个. **“tetra-”:**四个 **Repeat Unit,** 反复单元 **----- Monomer unit,**单体单元 **Synthetic,** 合成的, 如**Synthetic Rubber** **Synthesis, n,** 合成 **--------Syntheses, vt,** 合成 **Butadiene:** 丁二烯。 **Butyl-:** 丁基。**-ene:** 烯。**-yne:** 炔。 乙烯？**Ethylene** . **1-**丁烯？**Butylene.** 乙炔？**Ethyne.** **Polyethylene:** 聚乙烯. **Ethyl-:**乙基。 **Ethylene:** 乙烯。**Ethane:** 乙烷 **synthetic:** 合成的。名词？动词？ **Viscous:** 粘的。名词？	**Polyvinyl alcohol:** 聚乙烯醇。 **Vinyl:** 乙烯基 **Sodium chloride,** 氯化钠， **potassium sulfate,** 硫酸钾； **sulfuric acid,** 硫酸 **Settle,** 使（液体）澄清，沉淀,沉降 **Precipitate,** 使沉淀，使凝结 **Precipitant,** 沉淀剂 **Stir,** 搅拌 **Saturation,** 饱和 **------- Unsaturation,** 不饱和 **Dissolution, n,**溶解 **------Dissolve, vt,** 溶解 **solution n** 溶液; **solution polymerization** **solubility n** 溶解度，溶解性 **solvent n** 溶剂, **solvent effect** **Viscous, a,** 粘稠的 **----Viscosity,** 粘度(性) **Clean,** 完全的，彻底的； **sharply,** 明显地，精明地，敏锐地，忽然地，急剧地 **Increasingly,** 越来越…., **Striking,** 明显的， 引人注目的， **with respect to** 有关，就……而论 **Thereafter,** 此后 **Distort,** 畸变，扭变，变形。 **Consistency,** 一致性，结实性。 **Peculiarity,** 独特性，特色，特质，特殊的东西，怪癖。 **issue from,** 由…..产生，由…得出…. **Adventitious** **[ædven’tiSəs],**外来的，偶尔的，**abstract,**

Plastics, 塑料 -------- Rubber, 橡胶 -------	分离，转移

Fiber, 纤维 Adhesive, 黏合剂 ---------- Paints, 涂料 Polybutadiene, 聚丁二烯 Polyvinyl alcohol, 聚乙烯醇 Polyvinyl chloride, 聚氯乙烯 Polyester, 聚酯 Polystyrene, 聚苯乙烯 Polypropylene, 聚丙烯 Polyethylene, 聚乙烯 Polyamide, 聚酰胺 Polyether:聚醚 Thermoplastics, 热塑性塑料 Thermosetting resin, 热固性树脂 Elastomers, 弹性体 Thermoelastomers, 热塑性弹性体 Homopolymers and copolymers, 均聚物和共聚物 Homo-：均匀的。Homogenous:均相的 Hetero-：异的，不一样的 heterogenous: 异相的 Block copolymers,嵌段共聚物 Random copolymers,无规共聚物 Alternating copolymers,交替共聚物 Terpolymers,三元共聚物 Graft copolymers,接枝共聚物	profound,意义深远的，深刻的，notably，明显的，著名的， 这个句型很有用 just as it is not necessary for …to be …, it is also not necessary for …to be… 正…不一定是….同样，….也不一定是…. The moment, 一….就……. Segment, 链段 Backbone, 主链，骨架(脊骨,脊柱)//skeleton, 骨骼,骨架（建筑）,骷髅 Skeleton atom (structure),骨架原子（构造） substituent, substituted group,取代基 side（pendant, lateral）group,侧基//end group,端基 Side chain, 侧链，支链 Side reaction, 副反应. Linear polymers, 线型高分子//Nonlinear polymers,非线型高分子 Branched polymers,支化高分子 Crosslinked polymers,交联高分子 Stars and dendrimers,星型高分子及树枝状高分子 Ladder polymers,梯型高分子 Cyclolinear polymers,线型环聚合物//Cyclomatrix polymer,体型聚合物 Telechelic polymers,远螯聚合物，遥爪聚合物 Mono-telechelic polymer,单遥爪聚合物 Di-telechelic polymer,双遥爪聚合物 Amorphous polymers,无定形高分子//Crystalline polymers,结晶高分子

Unit 2 Chain Polymerization

Many olefinic and vinyl unsaturated compounds are able to form chain-like macromolecules through elimination of the double bond, a phenomenon first recognized by Staudinger. Diolefins polymerize in the same manner, however, only one of the two

double bonds is eliminated.

Staudinger首先发现许多烯烃和不饱和烯烃通过打开双键可以形成链式大分子。二烯烃以同样的方式聚合，但仅消除两个双键中的一种。

Such reactions occur through the initial addition of a monomer molecule to an initiator radical or an initiator ion, by which the active state is transferred from the initiator to the added monomer.

此类反应是通过单体分子首先加成到引起剂自由基或引起剂离子上而进行的，靠这些反应活性中心由引起剂转移到被加成的单体上。

In the same way by means of a chain reaction, one monomer molecule after the other is added (2023~20230 monomers per second) until the active state is terminated through a different type of reaction.

单体分子通过链式反应以同样的方式一种接一种地加上（每秒**2023～20230**个单体）直到活性中心通过不一样的反应方式终止。

The polymerization is a chain reaction in two ways: because of the reaction kinetic and because as a reaction product one obtains a chain molecule. The length of the chain molecule is proportional to the kinetic chain length.

聚合反应成为链式反应的两种原因：反应动力学和作为链式反应产物分子。链分子的长度与动力学链长成正比。

One can summarize the process as follow (R. is equal to the initiator radical):

链式反应可以概括为如下过程（**R·**相称与引起剂自由基）：略

One thus obtains polyvinylchloride from vinylchloride, or polystyrene from styrene, or polyethylene from ethylene, etc.

因而通过上述过程由氯乙烯得到聚氯乙烯，或由苯乙烯获得聚苯乙烯，或乙烯获得聚乙烯，等等。

The length of the chain molecules, measured by means of the degree of polymerization, can be varied over a large range through selection of suitable reaction conditions.

分子链长通过聚合度测量，可以通过选择合适的反应条件大为变化

Usually, with commercially prepared and utilized polymers, the degree of polymerization lies in the range of 1000 to 5000, but in many cases it can be below 500 and over 10000.

商业制备和使用的聚合物，聚合度一般在**1000～5000**范围内，但在许多状况下可低于**500**或高于**10000**。

This should not be interpreted to mean that all molecules of a certain polymeric material consist of 500, or 1000, or 5000 monomer units. In almost all cases, the polymeric material consists of a mixture of polymer molecules of different degrees of polymerization.

这不应当把聚合物材料所有的分子理解为由**500**，或**1000**，或**5000**个单体单元构成。在几乎所有的状况下，聚合物材料由不一样聚合度的聚合物分子的混合物构成。

Polymerization, a chain reaction, occurs according to the same mechanism as the well-known chlorine-hydrogen reaction and the decomposition of phosegene.

链式聚合反应的机理与众所周知的氯（气）-氢（气）反应和光气的分解机理相似。

The initiation reaction, which is the activation process of the double bond, can be brought about by heating, irradiation, ultrasonics, or initiators. The initiation of the chain reaction can be observed most clearly with radical or ionic initiators.

通过双键活化的引起剂反应，可以通过热、辐射、超声波或引起剂产生。可以很清晰地进行研究用自由基型或离子型引起剂引起的链式反应。

These are energy-rich compounds which can add suitable unsaturated compounds (monomers) and maintain the activated radical or ionic state so that further monomer molecules can be added in the same manner.

这些是高能态的化合物，它们可以加成不饱和化合物（单体）并保持自由基或离子活性中心 以致单体可以以同样的方式深入加成。

For the individual steps of the growth reaction one needs only a relatively small activation energy and therefore through a single activation step (the actual initiation reaction) a large number of olefin molecules are converted, as is implied by the term "chain reaction".

对于增长反应的各个环节，每一步仅需要相称少的活化能，因此通过一步简朴的活化反应（即引起反应）即可将许多烯类单体分子转化成聚合物，这正如连锁反应这个术语的内涵那样。

Because very small amounts of the initiator bring about the formation of a large amount of polymeric material (1:1000 to 1:1000), it is possible to regard polymerization from a superficial point of view as a catalytic reaction.

由于少许的引起剂引起形成大量的聚合物原料（**1：1000～1：10000**），从表面上看聚合反应被当作是催化反应。

For this reason, the initiators used in polymerization reactions are often designated as polymerization catalysts, even though, in the strictest sense, they are not true catalysts because the polymerization initiator enters into the reaction as a real partner and can be found chemically bound in the reaction product ,i.e. ,the polymer.

由于这个原因，一般把聚合反应的引起剂看作是聚合反应的引起剂。但由于聚合反应的催化剂进入到反应内部而成为一部分，同步可以在反应产物，既聚合物的末端发现催化剂，因此严格地讲它们不是真正意义上的催化剂，

In addition to the ionic and radical initiators there are now metal complex initiators (which can be obtained, for example, by the reaction of titanium tetrachloride or titanium trichloride with aluminum alkyls), which play an important role in polymerization

reactions (Ziegler catalysts) ,The mechanism of their catalytic action is not yet completely clear.

除离子引起剂和自由基引起剂外，尚有金属络合物引起剂（可以通过四氯化钛或三氯化钛与烷基铝的反应得到）。它们在聚合反应中起到了重要作用（齐格纳引起剂）。它们催化活动的机理还不是十分清晰。

Radical, 自由基； **ion,** 离子，**ionic,** 离子的，**ionic polymer,** 离子聚合物，**ionomer,** 离聚体 **Activation,** 活化（作用），活化过程; **Active state,** 活性中心 **Polyvinyl chloride:** 聚氯乙烯 **Polystyrene :** 聚苯乙烯 **Degree of polymerization:** 聚合度（DP) **Mechanism:**机理 **Chlorine:** 氯气;**Hydrogen:** 氢气 **Decomposition:** 分解。**Degradation:** 降解 **Irradiation,**辐射，照射。**ultrasonics,** 超声波 **Imply,** 暗指，具有…….的意思 **regard,** 把…….看作…….. **Catalyst:** 催化剂 **Ionic:** 离子的 。**Ion:** 离子。**Cation:** 阳离子。**Anion:**阴离子 **Complex:** 络合物 **Di-:** 二。**Tri-:**三。**Tetra-:** 四。**Mono-**：单。**Penta-:** 五个；**hexa-:**六 **Alkyl:** 烷基 **alkane:** 烷烃。**Alkene:** 烯烃 **by means of…: By using** **One…after the other…** 一种接一种….. **be proportional to…:** 和…成正比 **Lie in** 处在，落在，在于 **Bring about,**引起，产生，导致 **from a superficial point of view,** 从表面上看 **in the proper(strict、literal)sense** 在本来（严格、字面）的意义上说的	**Radical,**自由基**//Initiator,**引起剂**//** **Unsaturated monomer,** 不饱和单体 **Organic peroxide,** 有机过氧化物**//hydroperoxide,** 过氧化氢 **Redox agent,** 氧化－还原试剂 **Azo compounds,**偶氮化合物 **Organometallic reagents,**有机金属 **Irradiation,**光辐射，紫外光照射 **High energy radiation,** 高能辐射 **Homolytic dissociation,** 均裂 **Chain initiation,** 链引起反应**//chain propagation,**链增长反应 **Steady-state assumption,** 稳态假设 **Rate of polymerization,**聚合速率 **Chain transfer,**链转移**//chain termination**，链终止反应 **Combination,** 偶合（终止），结合 **Disproportionation,** 歧化（终止） $x+1$ x plus one $x-1$ x minus one $x \pm 1$ x plus or minus one xy xy / x multiplied by y $(x-y)(x+y)$ x minus y, x plus y $\frac{x}{y}$ x over y $=$ the equals sign $x=5$ x equals 5 / x is equal to 5 $x \neq 5$ x (is) not equal to 5

play an important role in…: 在….方面起重要作用 **Even though=even if ,**虽然，纵然 **In addition to…** 除了…….之外，在…….起重要作用	

UNIT 3 Step-Growth polymerization

Many different chemical reactions may be used to synthesize polymeric materials by step-growth polymerization. These include esterification, amidation, the formation of urethanes, aromatic substitution, etc.

通过逐渐聚合可用许多不一样旳化学反应来合成聚合材料。这些反应包括酯化、酰胺化、氨基甲酸酯、芳香族取代物旳形成等。

Polymerization proceeds by the reactions between two different functional groups, e.g., hydroxyl and carboxyl groups, or isocyanate and hydroxyl groups.

通过在两种不一样旳官能团，如，羟基和羧基，或异氰酸酯和羟基之间可发生聚合反应。

All step-growth polymerization fall into two groups depending on the type of monomer(s) employed. The first involves two different polyfunctional monomers in which each monomer possesses only one type of functional group.

所有旳逐渐聚合反应根据所使用单体旳类型可分为两类。第一类波及两种不一样旳官能团单体，每一种单体仅具有一种官能团。

A polyfunctional monomer is one with two or more functional groups per molecule. The second involves a single monomer containing both types of functional groups.

一种多官能团单体每个分子有两个或多种官能团。第二类波及具有两类官能团旳单个单体。

The synthesis of polyamides illustrates both groups of polymerization reactions. Thus, polyamides can be obtained from the reaction of diamines with diacids or from the

reaction of amino acids with themselves.

聚酰胺的合成阐明了两类聚合反应。因此聚酰胺可以由二元胺和二元酸的反应或氨基酸之间的反应得到。

The two groups of reactions can be represented in a general manner by the equations as follows

两种官能团之间的反应一般来说可以通过下列反应式表达

Reaction (3.1) illustrates the former, while (3.2) is of the latter type.

反应（**3.1**）阐明前一种形式，而反应（**3.2**）具有后一种形式。

Polyesterification, whether between diol and dibasic acid or intermolecularly between hydroxy acid molecules, is an example of a step-growth polymerization process.

聚酯化反应是逐渐聚合反应过程的一种例子。反应也许在二元酸和二元醇之间或羟基酸分子间进行。

The esterification reaction occurs anywhere in the monomer matrix where two monomer molecules collide, and once the ester has formed, it, too, can react further by virtue of its still-reactive hydroxyl or carboxyl groups.

酯化反应出目前单体本体中两个单体分子相碰撞的位置，且酯一旦形成，依托酯上仍有活性的羟基或羧基还可以深入进行反应。

The net effect of this is that monomer molecules are consumed rapidly without any large increase in molecular weight.

酯化的成果是单体分子很快地被消耗掉，而分子量却没有多少增长。

Fig. 3.1 illustrates this phenomenon. Assume, for example, that each square in Fig. 3.1a represents a molecule of hydroxy acid. After the initial dimmer molecules from (b), half the monomer molecules have been consumed and the average degree of polymerization (DP) of polymeric species is 2.

图3.1阐明了这个现象。假定图3.1中的每一种方格代表一种羟基酸分子。产生二聚体分子后（b），二分之一的单体分子消耗了，这时平均聚合度（DP）是2。

As trimer and more dimer molecules form (c), more than 80% of the monomer molecules have reacted, but DP is still 2.5. When all the monomer molecules have reacted (d), DP is 4.

（c）中形成三聚体和更多的二聚体，超过80%的单体分子已参与反应，但DP仅仅还是2.5。（d）中所有的单体反应完，DP是4。

But each polymer molecule that forms still has reactive end groups; hence the polymerization reaction will continue in a stepwise fashion, with each esterification step being identical in rate and mechanism to the initial esterification of monomers.

但形成的每一种聚合物分子尚有反应活性的端基；因此，聚合反应将以逐渐的方式继续进行，其每一步酯化反应的反应速率和反应机理均与初始单体的酯化作用相似。

Thus, molecular weight increases slowly even at high levels of monomer conversion, and it will continue to increase until the viscosity build-up makes it mechanically too difficult to remove water of esterification or for reactive end groups to find each other.

这样，分子量在高单体转化率下缓慢增长，继续增长直到粘度增长到难以除去酯化反应的水或端基难以互相反应为止。

It can also be shown that in the A-A+B-B type of polymerization, an exact stoichiometric balance is necessary to achieve high molecular weights. If some monofunctional impurity is present, its reaction will limit the molecular weight by rendering a chain end inactive.

在A-A+B-B的聚合反应中，精确的定量配比是获得高分子量所必需的。假如存在某些单官能团杂质，由于链的端基失活，其反应将限制分子量。

Similarly, high-purity monomers are necessary in the A-B type of polycondensation and it

follows that high-yield reactions are the only practical ones for polymer formation, since side reactions will upset the stoichiometric balance.

同样，在A-B类的缩聚反应中高纯度的单体是必要的。由于副反应会破坏定量配比，能形成聚合物的实用措施只能是高收率的反应。

Step-growth polymerization: 逐渐聚合(包括缩聚) Synthesize : v. 合成 synthesis: n. Esterification: 酯化(COOH 和-OH的反应). Ester: 酯. COOR polyester, 聚酯。 Amide: 酰胺 (-CONH2) ， Amidation: 酰胺化，polyamide, 聚酰胺，尼龙 Urethane: (cabarmate)氨基甲酸酯 . RO(CO) NR2. 氨基甲酸乙酯，NH2CO2C2H5 Polyurethane, 聚氨酯， 弹性体。 Aromatic: 芳香族的(环状的闭合共轭体系,如含苯环的化合物) Aromatic, 芳香族的，aromatics，芳香族化合物，香料，芳香剂。aroma, 香味，aromatic acid, 芳香酸 Substitution: n.取代,替代,取代反应 substitute: v. 取代 举例: C6H5-Br C6H5-OH Functional group: 官能团 Monofunctional, 单官能度的//difunctional,两官能团的 Polyfunctional, 多官能团的，多官能度的 Hydroxyl，羟基，hydro-，氢化的，氢的，水的；-oxyl，…氧基，如methoxyl，甲氧基。 carboxyl， 羧基，carbo-，碳，羰 isocyanate，异氰酸酯。RN=C=O. iso-，异，等位，如，isoelectric point，等电离点。Isobutylene，异丁烯。。 Iso-propanol : 异丙醇。异丁醇	Fall into, 归入， 可分为….. Depending on…, 根据……. In a general manner, 一般来说 Whether….or…., 无论是…..还是……., 或者……或者……，不是……就是….. By（后in）virtue of…….依托，借助于……. Be identical in… to…, 在…….方面和…..是相似的。 Identical[ai'dentikəl], a, 同一的，完全相似的，相等的，有同一原因（来源）的， Identical twins, 同卵双胞胎，identical equation, 恒等式 The fingerprints of no two persons are identical. Your voice is identical to hers in volume. build-up: 增长 烷(-ane) methane ethane propane butane 烷基（-yl) methyl ethyl propyl butyl 亚烷基(-ylene) methylene ethylene 环烷(cyclo-) cyclopropane cyclohexane 烯(-ene) ethene propene butene 炔(-yne) ethyne propyne butyne 醇(-ol) methanol ethanol propanol butanol 醛(-al) formaldehyde ethanal 酮(-one) acetone 酸(-ic acid) acetic acid 酸酐(anhydride) formic anhd. acetic anhd. 酰胺 (amide) acetamide 胺(amine) methyl amine ethyl amine stoichiometric balance，化学计量平衡//conversion,转化率//yield,产率

ROH + R'NCO → ROC(O)N(H)R' Cyanate, 氰酸盐，氰酸酯, RO-CN。Cyanide, 氰化物，如potassium cyanate, 氰化钾。 Dimmer, 二聚体，trimer，三聚体，tetramer，四聚体， pentamer，五聚体，Hexamer，六聚体。 Heptamer, 七聚体， Oligomer,低聚物，低聚体 Diamine，二元胺// diol,二元醇// triol,三元醇// polyol,多元醇酸 Ethylene diamine(?) dibasic,二元的// diacid, 二元酸// amino acid，氨基酸	The average degree of polymerization, 平均聚合度 Molecular weight:分子量 Impurity：杂质。Purity: 纯度。Im-:不。impossible Polycondensation: 缩聚 Side reaction: 副反应

UNIT 4 Ionic Polymerization

Ionic polymerization, similar to radical polymerization, also has the mechanism of a chain reaction. The kinetics of ionic polymerization are, however, considerably different from that of radical polymerization.

离子聚合反应，与自由基聚合反应相似，也是链反应机理。但离子聚合的动力学明显地不一样于自由基聚合反应。

(1) The initiation reaction of ionic polymerization needs only a small activation energy. Therefore, the rate of polymerization depends only slightly on the temperature.

(1)离子聚合的引起反应仅需要很小的活化能。因此，聚合反应的速率与温度关系不大。

Ionic polymerizations occur in many cases with explosive violence even at temperature. below 50℃(for example, the anionic polymerization of styrene at －70℃ in tetrahydrofuran, or the cationic polymerization of isobutylene at －100℃ in liquid ethylene).

在许多状况甚至低于**50**℃下离子聚合反应剧烈（例如，苯乙烯的阴离子聚合在**-70**℃在四氢呋喃中反应，异丁烯的阳离子聚合在**-100**℃在液态乙烯中反应）。

With ionic polymerization there is no compulsory chain termination through recombination, because the growing chains can not react with each other.

对于离子聚合来说，由于生长链之间不能发生反应，不存在通过再结合反应而进行的强迫链终止。

Chain termination takes place only through impurities, or through the addition of certain compounds such as water, alcohols, acids, amines, or oxygen, and in general through compounds which can react with polymerization ions under the formation of neutral compounds or inactive ionic species.

链终止反应仅仅通过杂质而发生，或者说通过和某些像水、醇、酸、胺或氧这样的化合物进行加成而发生，且一般来说（链终止反应）可通过这样的化合物来进行，这种化合物可以和活性聚合物离子进行反应生成中性聚合物或没有聚合活性的离子型聚合物。

If the initiators are only partly dissociated, the initiation reaction is an equilibrium reaction, where reaction in one direction gives rise to chain initiation and in the other direction to chain termination.

假如引起剂仅仅部分地离解，引起反应即为一种平衡反应，在出现平衡反应的场所，在一种方向上进行链引起反应，而在另一种方向上则发生链终止反应。

In general ionic polymerization can be initiated through acidic or basic compounds.

一般离子聚合反应能通过酸性或碱性化合物被引起。

For cationic polymerization, complexes of BF3, AlCl3, TiCl4, and SnCl4 with water, or alcohols, or tertiary oxonium salts have shown themselves to be particularly active. The positive ions are the ones that cause chain initiation. For example:

对于阳离子聚合反应来说，**BF3,AlCl3,TiCl4**和**SnCl4**与水、或乙醇，或叔烊盐的络合物活性尤其高。正离子产生链引起。例如：

However, also with HCl, H2SO4, and KHSO4, one can initiate cationic polymerization. Initiators for anionic polymerization are alkali metals and their organic compounds, such as phenyllithium, butyllithium, phenyl sodium, and triphenylmethyl potassium, which are more or less strongly dissociated in different solvents.

但**BF3**与**HCl**、**H2SO4**和**KHSO4**也可以引起阳离子聚合反应。阴离子聚合反应的引起剂是碱金属和它们的有机金属化合物，例如苯基锂、丁基锂和三苯甲基锂，它们在溶剂中高度离解。

To this group belong also the so called Alfin catalysts, which are a mixture of sodium isopropylate, allyl sodium, and sodium chloride.

所谓的**Alfin**催化剂就是属于这一类，此类催化剂是异丙醇钠、烯丙基钠和氯化钠的混合物。

With BF3 (and isobutylene as the monomer), it was demonstrated that the polymerization is possible only in the presence of traces of traces of water or alcohol.

BF3为引起剂（异丁烯为单体），在痕量水或乙醇下聚合反应才可以进行。

If one eliminates the trace of water, BF3 alone does not give rise to polymerization. Water or alcohols are necessary in order to allow the formation of the BF3-complex and the initiator cation according to the above reactions. However, one should not describe the water or the alcohol as a "cocatalyst".

假如消除痕量的水，**BF3**单独不会引起聚合反应。对于上述反应，水或乙醇对于形成**BF3**-络合物和引起剂离子是必需的。不过水或乙醇不应认为是“助催化剂”。

Just as by radical polymerization, one can also prepare copolymers by ionic polymerization, for example, anionic copolymers of styrene and butadiene, or cationic copolymers of isobutylene and styrene, or isobutylene and viny ethers, etc.

与自由基聚合反应同样，通过离子聚合反应也能制备共聚物，例如，苯乙烯-丁二烯阴离子共聚物，或异丁烯-苯乙烯阳离子共聚物，或异丁烯-乙烯基醚共聚物，等等。

As has been described in detail with radical polymerization, one can characterize each monomer pair by so-called reactivity ratios r1 and r2.

正如对自由基型聚合已经详细描述过那样，人们可以用所谓的竞聚率**r1**和**r2**来表征每单体对。

Ionic polymerization: 离子型聚合 **Cationic polymerization:**阳离子聚合 **Anionic polymerization:**阴离子聚合 **Ion,**离子**//ionic,**离子的**//nonionic,**非离子的 **cation,**正（阳）离子**//cationic,**正（阳）离子的 **Anion,**负（阴）离子**//anionic,**负（阴）离子的 **Radical polymerization:** 自由基聚合 **Kinetics** 动力学 **thermodynamic :** 热力学 **Isobutylene,**异丁烯**//isoprene,**异戊二烯 **Tetrahydrofuran: (THF)** 四氢呋喃**.** **Tetra-:** 四**. Furan:**呋喃 **Pyrrole:** 吡咯 **thiophen:**噻吩 **Teriary:** 三元的 **quarternary:** 四元的 **Alfin catalyst:**醇**(**碱金属**)**烯催化剂 **A catalyst derived from reaction of an alkali alcoholate with an olefin halide; used to convert olefins (for example, ethylene, propylene, or butylenes) into polyolefin polymers.** **Isopropylate:**异丙醇金属，异丙氧化金属 **-ate:** 盐**,** 酯**. Sodium sulfate:** 硫酸钠 **Allyl:** 烯丙基**. -CH2CH=CH2** **Cation:** 正**(**阳**)**离子**. Anion:** 负**(**阴**)**离子 **Cocatalyst:**助催化剂 **Copolymer:** 共聚物**. Copolymerization:** 共聚反应 **Co-:** 共同的**. Covalent:** 共价	**Oxonium:** 氧鎓**,**氧负离子**,O-**。 **Positive,**正的**,**阳（性）的**//Neutral,**中性的 **//negative,**负的**,(**阴**)**性的 **Triethyloxonium-borofluoride: (C2H5)3O+ BF4-** **Tri-:** 三**. Ethyl:**乙基**. Boro:** 硼**. Fluoride:** 氟化物 **alkali metal :** 碱金属**, including : lithium, sodium, potassium.** **Phenyllithium:** 苯基锂 **Butyllithium:**丁基锂 **Phenylsodium:** 苯基钠 **triphenylmethyl potassium:**三苯甲基钾 **Methyl:** 甲基**. Ethyl:** 乙基**. Propyl:** 丙基**. Butyl:** 丁基 **with explosive violence:** 及其剧烈地**.very great force in action or feeling** **The wind blew with explosive violence.** **give rise to…:**引起，导致，产生，使….发生….. **lead to; to be the cause of** **These bad conditions have given rise to a lot of crime.** **more or less: I am more or less tired after such a long trip.** **much less: I didn't even see him, much less speak to him.** **so-called: They are so-called Christians who show no love to anyone.** **in the presence**

Characterize: 表征 **reactivity ratio:**竞聚率	**of…:**在…….存在旳状况下， **He was questioned in the presence of a large**

Parameter: 参数 **Coordinative polymerization, 配位(离子)聚合**	**number of people.** **just as: He came just as I was leaving.** **in detail: There is no time to explain in detail** **Stereoregular,立构规整性的** **Intermediate,中间产物，中间体** **Electrophilic substitution,亲电取代//nucleophilic substitution,亲核取代** **Proton,质子//protic acid,质子酸** **Aliphatic compound,脂肪族化合物//Aromatic compound,芳香组化合物**

UNIT 5 Introduction to Living Radical Polymerization

Traditional methods of living polymerization are based on ionic, coordination or group transfer mechanisms.

活性聚合的老式措施是基于离子，配位或基团转移机理。

Ideally, the mechanism of living polymerization involves only initiation and propagation steps.

理论上活性聚合的机理只包括引起和增长反应环节。

All chains are initiated at the commencement of polymerization and propagation continues until all monomer is consumed.

在聚合反应初期所有的链都被引起，然后增长反应继续下去直到所有的单体都被消耗殆尽。

A type of novel techniques for living polymerization, known as living (possibly use "controlled" or "mediated") radical polymerization, is developed recently.

近来开发了一种叫做活性自由基聚合的活性聚合新技术。

The first demonstration of living radical polymerization and the current definition of the processes can be attributed to Szwarc.

第一种活性自由基聚合的证明及目前对这一过程的解释或定义，应当归功于**Szwarc**。

Up to now, several living radical polymerization processes, including atom transfer radical

polymerization (ATRP), reversible addition-fragmentation chain transfer polymerization (RAFT), nitroxide-mediated polymerization (NMP), etc., have been reported one after another.

到目前为止，某些活性自由基聚合过程，包括原子转移自由基聚合，可逆加成-断裂链转移聚合，硝基氧介导聚合等聚合过程一种接一种被报道。

The mechanism of living radical polymerization is quite different not only from that of common radical polymerization but also from that of traditional living polymerization.

活性自由基聚合的机理不仅完全不一样于一般自由基聚合机理，也不一样于老式的活性聚合机理。

It relies on the introduction of a reagent that undergoes reversible termination with the propagating radicals thereby converting them to a following dormant form：

活性自由基聚合依赖于向体系中引入一种可以和增长自由基进行可逆终止的试剂，形成休眠种：

The specificity in the reversible initiation-termination step is of critical importance in achieving living characteristics.

这种特殊的可逆引起-终止反应对于获得分子链活性来说具有决定性的重要意义。

This enables the active species concentration to be controlled and thus allows such a condition to be chosen that all chains are able to grow at a similar rate (if not simultaneously) throughout the polymrization.

可逆引起终止使活性中心的浓度可以得以控制。这样就可以来选择合适的反应条件，使得在整个聚合反应过程中(只要没有平行反应)所有的分子链都可以以相似的速度增长。

This has, in turn, enabled the synthesis of polymers with controlled composition, architecture and molecular weight distribution.

这样就可以合成具有可控构成，构造和分子量分布的聚合物。

They also provide routes to narrow dispersity end-functional polymers, to high purity block copolymers, and to stars and other more complex architecture.

这些还可以提供获得狭窄分布末端功能化聚合物，高纯嵌段共聚物，星型及更复杂构造高分子的合成措施。

The first step towards living radical polymerization was taken by Ostu and his colleagues in 1982.

活性自由基聚合是Ostu和他的同事于1982年率先开展的。

In 1985, this was taken one step further with the development by Solomon et al. of nitroxide-mediated polymerization (NMP).

1985年，Solomon等对氮氧化物稳定自由基聚合的研究使活性自由基聚合深入发展。

This work was first reported in the patent literature and in conference papers but was not widely recognized until 1993 when Georges et al. applied the method in the synthesis of narrow polydispersity polystyrene.

这种措施首先在专利文献和会议论文中报道，不过直到1993年Georges等把这种措施应用在窄分子量分布聚苯乙烯之后，才得以广泛认知。

The scope of NMP has been greatly expended and new, more versatile, methods have appeared.

NMP的领域已经得到很大的延展，出现了新的更多样化的措施。

The most notable methods are atom transfer radical polymerization (ATRP) and polymerization with reversible addition fragmentation (RAFT).

最引人注目的措施是原子转移自由基聚合和可逆加成断裂聚合。

Up to 2023, this area already accounted for one third of all papers in the field of radical polymerization, as shown in Fig.5.1.

到2023年，这个领域的论文已经占所有自由基聚合领域论文的三分之一。如图5.1所示。

Naturally, the rapid growth of the number of the papers in the field since 1995 ought to be almost totally attributable to development in this area.

很自然，自从1995年以来，在这个领域里论文数量的迅速增长应当完全归功于这个领域的发展。

group transfer mechanism 基团转移机理 **commencement**开始 **living polymerization** 活性聚合 **living radical polymerization** 活性自由基聚合 **simultaneous reaction**平行反应 **Specificity** 特异性，专一性, 特性 **nitroxide-mediated polymerization (NMP)**氮氧化物稳定自由基聚合 **atom transfer radical polymerization (ATRP)**原子转移自由基聚合 **reversible addition-fragmentation chain transfer polymerization (RAFT)** 可逆加成-断裂链转移 **dormant**休眠的 **dormant species**休眠种 **active species**活性种 **versatile**用途广的 **Simultaneously** 平行地, 联立地 **Be attributed to** 归功于，归因于 **Rely on** 依赖，依托 **Convert……to….** 把…….转化成… **Take the first step** 开头做某事 **Account for:** 证明 **With respect to:** 有关 **in conclusion:** 总之 **In summary:** 总之 **Thus ; hence; therefore;** **Equal to:**等于 **Approximate:** 大概 **In the order to:** 按…次序 **Approach:**靠近	前缀: **¼ quarter** **1/2 hemi,semi** **1 mono,uni** **2 di,bi,bis** **3 ter,tri** **4 tetra,** **5 penta,** **6 hexa** **7 hepta,septi** **8 octa** **9 ennea,nona** **10 deca** **Mono-** 一，单 **monomer** 单体 **monoxide** 单氧化物 **monoacid** 一元酸 **Di-** 二，重，偶，联，双 **dimolecular** 双分子的 **dioxide** 二氧化物 **diphenyl** 联(二)苯 **Bi-** 两个，二，双 **bimolecular** 双分子的 **biphenyl** 联(二)苯 **Bis-** 双 **bisdiazo** 双偶氮 **Tri-** 三 **triangle** 三角 **trichloro methane** 三氯甲烷 **Tetra-** 四 **tetrahedron** 四面体 **carbon tetrachloride** 四氯化碳 **Add** 加 **Subtraction:**减 **Multiplication:**乘 **Divide:** 除 **Power:** 指数 **Extraction:** 减 **figure 1= Fig. 1:**图

Formula:公式 equation 1. macromolecule, polymer 高分子，又称“大分子” 2. supra polymer 超高分子 3. natural polymer 天然高分子 4. inorganic polymer 无机高分子 5. organic polymer 有机高分子 6. inorganic organic polymer 无机-有机高分子 7. Organometallic polymer 金属有机聚合物 8. element polymer 元素高分子 9. Oligomer 低聚物, "齐聚物“ 16. Heterochain polymer 杂链聚合物 17. heterocyclic polymer 杂环高分子	Diagram: 图解 Illustration: 图解 Outline:概述 Table Schedule:计划 Chart:表 Catalog:目录 10. Dimer 二聚体 11. Trimer 三聚体 12. Prepolymer 预聚物 13. Monodisperse polymer, uniform polymer 单分散聚合物 14. Polydisperse polymer, non-uniform polymer 多分散性聚合物 15. carbon chain polymer 碳链聚合物

Unit 6 Molecular Weight and its Distributions of Polymers

The molecular weight of a polymer is of prime importance in its synthesis and application.

Prime, 最初的，基本的，首要的，首位的，最佳的，第一流的

对聚合物的合成和应用而言，聚合物的分子量是最重要的。

The interesting and useful mechanical properties which are uniquely associated with polymeric materials are a consequence of their high molecular weight.

令人感爱好的和具有使用价值的力学性能与高分子材料存在的唯一的有关性，而这些性能是聚合物的高分子量带来的。聚合物材料的高分子量带来了令人感爱好的和具有运用价值的力学性能。

Most important mechanical properties depend on and vary considerably with molecular weight.

最重要的力学性能取决于分子量，并且伴随分子量变化而发生很大的变化。

Thus, strength of polymer does not begin to develop until a minimum molecular weight of about 5000～10 000 is achieved.

因此,直到最小分于量增大到大概5 000～10 000 后来, 聚合物旳强度才开始显示出来.

Above that size, there is a rapid increase in the mechanical performance of polymers as their molecular weight increases; the effect levels off at still higher molecular weights.

Level off…到达平衡，变平缓，趋缓

分子量不小于这个值旳时候，伴随分子量旳增长，聚合物旳机械性能迅速增长;到达更高旳分子量旳时候，这种效应才变平缓。

In most instances, there is some molecular weight range in which a given polymer property will be optimum for a particular application.

In most instances, 在大多数状况下 **Optimum**，最适条件，最适度，最适合旳

在大多数状况下，对于某种特定旳应用来说，某种聚合物存在着某一种分子量范围。

The control of molecular weight is essential for the practical application of a polymerization process.

Be essential for…，对……是必需旳

聚合物分子量旳控制对聚合过程旳实际应用而言是必需旳。对实际旳聚合过程而言，必须控制聚合物旳分子量。

When one speaks of the molecular weight of a polymer, one means something quite different from that which applies to small-sized compounds.

Speak of…，谈到……..

当人们谈到聚合物分子量旳时候，他所指旳是和(合用于)低分子化合物旳分子量完全不一样旳另一回事。

Polymers differ from the small-sized compounds in that they are polydisperse or heterogeneous in molecular weight.

Differ from…，与……..不一样，或不一致。 **Polydisperse,** 多分散性旳

Heterogeneous,不均匀旳，非均相旳，

聚合物与小分子量化合物的不一样在于聚合物的分子量是多分散性的或不均匀的。

Even if a polymer is synthesized free from contaminants and impurities, it is still not a pure substance in the usually accepted sense.

Free from…,没有……，无…….. **Contaminant,**污物 **Impurity,** 杂质 **In the usually accepted sense…**，在能被人们广泛接受的意义上

虽然聚合物在没有污物和杂质的状况下被合成，在人们广泛接受的意义上，它仍然不是纯物质。

Polymers, in their purest form, are mixture of molecules of different molecular weights.

最纯净的聚合物是具有不一样分子量的分子的混合物。

The reason for the polydispersity of polymers lies in the statistical variations present in the polymerization processes.

Lie in…，在于……. **Statistical,** 记录的 **Variation [v□əri'eiSən],n**，变化，变化

聚合物多分散性在于聚合过程中展现的记录变化。

When one discusses the molecular weight of a polymer, one is actually involved with its average molecular weight.

当我们讨论聚合物的分子量，精确的含义是平均分子量。

Both the average molecular weight and the exact distribution of different molecular weights within a polymer are required in order to fully characterize it.

In order to, 为了……

为了充足地表征聚合物，不仅规定平均分子量，并且也规定聚合物内不一样分子量确实切的分布状况。

The control of molecular weight and molecular weight distribution (MWD) is often used to obtain and improve certain desired physical properties in a polymer product.

为了获得和改善聚合物产品的某些理想的物理性质，我们常常需要控制分子量和分子量分布。

Various methods are available for the experimental measurement of the average molecular weight of a polymer sample.

在聚合物样品平均分子量的试验测试中有许多措施可以运用。

These include methods based on colligative properties, light scattering, viscosity, ultracentrifugation, and sedimentation.

Colligative property, 依数性； **Light scattering,** 光散射 **Viscosity,**粘度法 **Ultracentrifugation,** 超速离心分离 **Sedimentation,**沉降法

这些措施基于依数性，光散射，粘度法，超速离心分离，沉降法。

The various methods do not yield the same average molecular weight.

不一样的措施得到不一样的平均分子量。

Different average molecular weights are obtained because the properties being measured are biased different toward the different sized polymer molecules in a polymer sample.

biase ['baiəs],斜线，倾向性，偏向

Be biased toward….,有….偏向，偏于…

(对同一聚合物**)**得到了不一样的平均分子量，由于所测得的性质对试样中不一样尺寸的聚合物分子有不一样的偏差。

Some methods are biased toward the larger sized polymer molecules, while other methods are biased toward the smaller sized molecules.

某些措施对较大尺寸的聚合物分子有偏差（倾向性），而此外某些措施则对较小尺寸的聚合物分子有偏差（倾向性）。

The result is that the average molecular weights obtained are correspondingly biased toward the larger or smaller sized molecules.

所获得旳平均分子量分别对较大旳或较小旳分子有（偏差）倾向性。

The most important average molecular weights which are determined are the number-average molecular weight Mn, the weight-average molecular weight Mw and the viscosity-average molecular weight Mv.。

被测定的最重要平均分子量有数均分子量**Mn,** 重均分子量**Mw,**和粘均分子量**Mv.**

In addition to the different average molecular weights of a polymer sample, it is frequently desirable and necessary to know the exact distribution of molecular weights.

除聚合物样品的不一样的平均分子量外，常常需要懂得确切的分子量分布。

A variety of different fractionation methods are used to determine the molecular weight distribution of a polymer sample.

A variety of…,多种各样的 **Fractionation[frækSə'neiSən],**分级

多种各样的不一样的分级措施被用来确定聚合物样品的分子量分布。

These are based on fractionation of a polymer sample using properties, such as solubility and permeability, which vary with molecular weight.

Solubility, 溶解性 **Permeability,** 渗透性

这些措施基于使用诸如溶解性，渗透性等性质进行聚合物样品的分级，这些性质伴随分子量变化而变化。

molecular weight distribution:分子量分布 **Prime,** 最初的，基本的，首要的，首位的，最佳的，第一流的 **Uniquely,** 唯一地，独一无二地，独特地，无可匹敌地 **Consequence,** **n,**成果，后果，重要性，重大，推断，举足轻重 **mechanical property:**力学性能，机械性能 **Minimum:**最小值**,**最小的 **.**反义词最大的**?** **maximum** **We should achieve the maximum of efficiency with the minimum of labor.**	**Statistical:**记录的**. Statistics :**记录学 **Variation:** 变化，变化 **Colligative:**依数的**.** **depend upon the ratio of the number of solute particles to the number of solvent molecules in a solution. They are independent of the nature of the solute particles .** **Colligative properties include: (1) relative lowering of vapor pressure; (2) elevation of boiling point; (3) depression of freezing point and (4) osmotic pressure** **colligate vt.** 缚绑；综合，概括 **to tie or bind together** **Light scattering:**光散射

Today's maximum temperature will be 40 degrees. Strength:强度. 模量? Module optimum(复数optima): best or most favorable，最适条件，最适度，最适合的 Parents should establish\create optimum conditions for their children's growth. Polydisperse:多分散的 . Polydispersity n. 单分散的? monodisperse Heterogenous:不均匀的，非均相的. Homogenous:均匀的 Contaminant: 污物. Contaminate: v.污染 contaminant: -ant: "…的"、"…者" radiant, defiant(挑战、对抗的) Be essential for…,对…..是必需的 Air and water is essential for life. Speak of…，谈到…… In the usually accepted sense…，在能被人们广泛接受的意义上 Free from…,没有…….，无…. biase ,斜线，倾向性，偏向。 Be biased toward…,有…..偏向，偏于…….	Ultracentrifugation:超速离心(分离) ultra:超的. Ultrasonic: 超音速的. Sedimenation: 沉降法 number average molecular weight:数均分子量 weight average molecular weight:重均分子量 viscosity average molecular weight:粘均分子量 fractionation:分级 Solubility, 溶解性//Permeability, 渗透性 Be associated with…,与…….有关 Level off…到达平衡，变平缓，趋缓 In most instances, 在大多数状况下: He failed in the exam, but in most instances, he is a good student. A variety of…,多种各样的 The shop has a variety of toys. His failure was due to a variety of reasons. Lie in…，在于…….

UNIT 7 Polymer Solution

Dissolving a polymer is a slow process that occurs in two stages.

溶解高分子需要一种缓慢的过程，这个过程分两步发生。

First, solvent molecules slowly diffuse into the polymer to produce a swollen gel.

Diffuse，vt，扩散。Diffusion，n，扩散

溶剂分子缓慢地扩散到高分子中产生溶胀凝胶。

This may be all that happens if，for example，the polymer-polymer intermolecular forces are high because of crosslinking，crystallinity • or strong hydrogen bonding.

例如,

假如因交联，结晶和很强的氢键而形成很大的分子间力，(聚合物的溶解过程)有也许就只停留在这一阶段。

But if these forces can be overcome by the introduction of strong polymer-solvent interactions, the second stage of solution can take place.

不过假如这些力被强的高分子-溶剂之间互相作用克服，溶解的第二阶段就会发生。

Here the gel gradually disintegrates into a true solution. Disintegrate，分解，崩解，分裂，蜕变；disintegrable，能（在水中）崩解的

即，凝胶逐渐变成一种真正的溶液。

Only this stage can be materially speeded by agitation.

Agitation，搅拌，agitate，vt，搅拌，搅动，鼓动。注意：Stir之间的区别。

Agitator，stirrer，都是搅拌器，stirrer更强调具有反应的搅拌器。 Speed, vt, 增进； materially, ad,物质上，实质上，大大地，相称地

只有这个阶段可以通过搅拌得到明显增进。

Even so, the solution process can be quite slow (days or weeks) for materials of very high molecular weight. Even so，虽然如此

虽然如此，对高分子量的材料而言，溶解过程是相称缓慢的（几天或几种星期）。

Solubility relations in polymer systems are more complex than those among low molecular-weight compounds, because of the size differences between polymer and solvent molecules, the viscosity of the system, and the effects of the texture and molecular weight of the polymer.

由于高分子和溶剂分子之间尺寸上的区别，体系的粘度以及聚合物分子量及织态构造的影响等原因，高分子体系的溶解性关系比低分子量化合物要复杂得多。

In turn，the presence or absence of solubility as conditions(such as the nature of the

solvent， or the temperature)are varied can give much information about the polymer.

当条件(溶剂的性质或温度)变化的时候，有无溶解性又可提供出许多有关这种聚合物的信息。

As specified in the literature，the arrangements of the polymer chain differing by reason of rotations about single bands are termed conformations.

Specify， 定义，**literature,**文献，**by reason of…** 由于….的原因 **Be termed…** 被定义为….，叫做……..**arrangement**，排布，排列 **Conformation**，构象

正如在文献中所定义的那样，由于围绕着单键的旋转而导致的聚合物链不一样的空间排布叫做构象。

In solution, a polymer molecule is a randomly coiling mass most of whose conformations occupy[‘okjupai] many times the volume of its segments alone.

Segment, 链段，**randomly**，无规则的，**coiling**，线团状的，**mass**，物质，质点

在溶液中，聚合物分子是无规线团状,而大部分构象占链段分子自身体积的许多倍。

The average density of segments within a dissolved polymer molecule is of 10-4~10-5g/cm3.

溶解聚合物分子里的平均链段密度是**10-4~10-5g/cm3**

The size of the molecular coil is very much influenced by the polymer-solvent interaction forces.

聚合物-溶剂之间的作用力对分子线团尺寸有很大的影响。

In a thermodynamically “good” solvent, where polymer-solvent contacts are highly favored, the coils are relatively extended.

在热力学上的好溶剂中，聚合物-溶剂作用较强，线团是相对伸展的。

In a “poor” solvent they are relatively contracted.

Contracted，收缩的，缩小的，缩短的，已订婚的

而在不良溶剂中，线团则是相对收缩的。

It is the purpose to describe the conformational properties of both ideal and real polymer

chains.

使用上述措施的目的是描述理想的和真实的聚合物链构象。

The importance of the random-coil nature of the dissolved, molten, amorphous, and glassy states of high polymers cannot be overemphasized.

Overemphasize, [ouvə'emfəsaiz],过度强调

我们无论怎样强调溶解的，熔融的，无定形的，玻璃态的高分子无规线团性质的重要性都不过度。

Many important physical as well as thermodynamic properties of high polymers result from this characteristic structural feature.

高分子的许多重要的物理及热力学性质都是这个构造特性引起的。

The random coil(Fig. 7. 1) arises from the relative freedom of rotation associated with the chain bonds of most polymers and the formidably large number of conformations accessible to the molecule.

Arise from 由于…….而产生，而导致，起因于……. **Associate with…**.联合…..，与……发生联络 **Formidably,** 可怕地，难对付地，难 克服地

Accessible to...为……..所能到达的…….

无规线团**(**图**7.**

1)首先是由于聚合物链上的键自由旋转而产生的，另首先是由于**(**聚合物**)**分子**(**链**)**可到达巨大的构象数而产生的。**Fig. Tab.**

One of these conformations, the fully extended chain has special interest because its length, the contour length of the chain, can be calculated in a straightforward way.

Contour，外形，轮廓，**contour length** ，伸直长度，

in a straightforward way，直接地

我们对这些构象之一，也是充足伸展的链有特殊的爱好，由于它的长度，即链的伸直长度可以直接地计算出来。

In all other cases the size of the random coil must be expressed in terms of statistical parameters such as the root-mean-square distance between its ends, (r2)1/2, or its radius of gyration, the root-mean-square distance of the elements of the chain from its center of gravity, (s2)1/2.

the elements of the chain,链节。 **radius of gyration**，回转半径，回旋半径。 **For linear polymers that are not appreciably extended beyond their most probable shape, the mean-square end-to-end distance and the square of the radius of gyration are simply related:r2=6s2. for extended chains r2>6s2.**

Appreciably，可估计地，可感觉到地

在线型聚合物的形状没有超过的充足伸展的状况下，平均末端距离的平方和回转半径之间可以简朴地有关：**r2=6s2**。对伸展链则有：**r2>6s2.**

The use of the radius of gyration is sometimes preferred because it can be determined experimentally.

有时回旋半径更为常用，由于它可以用试验来确定。**center of gravity**，重心，质心。

在所有其他的场所，无规线团的尺寸必须用记录参数来表达，如链末端之间距离的均方根，**(r2)1/2**或回旋半径，从分子重心（质心）到链节距离的均方根**(s2)1/2**

For linear polymers that are not appreciably extended beyond their most probable shape, the mean-square end-to-end distance and the square of the radius of gyration are simply related:r2=6s2. for extended chains r2>6s2. **Appreciably**，可估计地，可感觉到地 在线型聚合物的形状没有超过的充足伸展的状况下，平均末端距离的平方和回转半径之间可以简朴地有关：**r2=6s2**。对伸展链则有：**r2>6s2.**	**disintegrate: integrate** 的反义词 **The rocks are disintegrated by frost and rain.** **dis-:** 不。 **Dislike:** 不喜欢 **Agitation**，搅拌，**agitate**，**vt**，搅拌，搅动，鼓动。注意：**Stir**之间的区别。 **Agitator**，**stirrer**，都是搅拌器，**stirrer**更强调具有反应的搅拌器。 **Speed, vt,** 增进； **materially,**

The use of the radius of gyration is sometimes preferred because it can be	**ad,**物质上，实质上，大大地，相称地 **Specify,** 定义，

determined experimentally. 有时回旋半径更为常用，由于它可以用试验来确定。 Arrangement，排布，排列 conformation: 构象 conform vt. 使一致、使符合 We should try our best to conform the newcomers to the new circumstances quickly. Segment: 链段 Thermodynamically:热力学地 randomly，无规则的， Coilng： 线团的。 Coil：线团。 Random coil:无规线团 Even so，虽然如此 Associate with….联合….，与……发生联络 by reason of…: The scheme failed by reason of bad organization. arise from:由于……而产生，而导致，起因于……Accidents arise from carelessness. a in a straightforward way，直接地 in terms of…: He tends to think of everything in terms of money.	literature,文献 Amorphous:无定形的，非晶态的. Crystal:晶体 morpho- “形状”、“形态. Morphology:形态学 Contour:外形，轮廓，contour length，伸直长度， Gyration:旋转，回旋 gyro-“旋转”、“环”. Gyroscope:回旋仪 Mean-square end-to-end distance:均方末端距 the elements of the chain,链节。 center of gravity，重心，质心。 Contracted，收缩的，缩小的，缩短的 Overemphasize, [ouvə’emfəsaiz],过度强调 Formidably, 可怕地，难对付地，难克服地 Pseudoplastic: 假塑性 Pseudo：假 Pseudo-first order: reaction 准一级反应 ccessible to：为……所能到达的…. The goal is accessible to ordinary people.

UNIT 8 Morphology of Solid Polymers

Solid polymers differ from ordinary, low molecular weight compounds in the nature of their physical state or morphology.

固体聚合物在物理态的性质或形态是有别于一般低分子量化合物。

Most polymers simultaneously show the characteristics of both crystalline solids and highly viscous liquids.

大多数聚合物同步体现结晶固体和高粘液体的特性。

X-ray and electron diffraction patterns often show the sharp features typical of three-dimensionally ordered，crystalline materials as well as the diffuse features materials characteristic of liquids.