CENTURY 21

高等学校教材

科技英语系列教程

Technology

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机电工程科技英语

English of Science and Technology for Mechatronic Engineering

西北工業大學出版社

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机电工程科技英语

English of Science and Technology for Mechatronic Engineering

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【内容简介】 本书以机电工程领域的英语文献为教学内容，全书包括：工程材料、金属成形、机械零件、计算机应用、工业设计、数控加工、计算机集成制造、特种加工、机电学与测量系统、汽车、飞机设计、飞机制造、微机电系统、机器人、工业工程等17个单元的教学内容，另外还包括了科技英语翻译、科技英语写作等科技英语技能拓展辅助教学内容。

本书旨在提高学生的专业英语快速阅读理解能力，同时希望能锻炼英文写作能力。

本书适合于理工科大专院校机械工程或机电工程专业的学生学习使用，也可供专业技术人员阅读。

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前言

英语不仅是国际交流中的重要工具，也是国际上科技信息的重要载体，专业科技英语对于理工科大学生的重要性不言而喻。我国国家教育部颁布的“大学英语教学大纲”中将专业英语列为英语教学计划中的必修课程。本书是为机械工程或机电工程学科编写的专业英语教材。

本书编写的宗旨是力图使读者通过使用本书的专业英语课程学习，扩大掌握专业英语词汇，了解科技英语的文体、语法特点，提高快速阅读英文科技资料文献的能力，并且锻炼科技英文写作能力。

本书主要取材于国外英文科技文献，在注重科技英语教学的同时，力求内容新颖，反映机电专业的发展。全书共包括：工程材料、金属成形、机械零件、计算机应用、工业设计、数控加工、计算机集成制造、特种加工、机电学与测量系统、汽车、飞机设计、飞机制造、微机电系统、机器人、工业工程等17个单元的教学内容，另外还包括了科技英语翻译、科技英语写作等科技英语技能拓展的辅助教学内容。每一单元含有基本课文、注释和阅读，还选编了练习。

本书由西北工业大学机电学院专业英语教学组编写，陶华任主编。其中吴建军编写了第1,2单元(不含练习)；谢琴编写了第3,12单元；周惠群编写了第4,5单元及附录；苟秉宸编写了第6,7单元；刘维伟编写了第8,9,10单元；马炳和编写了第11,15单元；陶华编写了第13,14单元；黄英亮编写了第16,17单元；谢琴、吴建军、陶华编写了“Development Skills for Technical English”；薛红前选编了第1,2单元的练习。

编者恳请英语教学、专业领域的专家和广大读者不吝赐教，批评指正，以利本书改进提高。

编 者

2007年5月于西北工业大学

CONTENTS

Unit 1 Engineering Materials

Text 1 Type of Materials

Materials may be grouped in several ways. Scientists often classify materials by their state: solid, liquid, or gas. They also separate them into organic (once living) and inorganic (never living) materials.

For industrial purposes, materials are divided into engineering materials or non-engineering materials. Engineering materials are those used in manufacture and become parts of products. Non-engineering materials are the chemicals, fuels, lubricants, and other materials used in the manufacturing process, which do not become part of the product.

This grouping is not exact. Engineering materials may be further subdivided into: metals, polymers, and ceramics. A fourth type of material sometime listed is called a composite. Materials in this group are made up of two or more materials from the engineering group, each of the materials in a composite retains its original characteristics. Examples of composites include wood, concrete, and graphite polymer advanced composites.

Pure metals are seldom-used in common industrial products. Pure copper is used in electrical applications, in automotive radiators, and gaskets. Pure aluminum has applications in the chemical and electrical industries. However, most metals are combinations of two or more elements. There are over 25,000 different iron-carbon alloys (steels) and over 200 standard copper alloys including a number of brasses, bronzes and nickel silvers. Each of these alloys is identified by a code number.

Text 2 Steel

Steel is the common name for a large family of iron alloys which are easily malleable after the molten stage. Steels are commonly made from iron ore, coal, and limestone. When these raw materials are put into the blast furnace, the result is a "pig iron" which has a composition of iron, carbon, manganese, sulfur, phosphorus, and silicon.

As pig iron is hard and brittle, steelmakers must refine the material by purifying it and then adding other elements to strengthen the material. The steel is next deoxidized by a carbon and oxygen reaction. A strongly deoxidized steel is called "killed", and a lesser degree of deoxidized steels are called "semikilled".

Steels can either be cast directly to shape, or into ingots which are reheated and hot worked into a wrought shape by forging, extrusion, rolling, or other processes. Wrought steels are the most common engineering material used, and come in a variety of forms with different finishes and properties.

Carbon steel in which the main alloying element is carbon and can be further divided into three groups.

Low carbon steel. This steel has a carbon content of less than 0. 30 percent. It is the most common type and is often called mild steel. It is relatively inexpensive, ductile, soft, and is easily machined and forged. Mild steel cannot be heat-treated (hardened). Low carbon steel is general-purpose steel.

Medium carbon steel. This steel has a carbon content between 0. 30 percent and 0. 80 percent. Harder and stronger than mild steel, it can be hardened by heat-treating. Medium carbon steel is most commonly used for forging, casting, and machined parts for automobiles, agricultural equipment, machines, and aircraft.

High carbon steel. This type of steel is easily heat-treated to produce a strong, tough part. The material has a carbon content above 0. 80 percent. High carbon steel is harder than low carbon steel, but it is much more difficult to work. It finds wide use in hand tools, springs, and piano wire.

Text 3 Polymer

Polymeric materials are characterized by long chains of repeated molecule units. These long chains intertwine to form the bulk of the plastic. The natures by which the chains intertwine determine the plastic's macroscopic properties.

Typically, the polymer chain orientations are random and give the plastic an amorphous structure. Amorphous plastics have good impact strength and toughness. Examples include acrylonitrile-butadiene-styrene (ABS), styrene-acrylonitrile copolymer (SAN), polyvinyl chloride (PVC), polycarbonate (PC), and polystyrene (PS).

If instead the polymer chains take an orderly, densely packed arrangement, the plastic is said to be crystalline. Such plastics share many properties with crystals, and typically will have lower elongation and flexibility than amorphous plastics. Examples of crystalline plastics include acetal, polyamide (PA; nylon), polyethylene (PE), polypropylene (PP), polyester (PET, PBT), and polyphenylene sulfide (PPS).

Most plastics can be classified as either thermoplastic or thermoset, a label which describes the strength of the bonds between adjacent polymer chains within the structure. In thermoplastics, the polymer chains are only weakly bonded (van der Waals forces). The chains are free to slide past one another when sufficient thermal energy is supplied, making the plastic formable and recyclable.

In thermosets, adjacent polymer chains form strong cross links. When heated, these cross links prevent the polymer chains from slipping past one another. As such, thermosets cannot be reflowed once they are cured (i. e. once the cross links form). Instead, thermosets can suffer chemical degradation (denaturing) if reheated excessively.

Text 4 Mechanical Properties of Material

Mechanical properties mean a material's ability to carry or resist the application of mechanical forces and loads. The material's reaction to these forces is usually either deformation or fracture.

Mechanical properties are probably the most important to manufacturing processing. They determine the extent to which a material may be formed, sheared, or machined.

Typical forces which are applied to a material are tension, compression, shear, and torsion, these forces are used to form and shape materials. Furthermore, materials must withstand excess amounts of these forces in product applications. Since screws are used to assemble wood parts, they must absorb torsion forces. Rods holding suspended fixtures must withstand excess tension forces. The head of a hammer must absorb compression forces.

(1) Stress-strain. The stress-strain relationship is often used to study many mechanical properties. Stress is force applied to material. It is usually measured in either pounds per square inch or kilograms per square centimeter. Strain is the change in the length of a material which is under stress. The strain measurements are given in term of the amount of elongation of the material per unit of length. Strain is given in thousandths of an inch per inch of material of millimeters (of smaller units) per centimeter of material. For most materials, the elongation of a material under stress is quite small.

A stress-strain diagram is widely used to chart stress-strain relationships. The stress is plotted on the vertical axis while the strain is plotted on the horizontal axis.

As stress is applied, the material first resists permanent deforming. This area is in the material's elastic range. This is a range in which the material will return to its original length when the force is released.

Applying additional stress will bring the material to its yield point. At this point, additional strain occurs without additional forces being applied. Strain above this point is produced with smaller amounts of force. The force also produces permanent changes in the length of the material.

This elongation which is above the material's elastic limit is called plastic deformation.

As stress is increasingly applied above the yield point, additional strain occurs. Finally, a maximum strain is reached and the material begins to fail. Its internal structure begins to come apart. This point is called the material's ultimate strength or tension strength.

Additional stress maybe cause a reduction in cross-sectional area (necking) and will finally cause fracture.

(2) Mechanical strengths. A material can be subjected to a number of different types of forces. They may be tension, shear, torsion, compression, or a combination of these forces. Each possible force causes a material to respond in a different way. A material, therefore, has different mechanical strengths. The strength depends on the force applied.

The most common mechanical strengths are;

A. Tensile strength—the maximum tension load material can withstand before fracturing. Tensile strength is the easiest strength to measure and, therefore, is widely used.

B. Compression strength—the ability to resist forces which tend to squeeze the material into a new shape. It is basically the opposite of tensile strength. Excessive compression force will cause the material to rupture (buckling and splitting).

C. Shear strength—the ability to resist fracture under shear forces. The shear force is caused by offset forces applied in opposite directions. These forces cause the grains or molecules of material to slide by one another and eventually fracture.

D. Bending strength—the ability of a material to resist the combination of tensile and compression forces. When a material is bent, the material on the inside of the bend must compress while that on the outside portion must stretch. A material must have flexure strength to undergo bending processes.

E. Torsion strength—the ability to resist twisting forces. Forces which exceed the torsion strength will cause the material rupture.

F. Fatigue strength—the ability to resist forces which vary in direction and/or magnitude. Typical of forces which cause fatigue are constant bending back and forth, applying and releasing tension forces, or torsion forces.

New Words

thermoplastics [ˌθəːmə'plæstiks] *n.* 热塑性塑料
thermoset [ə'θəːməset] *n.* 热固树脂
polymer ['pɔlimə] *n.* 聚合体,高分子聚合物质
intertwine [ˌintə(ː)'twain] *v.* (使)纠缠,(使)缠绕
malleable ['mæliəbl] *adj.* 有延展性的,可锻的
extrusion [eks'truːʒən] *n.* 挤出,推出,挤压
polycarbonate [ˌpɔli'kaːbənit,-neit] *n.* [化]聚碳酸酯
polystyrene [ˌpɔli'staiəriːn] *n.* 聚苯乙烯

Phrases and Expressions

pig iron 生铁
amorphous structure 不定型的结构
ABS 丙烯腈-丁二烯-苯乙烯

stress-strain relationship 应力应变关系
plastic deformation 塑性变形
yield point 屈服点

Notes

1. High carbon steel is harder than low carbon steel, but it is much more difficult to work. 句中 it 是代词，指代前面的 High carbon steel，不定式 to work 是形容词 difficult 的宾语。全句意思是：“高碳钢比低碳钢硬，可是加工则困难得多。”
2. As stress is applied, the material first resists permanent deforming. This area is in the material's elastic range. This is a range in which the material will return to its original length when the force is released. 第二句中的 This area 和 a range 是指应力作用的范围。上述两句可以翻译为：“当施加应力时，材料首先抵抗永久变形，这个应力作用的范围是在材料的弹性区域，在这个区域当载荷卸掉后材料将恢复到它初始长度。”
3. A strongly deoxidized steel is called “killed”, and a lesser degrees of deoxidized steels are called “semikilled”. 此句中的“killed”指调质的、脱氧的或优质的，而“semikilled”指半调质的、半脱氧的。全句可以翻译为：“高度脱氧钢被称为调质钢，而脱氧程度不高的钢称为半调质钢。”
4. Most plastics can be classified as either thermoplastic or thermoset, a label which describes the strength of the bonds between adjacent polymer chains within the structure. 此句中的 label 指分类。全句可以翻译为：“很多塑料可以被划分为热塑性塑料或者热固性塑料，这种划分描述了在结构中相临聚合物链之间的联结强度。”

Free Reading

What's a Composite?

The use of composites in all products—from sporting goods to bridges to satellites is increasing. Outside of the profession, though, many people would be hard pressed to identify a composite. This article presents a simple definition of composite materials. Although it is primarily written for people new to the materials; composite professionals may also find a few things of interest.

Most of the products we see every day are made from monolithic materials. That means the individual components consist of a single material (an unreinforced plastic), or a combination of materials that are combined in such a way that the individual components are indistinguishable (a metal alloy).

Composite materials, on the other hand, consist of two or more materials combined in such a way that the individual materials are easily distinguishable. A common example of a composite is concrete. It consists of a binder (cement) and a reinforcement (gravel). Adding another reinforcement (rebar) transforms concrete into a three-phase composite.

The individual materials that make up composites are called constituents. Most composites have two constituent materials: a binder or matrix, and a reinforcement. The reinforcement is usually much stronger and stiffer than the matrix, and gives the composite its good properties. The matrix holds the reinforcements in an orderly pattern. Because the reinforcements are usually discontinuous, the matrix also helps to transfer load among the reinforcements.

Reinforcements basically come in three forms: particulate, discontinuous fiber, and continuous fiber. A particle has roughly equal dimensions in all directions, though it doesn't have to be spherical. Gravel, micro balloons, and resin powder are examples of particulate reinforcements. Reinforcements become fibers when one dimension becomes long compared to others. Discontinuous reinforcements (chopped fibers, milled fibers, or whiskers) vary in length from a few millimeters to a few centimeters. Most fibers are only a few microns in diameter, so it doesn't take much length to make the transition from particle to fiber.

With either particles or short fibers, the matrix must transfer the load at very short intervals. Thus, the composite properties cannot come close to the reinforcement properties. With continuous fibers, however, there are few if any breaks in the reinforcements. Composite properties are much higher, and continuous fibers are therefore used in most high performance components, be they aerospace structures or sporting goods.

Matrix materials are usually some type of plastic, and these composites are often called reinforced plastics. There are other types of matrices, such as metal or ceramic, but plastics are by far the most common. There are also many types of plastics, but a discussion of them is beyond the scope of this week's column. Suffice it to say for now that the two most common plastic matrices are epoxy resins and polyester resins.

Composite materials are available as plies or lamina. A single ply consists of fibers oriented in a single direction (unidirectional) or in two directions (bidirectional; for example a woven fabric). There are other forms, but these are the most important for this discussion.

Composite properties are best in the direction of the fibers. Perpendicular, or transverse to the fibers, the matrix properties dominate because load must be transferred by the matrix every fiber diameter. Because most structures are not loaded in a single direction, even though one direction may dominate, it is necessary to orient fibers in multiple directions. This is accomplished by stacking multiple plies together. Such a stack is called a laminate.

The most efficient composites have most of their fibers oriented in the primary load direction, and just enough fibers oriented in the other directions to carry secondary loads and hold the structure together. Efficiency means both low weight and low cost, because any fibers which don't carry much load could probably be removed.

Exercise

1. Answer the following questions.
   (1) Could you give an example to explain fatigue strength of an alloy?
   (2) When selecting a material used as a mechanical part (an axle or a drill), what property, physical properties and mechanical properties, would you expect the material to possess?
2. Write a statement about the stress-strain of an aluminum alloy and a cast iron.
3. Translate the last three paragraphs of the free reading into Chinese.

Unit 2 Material Forming

Text 1 Metal Forming

We can obtain bars and sheet from steel by rolling the metal through huge rolls in a rolling mill. The roll pressures must be much greater for cold rolling than for hot rolling, but cold rolling enables the operators to produce rolls of great accuracy and uniformity, and with a better surface finish. Other shaping operations include drawing into wire, casting in mould, and forging.

The mechanical working of metal is the shaping of metal in either a cold or a hot state by some mechanical means. This does not include the casting of molten metal into some form by use of molds. In mechanical working processes, the metal is shaped by pressure—actually forging, bending, squeezing, drawing, or shearing it to its final shape. In these processes the metal either cold or hot-worked. Although, normal room temperature are ordinary used for cold working of steel, temperatures up to the re-crystallization range are sometimes used. Hot working of metals takes place above the re-crystallization or working-hardening range. For steel, re-crystallization starts around 650 to 700℃, although most hot work on steel is done at temperatures considerably above this range.

There is no tendency for hardening by mechanical work until the low limit of the re-crystallization range is reached. Some metals, such as lead and tin, have a low re-crystallization range and can be hot-worked at room temperature, but most commercial metal require some heating. Alloy composition has a great influence upon his proper working range, the usual result being to raise the re-crystallization range temperature. This range may also be increased by prior cold working.

Text 2 Sheet Forming

In stamping, drawing, or pressing, a sheet is clamped around the edge and formed into a cavity by a punch. The metal is stretched by membrane forces so that it conforms to the shape of the tools. The membrane stresses in the sheet far exceed the contact stresses between the tools and the sheet, and the through-thickness stresses may be neglected except at small tool radii. Fig. 2. 1 shows a stamping die with a lower counter-punch or bottoming die, but contact with the sheet at the bottom of the stroke will be on one side only, between the sheet and the punch or between the die and the sheet. The edge or flange is not usually held rigidly, but is allowed to move inward in a controlled fashion. The tension must be sufficient to prevent wrinkling, but not enough to cause splitting.

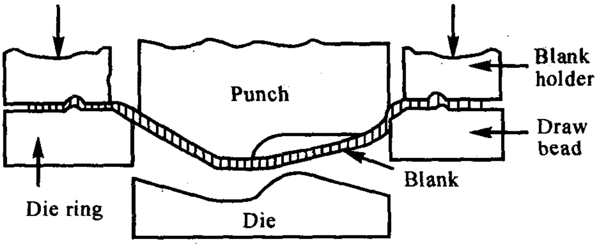

Fig. 2. 1 A schematic section of a typical stamping die

The sheet contacts only the punch or the die at any point. Membrane stresses stretch the sheet over the tools.

The limits of deformation, or the window for stamping, are shown in Fig. 2. 2. It is assumed that the failure limits are a property of the sheet. This assumption is reasonable if through-thickness stresses are negligible, and if each element follows a simple, linear path represented by a straight line radiating from the origin.

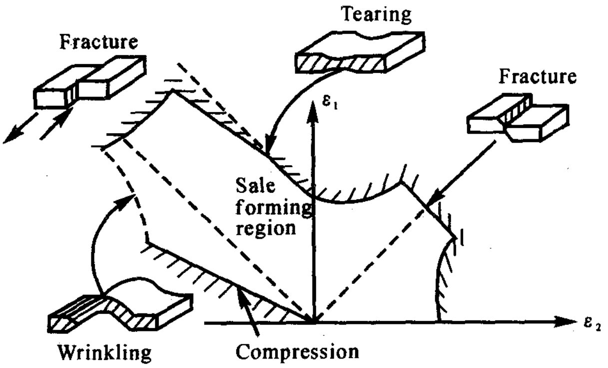

Fig. 2. 2 A schematic plot of the window of safe straining for simple paths the forming-limit diagram

The paths in stampings vary from equal biaxial stretching to uniaxial compression. Fig. 2. 3 shows the strain paths along two lines in a rectangular pressing. Such diagrams are strain signatures of the part. Unequal biaxial stretching will occur in the middle, *A*. In the sidewall, *C*, plane strain is most likely. If the side of the stamping is long and straight, plane strain will exist also at *D*. Over the rounded corner of the punch at *F*, the strain is biaxial. From *H* to *J*, strains are in the tension-compression quadrant. The concept of the forming limit curve is that all possible strain signatures are bounded by an envelope that is a characteristic of the material.