高等学校专业英语教材

机械工程专业英语（第2版）

唐一平 主编

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内 容 简 介

本书按照“内容新，知识面广，难度适中，反映最新科研成果”的原则编写而成。其内容包括：工程材料、铸造、锻造与模具、常规机械加工工艺、特种加工技术、公差与配合、定位与夹具、齿轮传动、液压传动、直接传动技术、数控技术、数控加工中心、自动控制技术、CAD/CAM、传感器、机器人、制造业的发展、信息技术与制造、制造与工程师的作用等；附录中包括：英文摘要写作、麻省理工学院简介、机床说明书翻译及校园常用词汇。同时，本书还提供配套的中文译稿和电子课件。

该书可供机械类及相关专业高年级本科生作为专业英语教材使用，也可作为企业和科研单位技术人员的英文阅读参考书。

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第 2 版前言

本教材自 2009 年 10 月出版发行以来，已被多所高等院校采用。由于该教材选材新颖，注释详实，尤其是其附录的内容颇具特色，实用价值高，受到了广泛的好评。为满足广大读者的需求，编者在采纳了部分院校授课教师提出的宝贵建议之后，对部分章节进行了修改、纠错与补充。同时，考虑到某些校外读者自学的方便，特在附录中增加了部分章节的参考译文，而对于完整的参考译文及电子课件，任课教师可通过如下方式联系，确认后获得。（编者联系电话：029-82665571，E-mail:yptang@mail.xjtu.edu.cn；出版社联系方式：yuy@phei.com.cn。）

编　者

2012 年 11 月

第 1 版前言

本书是根据电子工业出版社"高等院校机电类工程教育系列规划教材"的出版计划，组织有关高校编写而成的。目前，机械工程专业英语教材在国内已有数十种。然而，随着近年来机械制造科学与技术的不断发展，很多教材中的相当一部分内容多年来一直没有更新和改编，已显得陈旧和落后，从而与当前我们提出的"教育要面向世界，面向未来，要培养创新型科技人才"的要求很不相适应。鉴于此，我们组织了一些在高校中有多年专业英语教学经验的教师重新编写了这部教材。该教材没有参考和引用国内已出版的任何一本类似的教材，按照"内容新，知识面广，难度适中，要反映机械制造业中最新的科研成果"的原则，从近年来国外的优秀教材及有关科研论文与专著中，经过严格筛选、精心编写而成。该教材涵盖面广，信息集成度高，反映了制造业先进技术的发展趋势和近年来部分尖端成果（如高性能先进陶瓷材料、电主轴与高速加工技术、家用与医用机器人、信息化制造技术等）。这些教学内容对拓宽机械（电）类工科学生的眼界，帮助他们阅读本专业的英文科技文献有很大的促进作用。为了便于教师讲授和学生自学，每单元都附有详细的课文注释和词汇表。该书的另一个特点是在 20 个单元后增加了 4 个附录。附录包括了科技论文英文摘要写作要点、麻省理工学院简介、机床说明书翻译样本，以及目前在任何一本教材上从未出现过的、具有趣味性和实用价值的校园词汇。目前，专业英语在很多工科院校中都设为选修课，一般为 30 ~ 40 个学时，因此要将该教材 20 个单元和 4 个附录全部讲授完是不可能的。编者建议授课教师根据本校及本专业的特色有选择性地讲授其中某些内容，而不要按单元的顺序从头讲起。英文中有句常讲的话："Last but not least!"，也许后面几个单元的内容（包括附录）对不少学生来说会更加有用。

该教材可供机械类及相关专业高年级本科生作为专业英语阅读使用，也可作为企业和科研单位技术人员的英文阅读参考书。

本教材由唐一平教授担任主编，李艳副教授、徐海黎副教授担任副主编。唐一平负责其中的第 1，2，3，4，15，20 单元和 4 篇附录的编写；李艳负责第 5，6，7，8，9，10，13 单元的编写；徐海黎负责第 11，12，14，16，17，18，19 单元的编写。

为使本教材日臻完善，欢迎各有关专家学者在该书的使用过程中不吝赐教，提出宝贵的批评与建议。同时，本教材还将为授课教师提供全部中文译稿。

编　者

2009 年 7 月于西安交通大学

CONTENTS

Unit 1　Engineering Materials (I)

1.1 Introduction

For industrial purposes, materials can be divided into engineering materials and non-engineering materials. Engineering materials are those used in manufacturing and will become parts of products through definite processing. In generally, engineering materials may be further subdivided into metals, ceramics, composites and polymers.

Metals. Common metals are gold, silver, copper, iron, nickel, aluminum, magnesium and titanium, etc. Among these metals, gold and silver (also platinum) are precious metals; iron and nickel are magnetic materials (they are subject to the action of magnetic force); aluminum, magnesium and titanium are commonly called light metals. Of course, metal materials are seldom used in their pure states but in alloy states. Alloys contain more than one metallic element. Their properties can be modified by changing the element contents present in them. Examples of alloys include stainless steels which are alloys of Fe, Ni and Cr; and brass which is an alloy of Cu and Zn. In addition, metal materials can also be broadly divided into two groups, i.e. ferrous metals and nonferrous metals. Ferrous metals often refer to iron alloys (iron and steel materials) and nonferrous metals include all other metallic materials.

Ceramics. It seems that there hasn't been an exact and complete definition about advanced ceramics so far, but from a viewpoint of modern engineering and technology, advanced ceramics (differentiating from traditional household ceramics) may be defined as the new engineering materials composed of some special kinds of metallic oxides (e.g. alumina or corundum and zirconia) or carbides or nitrides of metallic and nonmetallic elements (e.g. tungsten carbide, silicon carbide, boron nitride, silicon nitride, etc.).[1] They have some unique properties such as high-temperature strength; hardness; inertness to chemicals, food, and environment; resistance to wear and corrosion; and low electrical and thermal conductivity. So they are widely used in turbine, automobile, aerospace components, heat exchangers, semiconductors and cutting tools.

Polymers. The word *polymer* was first used in 1866. In essence, they are organic macromolecular compounds. And in 1909, the word *plastics* was employed as a synonym for "polymers" . Plastic is from a Greek word *plastikos*, meaning "able to be molded and shaped". Plastics are one of numerous polymeric materials and have extremely large molecules. Because of their many unique and diverse properties, polymers have increasingly replaced metallic components in applications such as automobiles, civilian and military air craft, sporting goods, toys, appliances, and office equipment.

Composite materials. Among the major developments in materials in recent years are composite materials. In fact, composites are now one of the most important classes of engineered materials, because they offer several outstanding properties as compared with conventional materials. A composite material is a combination of two or more chemically distinct and insoluble phases; its properties and structural performance are superior to those of the constituents acting independently.[2]

Nanomaterials refer to those materials, at least one of whose three dimensions is at the nano-scale(1-100 nm) and hence we may have nano-powders, nano-fibers and nano-films.[3] They were first investigated in the early 1980s. However, we can not classified them in nature as distinct from other four common engineering materials, i.e. metals, ceramics, composite and macromolecular materials, because various nano-materials developed so far are all composed of one or combination of the above four materials.[4] Nevertheless, when the sizes of some common materials are reduced to the nano-scale, they will possess some special properties superior to traditional and commercially available materials. These properties can include strength, hardness, ductility, wear resistance and corrosion resistance suitable for structural (load-bearing) and nonstructural applications, in combination with unique electrical, magnetic, and optical properties. For example, nano-powders have very large specific surface area, up to hundreds even thousands of square meters per gram, making them become highly active adsorbents and catalysts with wide application prospect in organic synthesis and environmental protection.[5]

1.2 Ferrous Metals and Alloys

By virtue of their wide range of mechanical, physical, and chemical properties, ferrous metals and alloys are among the most useful of all metals. Ferrous metals and alloys contain iron as their base metal; the general categories are cast irons, carbon and alloy steels, stainless steels, tool and die steels.

The term cast iron refers to a family of ferrous alloys composed of iron, carbon (ranging from 2.11% to about 4.5%), and silicon (up to about 3.5%). Cast irons are usually classified as follows:

1. Gray cast iron, or gray iron;
2. Ductile cast iron, nodular cast iron, or spherical graphite cast iron;
3. White cast iron;
4. Malleable iron;
5. Compacted graphite iron.

The equilibrium phase diagram relevant to cast irons is shown in Fig.1.1, in which the right boundary is 100% carbon, that is, pure graphite. The eutectic temperature is 1154 °C (2109 °F), and so cast irons are completely liquid at temperatures lower than those required for liquid steels. Consequently, iron with high carbon content can be cast at lower temperatures than can steels.

Carbon steels are generally classified by their proportion (by weight) of carbon content.

1. Low-carbon steel, also called mild steel, has less than 0.30% carbon. It is generally used for common industrial products, such as bolts, nuts, sheet, plate, and tubes, and for machine components that do not require high strength.

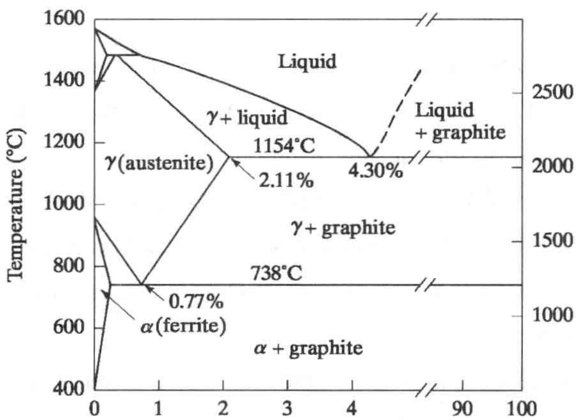

Fig.1.1 composition graphite(%)

2. Medium-carbon steel has 0.30% to 0.60% carbon. It is generally used in applications requiring higher strength than is available in low-carbon steels, such as in machinery, in automotive and agricultural equipment parts (gears, axles, connecting rods, crankshafts), in railroad equipment, and in parts for metalworking machinery.

3. High-carbon steel has more than 0.60% carbon. It is generally used for parts requiring strength, hardness, and wear resistance, such as cutting tools, cable, music string, springs, and cutlery. After being manufactured into shapes, the parts are usually heat treated and tempered. The higher the carbon content of the steel, the higher is its hardness, strength, and wear resistance after heat treatment.

Alloy steels contain significant amounts of alloying elements. Structural-grade alloy steels, as identified by ASTM specifications, are used mainly in the construction and transportation industries, because of their high strength. Other alloy steels are used in applications where strength, hardness, creep and fatigue resistance, and toughness are required. These steels may also have been heat treated, in order to obtain the desired properties.

Stainless steels are characterized primarily by their corrosion resistance, high strength and ductility, and high chromium content. They are called *stainless* because in the presence of oxygen (air) they develop a thin, hard adherent film of chromium oxide that protects the metal from corrosion (*passivation*). This protective film builds up again in the event that the surface is scratched.[6] For passivation to occur, the minimum chromium content should be 10% to 12% by weight. In addition to chromium, other alloying elements in stainless steels typically are nickel, molybdenum, copper, titanium, silicon, manganese, columbium, aluminum, nitrogen, and sulfur.

Tool and die steels are specially alloyed steels. They are designed for high strength, impact toughness, and wear resistance at room and elevated temperatures. They are commonly used in forming and machining of metals.

High-speed steels (HSS) are the most highly alloyed tool and die steels. First developed in the early 1900s, they maintain their hardness and strength at elevated operating temperatures. There are two basic types of high-speed steels: the *molybdenum type* (M series) and the *tungsten type* (T series).

Hot-work steels are designed for use at elevated temperatures. They have high toughness as well as high resistance to wear and cracking. The alloying elements are generally tungsten, molybdenum, chromium, and vanadium.

Cold-work steels are used for cold-working operations. They generally have high resistance to wear and cracking. These steels are available as oil-hardening or air-hardening types.

Shock-resisting steels are designed for impact toughness and are used in applications such as header dies, punches, and chisels. Other properties of these steels depend on the particular composition.

1.3 Nonferrous Metals and Alloys

Nonferrous metals and alloys cover a wide range of materials, from common metals such as aluminum, copper, and magnesium to high-strength, high-temperature alloys, such as those of tungsten, tantalum, and molybdenum. Although generally more expensive than ferrous metals, nonferrous metals and alloys have important applications because of properties such as corrosion resistance, high thermal and electrical conductivity, low density, and ease of fabrication.

Aluminum(Al). Typical examples of the applications of nonferrous metals and alloys are aluminum for cooking utensils and aircraft bodies, copper wire for electricity, copper tubing for residential water supply, zinc for galvanized sheet metal for car bodies, titanium for jet-engine turbine blades and for orthopedic implants.

The principal uses of aluminum and its alloys are in containers and packaging (aluminum cans and foil), in buildings and other types of construction, in transportation (aircraft and aerospace applications, buses, automobiles), in electrical applications (economical and nonmagnetic electrical conductor), in consumer durables (appliances, cooking utensils, and furniture). Nearly all high-voltage transmission wiring is made of aluminum. In its structural (load-bearing) components, 82% of a Boeing 747 aircraft (and 79% of a Boeing 757 aircraft) is aluminum.

Porous Aluminum. Blocks of aluminum have recently been produced that are 37% lighter than solid aluminum and have uniform permeability (microporosity). This characteristic allows their use in applications where a vacuum or differential pressure has to be maintained. Examples are the vacuum holding of fixtures for assembly and automation and the vacuum forming or thermoforming of plastics.[7] These blocks are 70% to 90% aluminum powder; the rest is epoxy resin. They can be machined with relative ease and can be joined together using adhesives.

Magnesium (Mg) is the lightest engineering metal available, and it has good vibration-damping characteristics. Its alloys are used in structural and nonstructural applications wherever weight is of primary importance. Magnesium is also an alloying element in various nonferrous metals. A variety of magnesium alloys have good casting, forming, and machining characteristics.

Typical uses of magnesium alloys are in aircraft and missile components, material-handling equipment, portable power tools (such as drills and sanders), ladders, luggage, bicycles, sporting goods, and general lightweight components.

Copper (Cu), first produced in about 4000 B.C., and its alloys have properties somewhat similar to those of aluminum and its alloys. In addition, they are among the best conductors of electricity and heat, and they have good corrosion resistance. They can be processed easily by various forming, machining, casting, and joining techniques.

Copper alloys are often attractive for applications where a combination of electrical, mechanical, nonmagnetic, corrosion-resistant, thermally conductive, and wear-resistant qualities are required. Applications include electrical and electronic components; springs; cartridges for small arms; plumbing; heat exchangers; marine hardware, and consumer goods, such as cooking utensils, jewelry, and other decorative objects.

Titanium (Ti), named after the giant Greek god Titan, was discovered in 1791, but it was not produced commercially until the 1950s. Although it is expensive, its high strength-to-weight ratio and its corrosion resistance at room and elevated temperatures make it attractive for many applications including aircraft, jet-engine, racing-car, chemical, petrochemical, and marine components, submarine hulls, and biomaterials, such as orthopedic implants. Titanium alloys have been developed for service at 550°C (1000 °F) for long periods of time and at up to 750 °C (1400 °F) for shorter periods.

The properties and manufacturing characteristics of titanium alloys are extremely sensitive to small variations in both alloying and residual elements. These elements cause embrittlement of titanium and, consequently, reduce toughness and ductility.

Superalloys are important in high-temperature applications; hence, they are also known as heat-resistant or high-temperature alloys. Major applications of superalloys are in jet engines and gas turbines; other applications are in reciprocating engines, in rocket engines, in tools and dies for hot-working of metals, and in the nuclear, chemical, and petrochemical industries. Superalloys generally have good resistance to corrosion, to mechanical and thermal fatigue, to mechanical and thermal shock, to creep, and to erosion at elevated temperatures.

Most superalloys have a maximum service temperature of about 1000 °C (1800 °F) in structural applications. The temperatures can be as high as 1200 °C (2200 °F) and above and a major application for the superalloys of rapidly-solidified powders is consolidation into near-net shapes for parts used in aerospace engines.

Low-melting alloys are so named because of their relatively low melting points. The major metals in this category are lead, zinc, and tin and their alloys.

Lead (Pb) has properties of high density, resistance to corrosion (by virtue of the