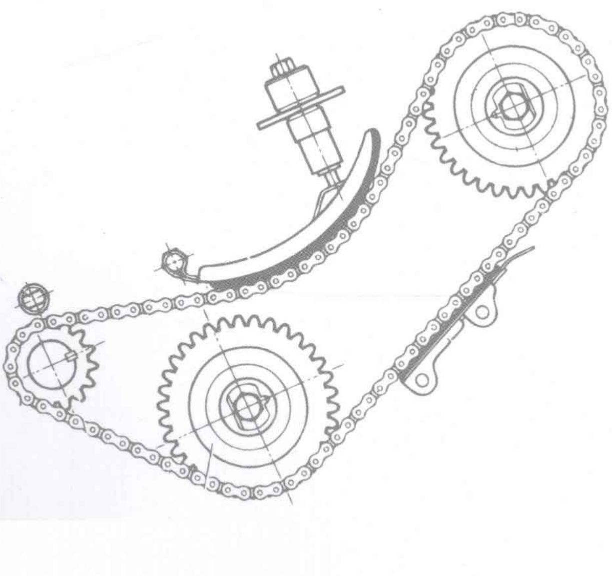
普通高等院校机械工程学科"十二五"规划教材

专业英语
（机械类）

秦志钰　郝兴明　容幸福　编著



国防工業出版社
National Defense Industry Press

普通高等院校机械工程学科“十二五”规划教材

专业英语

（机械类）

秦志钰　郝兴明　容幸福　编著

国防工业出版社

·北京·

内容简介

全书主要包括4篇内容，共12章60个单元。第1篇为工程材料，概括介绍了工程材料及测试、钢铁材料、钢的热处理、表面处理、合金钢及有色金属材料等。第2篇为铸造、锻压和焊接，介绍了金属毛坯成形常用方法以及一些现代成形工艺和方法，如铸造、锻压和焊接的基本理论和工艺知识。第3篇为机械原理和零件设计，主要介绍了机械原理中的自由度、机构等基本知识及概念，以及凸轮和齿轮机构基本原理和知识；还介绍了零件设计中的基本步骤和要求，以及紧固和轴承等机械零件设计的基本知识、要点和步骤。第4篇为金属的机械加工，重点介绍了金属切削基本知识、机床、车床、组合机床及自动化、CNC以及CAD/CAM、CIFM和AAC等基础内容。

本书可作为普通高等院校机械类各专业高年级相关专业基础课程的教材，可供普通高等工科院校机械工程类、近机械类专业以及其他工程类专业使用，还可以供高等职业技术学院、高等工业专科学校以及相关技术人员使用。

图书在版编目(CIP)数据

专业英语：机械类/秦志钰，郝兴明，容幸福编著．—北京：国防工业出版社，2012.9

普通高等院校机械工程学科“十二五”规划教材

ISBN 978-7-118-08314-9

Ⅰ．①专… Ⅱ．①秦… ②郝… ③容… Ⅲ．①机械工程—英语—高等学校—教材 Ⅳ．①H31

中国版本图书馆CIP数据核字(2012)第185866号

※

国防工业出版社出版发行

(北京市海淀区紫竹院南路23号 邮政编码100048)

北京奥鑫印刷厂印刷

新华书店经售

*

开本 787×1092 1/16 **印张** 14 **字数** 315千字

2012年9月第1版第1次印刷 **印数** 1—4000册 **定价** 29.00元

国防书店：(010)88540777 发行邮购：(010)88540776

发行传真：(010)88540755 发行业务：(010)88540717

普通高等院校机械工程学科“十二五”规划教材

编委会名单

序

国防工业出版社组织编写的“普通高等院校机械工程学科‘十二五’规划教材”即将出版，欣然为之作“序”。

随着国民经济和社会的发展，我国高等教育已形成大众化教育的大好形势，为适应建设创新型国家的重大需求，迫切要求培养高素质专门人才和创新人才，学校必须在教育观念、教学思想等方面做出迅速的反应，进行深入教学改革，而教学改革的主要内容之一是课程的改革与建设，其中包括教材的改革与建设，课程的改革与建设应体现、固化在教材之中。

教材是教学不可缺少的重要组成部分，教材的水平将直接影响教学质量，特别是对学生创新能力的培养。作为机械工程学科的教材，不能只是传授基本理论知识，更应该是既强调理论，又重在实践，突出的要理论与实践结合，培养学生解决实际问题的能力和创新能力。在新的深入教学改革、新课程体系的建立及课程内容的发展过程中，建设这样一套新型教材的任务已经迫切地摆在我们面前。

国防工业出版社组织有关院校主持编写的这套“普通高等院校机械工程学科‘十二五’规划教材”，可谓正得其时。此套教材的特点是以编写“有利于提高学生创新能力培养和知识水平”为宗旨，选题论证严谨、科学，以体现先进性、创新性、实用性，注重学生能力培养为原则，以编出特色教材、精品教材为指导思想，注意教材的立体化建设，在教材的体系上下功夫。编写过程中，每部教材都经过主编和参编辛勤认真的编写和主审专家的严格把关，使本套教材既继承老教材的特点，又适应新形势下教改的要求，保证了教材的系统性和精品化，体现了创新教育、能力教育、素质教育教学理念，有效激发学生自主学习能力，提高学生的综合素质和创新能力，为培养出符合社会需要的优秀人才服务。丛书的出版对高校的教材建设、特别是精品课程及其教材的建设起到了推动作用。

衷心祝贺国防工业出版社和所有参编人员为我国高等教育提供了这样一套有水平有特色、高质量的机械工程学科规划教材，并希望编写者和出版者在与使用者的过程中，认真听取他们的宝贵意见，不断提高该套规划教材的水平

中国工程院院士

2010 年 6 月

前　言

当前，我国的机械工业正向着高速、自动、精密方向迅速发展，并且相应的国际交流和国际化程度越来越大。因此，根据教育部国家教改委颁布的“大学英语教学大纲”，把专业英语列为必修课并纳入英语教学计划，强调通过4年不断线的英语教学措施，使学生能够达到自如阅读专业英语书刊及文献和用英语相互交流的水平。《专业英语（机械类）》课程正是为实现这一目标而设置的。

从该课程体系、教育和教学改革发展趋势以及新世纪对培养现代工程技术人才等要求出发，专业英语教学已经成为普通高等院校教学水平和质量的评估条件之一。根据我国普通高等教育重点教材建设规划精神，为培养和提高普通高等院校机械类专业高年级学生阅读专业英语书刊及文献和用英语相互交流的能力，我们编著了本教材。

全书分为4篇，共12章60个单元。第1篇为工程材料，共3章20个单元，概括介绍了工程材料及测试、钢铁材料、钢的热处理、表面处理、合金钢及有色金属材料等。第2篇为铸造、锻压和焊接，共3章17个单元，介绍了金属毛坯成形常用方法以及一些现代成形工艺和方法，如铸造、锻压和焊接的基本理论和工艺知识。第3篇为机械原理和零件设计，共2章9个单元，主要介绍了机械原理中的自由度、机构等基本知识及概念，以及凸轮和齿轮机构基本原理和知识；还介绍了零件设计中的基本步骤和要求，以及紧固和轴承等机械零件设计的基本原理、步骤和知识。第4篇为金属机械加工，共4章14个单元，重点介绍了机床、切削基本知识、车床、组合机床及自动化、CNC以及CAD/CAM、CIFM和AAC等基础内容。

本教材具有以下特点：

(1) 符合国家教改委强调的4年不断线英语教学过程中专业英语课程教学目标要求。

(2) 所有内容均为英语。这有利于该课程的计划与安排，可以根据实际教学课时、授课教师以及授课对象灵活、合理地选择课程重点并组织和实施教学。

(3) 在介绍机械设计和制造及其自动化基本原理和知识的基础上，注重扩展新材料、

新技术和新工艺的内容。

(4) 内容深入浅出、宽精适度、侧重新颖适用和通俗易懂。

(5) 注重培养高年级学生英语阅读、自习和交流的能力；强调实际、实用和实践，为学生今后持续学习科技和工程英语奠定基础。

本书由太原理工大学秦志钰、郝兴明和容幸福编著，由秦志钰编著第 2 章和第 3 章的 6 单元～20 单元、第 5 章～第 12 章的 27 单元～60 单元；郝兴明编著第 4 章的 21 单元～26 单元；容幸福编著第 1 章的 1 单元～5 单元。全书经编著者互审，最后由容幸福统稿。

本书在编著过程中，得到有关同志和同仁的热忱帮助和支持，在此谨表示衷心的感谢。由于我们教学及实践经验有限，加之编著时间仓促，书中可能有欠妥之处，恳切希望广大读者提出宝贵意见，以便在再版重印时予以修订。

编著者

2012 年 6 月于太原

Contents

PART I ENGINEERING MATERIALS

PART II CASTING, FORGING AND WELDING

PART III THEORY OF MACHINES AND MECHANISMS, MECHANICAL DESIGN

PART IV MACHINING OF METAL

PART I ENGINEERING MATERIALS

Chapter 1 Engineering Materials and Testing

Unit 1 Engineering Materials

Metal and Alloy. If there is a typical engineering material that is associated with modern engineering practice, it is structural steel. This versatile construction material has several characteristics, or properties, that we consider metallic:

(1) It is strong and can be readily formed into practical shapes.

(2) Its extensive, permanent deformability, or ductility, is an important asset in permitting small amounts of yielding to sudden and severe loads.

(3) A freshly cut steel surface has a characteristic metallic luster.

(4) A steel bar shares a fundamental characteristic with other metals: it is a good conductor of electrical current.

An alloy is a metal composed of more than one element. Engineering alloys include the cast-irons and steels, aluminum alloys, magnesium alloys, titanium alloys, nickel alloys, zinc alloys and copper alloys. For example, brass is an alloy of copper and zinc.

Rarely do we find metallic elements in the "free" state. Society gets its metals from an ore, not from the natural element found in nature. Ores are often a combination of the metallic element and a non-metallic element. Consider, for example, Galena. Galena, PbS, is a common and popular mineral for rock hounds. Its characteristic cubes, distinctive cleavage and high density make it easy to identify. The structure of Galena is identical to that of halite, NaCl. The two minerals have the same crystal shapes, symmetry and cleavage. Some Galena may contain up to 1% silver in place of lead. The large volume of Galena that is processed for lead produces enough Silver as a by product in the production of Galena, the leading ore of Silver.

The basic oxygen furnace is just one method for producing steel. One way to make something useful is to pour the liquid metal directly into a crucible or mold and let it solidify. However, there are alternative processes such as the condensation of evaporated metallic elements; or the consolidation of micron-size particles.

The aluminum alloy used in the production of beverage cans contains manganese and is highly hardenable. This means that when worked (or hammered), the aluminum becomes harder or "more resistant" to further deformation. The all aluminum-can is one of the most convenient and cost-effective containers ever developed for delivering beverages to consumers.

A materials engineer (or mechanical engineer with materials expertise) would be involved with the following issues regarding the design and fabrication of advanced bicycle spokes:

(1) What alloy should be used?

(2) What are the fabrication steps to make this unique blade-shape?

(3) At what times and temperatures should the alloy be heat-treated?

(4) What are the appropriate surface-finish operations?

(5) What fatigue life is predicted for the spoke?

(6) Do mechanical tests confirm strength and fatigue life requirements?

There is a class of alloys called shape memory alloys (SMA). These alloys provide the engineer a means of restoring a bent metal wire to some trained alternate shape. These SMA's have applications ranging from frames for optical glasses to repair parts for the human body. For example, fine NiTi (containing approximate equal parts of nickel and titanium) shape memory or superelastic wires can be woven into cylindrical shapes for various applications. One such application is vascular stents to reinforce blood vessels in the human body. The stent is crushed and inserted through a cannula into the proper location in the blood vessel. Upon warming above its transformation temperature, the stent returns to its trained cylindrical shape and provides reinforcement to the walls of the blood vessel.

Ceramics. Ceramic materials are inorganic, nonmetallic materials. Most ceramics are compounds between metallic and nonmetallic elements for which the interatomic bonds are either totally ionic or predominantly ionic but having some covalent character. The term ceramic comes from the Greek word keramikos, which means burnt stuff, indicating that desirable properties of these materials are normally achieved through a high-temperature heat treatment process called firing.

Ceramic materials are important in today's society. Consider the ceramic engine and what advantages it offers in terms of fuel economy, efficiency, weight savings and performance. What about fabricating a ceramic turbine in the millimeter range for some very, very small engine of the future? It is part of a new technology for producing micro-electromechanical systems, termed MEMS. The entire device, complete with an integrated electric generator, is expected to weigh in at just 1 gram.

You may think that copper is a good conductor of electricity. It is pretty good, really. But do you realize that a ceramic can be a better conductor of electricity than copper!? This is true of the recently discovered, high-temperature superconducting ceramic materials. At 100 degrees Kelvin and below, these materials offer no resistance to conduction of electrons. In addition, these materials reject magnetic flux lines (the Meissner effect) so that a magnet can be suspended in the space above the superconductor.

Polymers. The word polymer literally means "many parts". A polymeric solid material may be considered to be one that contains many chemically bonded parts or units which themselves are bonded together to form a solid. Two industrially important polymeric materials are plastics and elastomers. Plastics are a large and varied group of synthetic materials which are processed by forming or molding into shape. Just as we have many types of metals such as aluminum and copper, we have many types of plastics such as polyethylene and nylon. Plastics can be divided into two classes, thermoplastics and thermosetting plastics, depending on how they are structurally and chemically bonded. Elastomers or rubbers can be elastically deformed a large amount when a force is applied to them and can return to their original shape (or almost) when the force is released.

We are all pretty aware of the various plastic/polymer products in our life. We see recognizable applications of polymers: modern telecommunications equipment and the ski boot. The basic building block of a plastic is the polymer molecule, a long chain of covalent-bonded atoms. Secondary bonds then hold groups of polymer chains together to form the polymeric material.

Engineers the world over use heat-shrinkable tubing instead of standard approaches to insulation, such as taping or molding in place. The tubing comes in a wide range of sizes, colors, and materials. When heated, it shrinks to conform to the size and shape of the underlying material, making installation fast and easy.

Do you know that recent technological developments have lead to electrically conductive polymers? Semiconductor behavior is now possible using polymeric systems. For example, semiconducting polymers, sandwiched between two electrodes, can generate light of any color. This technology will lead to OLED (organic light-emitting diode), flat panel displays.

Polymers are materials comprised of long molecular chains. Most polymers are carbon based and have relatively low melting points. Polymers have a very wide range of properties which allow for their extensive use in society. Uses include: car parts, food storage, electronic packaging, optical components, and adhesives.

Synthetic fabrics are man-made copies of natural fabrics. Synthetic fibers do not occur in nature as themselves but are usually derivatives of petroleum products. Examples of common synthetic fabrics are polyester, spandex, rayon, and velcro.

We are all familiar with liquid crystal display (LCD) devices, image left. Do you realize liquid crystals are polymeric materials? A liquid crystal is, as the name suggests, a state of matter intermediate between a "normal" liquid and a solid. Liquid crystal phases are formed from geometrically anisotropic molecules—usually this means they are cigar shaped, though other shapes are possible. In a liquid crystal phase, the polymer molecules have a certain degree of order. In the simplest case, the Nematic phase, the molecules generally point in the same direction but still move around with respect to one another as would be expected in a liquid. Under the influence of an applied electric field, alignment of the polymer molecules gives rise to light absorption.

Composites. Composites are combinations of two materials in which one of the materials, called the reinforcing phase, is in the form of fibers, sheets, or particles, and are embedded in the other materials called the matrix phase. The reinforcing material and the matrix material can be metal, ceramic, or polymer. Typically, reinforcing materials are strong with low densities while the matrix is usually a ductile, or tough, material. If the composite is designed and fabricated correctly, it combines the strength of the reinforcement with the toughness of the matrix to achieve a combination of desirable properties not available in any single conventional material. The downside is that such composites are often more expensive than conventional materials. Examples of some current application of composites include the diesel piston, brake-shoes and pads, tires and so on.

Recreational equipment is heavily dependent on materials technology. For example, consider a snowboard. It is stiff and torsionally rigid so one can rail them at high speed and launch and land the hugest airs.

Various structural composite articles consist of glass fibers incorporated in a polymeric resin matrix. When the resin cures to a hard state, it is strengthened by the reinforcement. The shape of the finished part is dependent on a mold, die or other tooling that controls the geometry of the composite during processing. A structural composite often begins with lay-up of prepreg. The choice of fiber will influence the basic tensile and compressive strength and stiffness, electrical and thermal conductivity, and thermal expansion of the final prepreg material. The cost of the composite is also strongly influenced by the fiber selected.

The strength of the resin/fiber composite depends primarily on the amount, arrangement and type of fiber (or particle) reinforcement in the resin. Typically, the higher the reinforcement content, the greater the strength. In some cases, glass fibers are combined with other fibers, such as carbon or aramid, to create a "hybrid" composite that combines the properties of more than one reinforcing material. In addition, the composite is often formulated with fillers and additives that change processing or performance parameters.

A mountain bike is another piece of recreational equipment that is dependent on advanced material's technology. The mountain bike utilizes composite materials; but it also is an integration of a number of other structural materials (i. e. , metals, elastomers, etc.). It is, thus, a composite system. These bikes can weigh less than 16 pounds and still meet the rigors of the sport.

Unit 2 Materials Characterization

Materials Characterization represents many different disciplines depending upon the background of the user. These concepts range from that of the scientist, who thinks of it in atomic terms, to that of the process engineer, who thinks of it in terms of properties, procedures, and quality assurance, to that of the mechanical engineer, who thinks of it in terms of stress distributions and heat transfer. The definition selected for the ASM-International Materials Characterization Handbook is as follows: "Characterization describes those features of composition and structure (including defects) of a material that are significant for a particular preparation, study of properties, or use, and suffice for reproduction of the material." This definition limits the characterization methods included in the Handbook to those that provide information about composition, structure, and defects and excludes those methods that yield information primarily related to materials properties, such as thermal, electrical, and mechanical properties.

An important component of the materials engineering methodology involves knowledge of the structure of materials. Typical structure is necessarily viewed through a microscope... an optical microscope, the electron microscope (imaging of electrons passed through a thin specimen in the transmission electron microscope (TEM)); or imaging by collecting electrons emitted from the surface of the material of interest in the scanning electron microscope (SEM).

This is a scanning electron micrograph (Fig. 1) of a dendrite. When solid metal grows from the liquid state, a tree-like feature grows which is called a dendrite. The dendrite is, essentially, a single crystal feature. The growth of dendrites occurs when liquid metals solidify, and the phenomenon is analogous to the process of formation of ice crystals from supersaturated.

This is a polycrystalline array of grains in an aluminum metallization line on an integrated circuit. It is a color photomicrograph (Fig. 2). Each colored grain is a single crystal of aluminum, oriented differently with respect to its neighbors.

Fig. 1

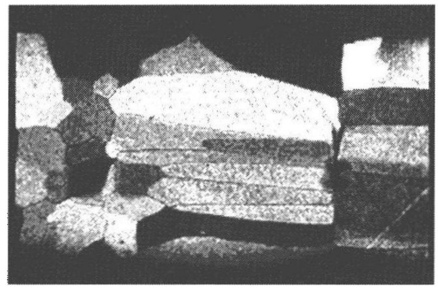


Fig. 2

Photomicroscopy is an important tool in the characterization of engineering materials. The scanning electron micrograph (Fig. 3) shows a typical TiC coating of 150 micrometers on a graphite. These TiC coatings feature both an equiaxed structure adjacent to the coating-substrate interface, and columnar grains away from the interface. Additionally, these coatings adhere well to their graphite substrates even after fracture. Thicknesses for these coatings can be controlled from a few micrometers to 250 micrometers.

The Concept of Structure. The structure of a material may be divided into four levels: atomic structure, atomic arrangement, microstructure, and macrostructure.

Atomic structure influences how the atoms are bonded together, which in turn helps one to categorize materials as metals, ceramics, and polymers and permits us to draw some general conclusions concerning the mechanical properties and physical behavior of these three classes of materials.

A crystalline state is characterized primarily by an ordered regular arrangement of atoms in space. The crystal structure of a material or the arrangement of atoms in a crystal structure can be described in terms of its unit cell (Fig. 4). The unit cell is a tiny box containing one or more motifs, a spatial arrangement of atoms. The unit cells stacked in three-dimensional space describes the bulk arrangement of atoms of the crystal. The crystal structure has a three dimensional shape. The unit cell is given by its lattice parameters, the length of the cell edges and the angles between them, while the positions of the atoms inside the unit cell are described by the set of atomic positions (x_i, y_i, z_i) measured from a lattice point. Crystals of metals are usually small in size, so that a metallic article consists, of a very large number of crystals. Such a structure is called poly-crystalline. Such crystals of irregular shape are called *grain* or *crystallite*.

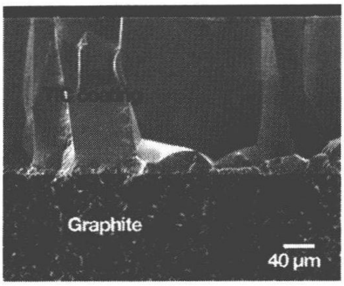


Fig. 3

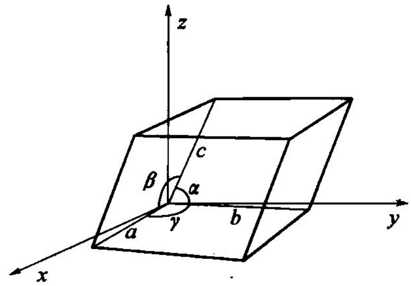


Fig. 4

The Structure of Metals. Metals are giant structures of atoms held together by metallic bonds. "Giant" implies that large but variable numbers of atoms are involved—depending on the size of the bit of metal. Most metals are close packed —that is, they fit as many atoms as possible into the available volume. The structures of pure metals are easy to describe because the atoms that form these metals can be thought of as identical perfect spheres. Atoms tend to occupy positions as close as possible as to one another and thus form other types of crystal lattice: body-centred cubic (b. c. c. , Fig. 5), face-centred cubic (f. c. c. , Fig. 6) and close-packed hexagonal (c. p. h. , Fig. 7).

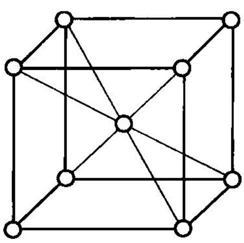


Fig. 5

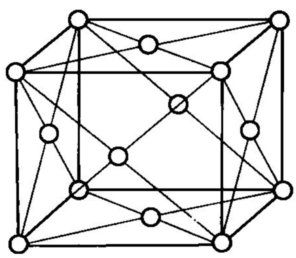


Fig. 6

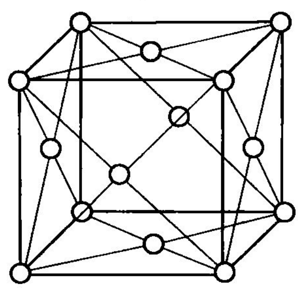


Fig. 7

It would be misleading to suppose that all the atoms in a piece of metal are arranged in a regular way. Any piece of metal is made up of a large number of "crystal grains", which are regions of regularity. At the grain boundaries atoms have become misaligned (Fig. 8).

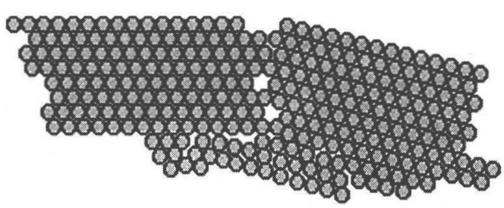


Fig. 8