复旦卓越·普通高等教育21世纪规划教材机械类、近机械类

机械工程专业英语

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内容提要

本教材以介绍机械类英语专业词汇和表达方式，培养机械类、近机类学生专业英语能力为目标，使具有大学英语水平的学生通过学习本教材，掌握专业英语的基本阅读和表达技能。

本教材根据机械工程类各专业所涉及的专业知识，将全书分为机械工程材料、金属的冷热加工、机械设计、机电一体化等10个单元。所有文章均选自国外原版资料，在内容上紧密结合机械类各相关专业，教师可根据各专业方向的特点选讲有关内容。全书总阅读量约100 000词，推荐教学时数32学时。附录列出了机械类英语常用词汇。

前　言

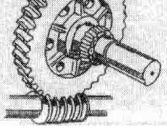
机械工程专业英语是机械类、近机类专业继基础英语和专业基础课的后续课程，主要任务是：通过本课程的学习，使学生掌握机械工程常用专业词汇及术语，能够借助专业词典阅读、理解本专业英文资料、设备（产品）说明书，初步具备专业英语的翻译能力。学生在具备了较好的英语运用能力之后，通过专业英语的学习，一方面可以巩固已经掌握的词汇和语法知识；另一方面可以扩大专业词汇量，掌握专业英语文章的语法结构及文体方面的知识，提高阅读理解和翻译英文专业资料的能力。

本教材按照高等学校机械学科专业规范、培养方案和课程教学大纲的要求，由长期从事一线教学工作、具有丰富教学经验的教师以科学性、先进性、系统性和实用性为目标编写，以提高学生专业英语能力为目标，能够满足不同类型和层次的教学需要。

教材共分10个单元，主要介绍了机械工程材料、金属的冷热加工、机械设计、机制工艺与设备、数控技术、机电一体化技术和生产管理等相关内容。文献选自英文著作、教材、科技报告和专业期刊，兼顾多种体裁以及英美英语的不同风格。各单元之间既有一定的内在联系，又相互独立，教学时可根据不同的学时灵活选用。

编者

2014年2月



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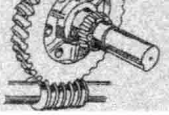

Unit one Metal Material and Heat Treatment of Steel

Passage One

The Mechanical Engineering Material

Text

Types of materials

Materials may be grouped in several ways, and often be classified by their state: solid, liquid, and gas. The scientists also separate the materials into organic and inorganic materials.

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

Engineering materials may be futher subdivided into: Metals, Polymers, and Ceramics. A fourth type of material sometimes listed is called a composite. Materials in this group are made up of two or more materials from the engineering groups. Each of the materials in a composite retains its orginal characteristics. Examples of composites include wood-, concrete-, glass-reinforced polyester, and graphite polymer advanced composites.

Classification of metals

Metals were formerly thought to be those elements that had a

metallic luster and were good conductors of heat and electricity. Actually metals are generally defined as those elements whose hydroxides form bases (such as sodium or potassium). The nonmetals' hydroxides form acids (such as sulphur). Metals may exist as pure elements. When two or more metallic elements are combined, they form a mixture called an alloy.

The term alloy is used to identify any metallic system. **In metallurgy it is a substance, with metallic properties, that is composed of two or more elements, intimately mixed.** Of these elements, one must be a metal. Plain carbon steel, in the sense, is basically an alloy of iron and carbon. Other elements are presented in the form of impurities. However, for commercial purposes, plain carbon steel is not classified as an alloy steel.

Alloys may be further classified as ferrous and nonferrous. Ferrous alloys contain iron. Nonferrous alloys do not contain iron. All commercial varieties of iron and steel are alloys. The ordinary steels are thought of as iron-carbon alloys. However, practically all contain silicon and manganese as well. In addition, there are thousands of recognized alloy steels, and the base metal for all these is iron.

Nonferrous metals are seldom found in the pure state. They must be separated from the gangue before the ore can be reduced. Metals and metal compounds are heavier than the gangue. They settle to the bottom if such a mixture has been agitate in water. This process is similar to the method used by the early miners who panned for gold. However, refinements have been developed to speed up the accumulation of metal compounds by using this principle.

Properties of metals

All materials have their own properties or characeristics. These properties may be arranged into major groups which include: physical properties, mechanical properties, chemical properties, thermal properties, electrical and magnetic properties, optical properties, etc.

Metals have properties that distinguish them from other materials. The most important of these properties is strength, or the ability to support weight without bending or breaking. This property combined

with toughness is important. Metals also have advantages regarding resistance to corrosion. They are responsive to heat treatment.

The properties of metals may be classified in three categories: chemical properties, mechanical properties, and physical properties. Here we will emphasize the primary mechanical properties of metals. In understanding the related areas of metalworking and methods used today, mechanical properties of metals are of the utmost importmace. And the most two important mechanical properties of metals is strength and hardness.

The strength of a metal is its ability to resist deformation or rupture. In certain items such as a machine tools, a combination of strength and plasticity is desirable. A tough metal possesses very high strength. It also has the capability to deform permanently and resist rupture. Toughness enables the metal to survive shock or impact without fracture.

Hardness is the resistance of a material to penetration or scratching. It accounts for abrasion resistance as well as resistance to denting. The hardness of metals varies greatly. Some, like lead, can be indented easily. Others like tungsten carbide, approach diamond hardness. Hardness is also directly related to strength. The harder a material, the stronger it is.

Notes

1. Metals were formerly thought to be those elements that had a metallic luster and were good conductors of heat and electricity.
   metals 为主语，that 引导的定语从句修饰宾语 elements。
2. In metallurgy it is a substance, with metallic properties, that is composed of two or more elements, intimately mixed.
   in metallurgy 为状语，with metallic properties 为插入语，由 that 引导的定语从句修饰表语 a substance。
   译文应为：在冶金学中，合金是由两种或两种以上的元素均匀混合、具有金属特性的物质。

Key Words and Expression

polymer /ˈpɒlɪmə/ 聚合物，高分子材料	nonferrous /nɒnˈferəs/ 不含铁的，非铁的
ceramic /sɪˈræmɪk/ 陶瓷	silicon /ˈsɪlɪkən/ 硅，硅元素
composite /ˈkɒmpəzɪt/ 复合材料	manganese /ˈmæŋgəniːz/ 锰
glass-reinforced polyster 玻璃纤维增强聚酯	special tool steel 特殊工具钢
graphite /ˈgræfaɪt/ 石墨	alloy /ˈælɒɪ/ 合金
hydroxide /haɪˈdrɒksaɪd/ 氢氧化物	nickel /ˈnɪkəl/ 镍
metallic /mɪˈtælɪk/ 金属(性)的	bronze /brɒnz/ 青铜—除铜锌、铜镍以外的铜合金
luster /ˈlʌstə/ 光泽	brass /brɑːs/ 黄铜—铜锌合金
sodium /ˈsəʊdɪəm/ 钠	Monel /məʊˈnel/ 蒙乃尔铜—镍合金
potassium /pəˈtæsɪəm/ 钾	gangue /gæŋ/ 脉石
nonmetal /ˈnɒnˌmetəl/ 非金属(元素)	ore /ɔː/ 矿石
sulphur /ˈsʌlfə/ 硫磺	reverberatory furnace 反射炉
term /tɜːm/ 术语	agitate /ˈædʒɪteɪt/ 搅动，搅拌
metallurgy /meˈtælədʒɪ/ 冶金，冶金术	refractory /rɪˈfræktərɪ/ 耐火的
plain carbon steel 普通碳钢，碳素钢	strength /streŋθ/ 强度
ferrous /ˈferəs/ 铁的，含铁的	toughness /ˈtʌfnɪs/ 韧性

Exercises

1. Answer the following questions according to the text.

(1) How many types may be the engineering material classified?

(2) What is the composite?

(3) What is the alloy?

2. Fill in the blanks according to the text.

(1) Alloy may be further classified as _____ and _____.

(2) Engineering materials may be further subdivided into: _____, _____, and _____.

(3) The most important of these properties is _____, or the ability to support weight without bending or breaking.

机械工程材料

材料的分类

材料可以通过多种方式分类，通常可以根据状态分为固态、液态和气态。科学家也把材料分为有机材料和无机材料两种。

从工业角度材料可以分为工程材料和非工程材料两种。工程材料是那些在制造中使用并最终成为产品部分的材料。非工程材料则是那些在制造过程中使用的化学品、燃料、润滑剂和其他不会成为产品部分的材料。

工程材料还可进一步细分为金属、塑料和陶瓷等。有时也列出第四种类型，称为复合材料。复合材料由两种和两种以上的工程材料组成。其中每种都保留了它们固有的特性。复合材料包括木材、混凝土、玻璃纤维增强的聚酯和石墨聚合物等先进的复合材料。

金属分类

金属以前被认为是那些有金属光泽、导电导热性良好的物质。实际上金属的定义是氢氧化物为碱性的物质(如钠、钾)，而非金属的氢氧化物则显酸性(如硫)。金属可以以纯金属的形式存在，也可以是由两种或两种以上金属元素组成的混合物，称为合金。

专有名词“合金”用来鉴别所有金属系统。在冶金学领域，合金是由两种或两种以上元素均匀混合并具有金属特性的物质。在构成合金的元素中，至少有一种是金属。从这个意义上来讲，普通碳钢基本上可以认为是铁碳合金，其他的元素则以杂质的形式存在。然而从商业角度考虑，普通碳素钢没有被归入合金钢一类。

合金可以进一步划分为黑色金属和有色金属。黑色金属中含有铁元素，有色金属合金不含铁。所有的商用钢铁都是合金，一般的钢材被认为是铁碳合金，但实际上都还含有硅和锰。另外还有成千上万种已知的合金钢，都是以铁元素为基本元素的。

有色金属很少以纯金属的形态存在。在冶炼之前必须将矿石从脉石中分离出来。纯金属或金属化合物要比脉石重。如果将这样的混合物放在水中搅动，金属及其化合物会沉淀在底部。这个工艺和早期的矿工淘金的使用方法类似。然而，利用这一原理发展起来的精炼技术大大加快了金属化合物的累积速度。

金属的性能

所有的材料都有自己的特性或属性。这些属性可以分成几个主要种类，其中包括物理性能、机械性能、化学性能、热性能、电磁特性和光学特性等。

金属具有与其他材料不同的特性。这些特性中最重要的是强度，或者承受载荷而不弯曲或断裂的能力。强度和韧性结合是很重要的。金属同样具有耐腐蚀的优点，这个特性与热处理有关。

金属的性能可分为三类：化学性能、机械性能和物理性能。在这里，我们更看重的主要是机械性能。在了解金属加工和使用方法相关领域的今天，金属的力学性能是极为重要的。而金属最重要的两个机械性能指标就是强度和硬度。

金属的强度是其抵抗变形或断裂的能力。在某些产品，比如机床当中，需要强度和塑性的组合。一种硬的金属具有很高的强度，也具有产生永久变形却不断裂的能力。韧性使金属能够承受冲击载荷而不断裂。

硬度是材料抵抗穿透或者划痕的能力。它也决定材料的耐磨性和抵抗压痕的能力。金属的硬度变化很大。一些金属，比如铅，很容易被压出凹痕。而另一些，比如碳化钨，则接近了金刚石的硬度。硬度也和强度直接相关。金属越硬，强度就越大。

Passage Two

Heat Treatment of Steels

Text

Heat treatment is the operation of heating and cooling a metal in its solid state to change its physical properties. According to the procedure used, steel can be hardened to resist cutting action and abrasion, or it can be softened to permit machining. With the proper heat treatment internal stresses may be removed, grain size reduced, toughness increased, or a hard surface produced on a ductile interior.

The following discussion applies principally to the heat treatment of ordinary commercial steels known as plain-carbon steels. With this process the rate of cooling is the controlling factor, rapid cooling from above the critical range results in hard structure, whereas very slow cooling produces the opposite effect.

Hardening

Hardening is the process of heating a piece of steel to a temperature

within or above its critical range and then cooling it rapidly.

The hardness obtained from a given treatment depends on the quenching rate, the carbon content, and the workpiece size. In alloy steels the kind and amount of alloying element influences only the hardenability (the ability of the workpiece to be hardened to depths) of the steel and does not affect the hardness except in unhardened or partially hardened steels.

The hardness that can be obtained from a given treatment depends upon the following three factors:

(1) Quenching rate.

(2) Carbon content.

(3) Workpiece size.

Rapid quenching is needed to harden low carbon and medium plain carbon steels. Water is generally used as a quench for these steels. For high-carbon or alloy steel, oil is used. Its action is not as well as that of water. Where extreme cooling is desired, brine is used.

The maximum degree of hardness obtainable in steel by direct hardening is determined largely by the carbon content. Steel with a low carbon content will not respond greatly to the hardening process. Carbon steels are generally considered as shallow hardening steels. The hardening temporature varies for different steels; it depends upon the carbon content in fact.

Tempering

Steel that has been hardened by rapid quenching is brittle and not suitable for most uses. By tempering or drawing, the hardness and brittleness may be reduced to the desired point for service conditions. The operation consists of reheating quench-hardened steel to some temperature below the critical range followed by any rate of cooling. The final structure obtained from tempering a fully hardened steel is called tempered martensite.

In the process of tempering, some consideration should be given to time as well as to temperature. Although most of the softening action occurs in the first few minutes after the temperature is reached, there is

some additional reduction in hardness if the temperature is maintained for a prolonged time. Usual practice is to heat the steel to the desired temperature and hold it there only long enough to have it uniformly heated.

Annealing

The primary purpose of annealing is to soften hard steel so that it may be machined or cold worked. It is usually accomplished by heating the steel to slightly above the critical temperature, holding it there until the temperature of the piece is uniform throughout, and then cooling at a slowly controlled rate so that the temperature of the surface and that of the center of the piece are approximately the same. This process is known as full annealing because it wipes out all trace of previous structure, refines the crystalline structure, and softens the metal. Annealing also relieves internal stresses previously set up in the metal.

The temperature to which a given steel should be heated in annealing depends on its composition; for carbon steels it can be obtained readily from the partial iron- carbide equilibrium diagram. When the annealing temperature has been reached, the steel should be held there until it is uniform throughout. For maximum softness and ductility the cooling rate should be very slow, such as allowing the parts to cool down with the furnace. The higher the carbon content, the slower this rate must be.

There aye three different types of annealing processes used in industry: (1) full annealing, (2) process annealing, (3) spheroidizing.

Normalizing and Spheroidizing

The process of normalizing consists of heating the steel about 10～40℃ above the upper critical range and cooling in still air to room temperature. This process is principally used with low-and medium-carbon steels as well as alloy steels to make the grain structure more uniform, to relieve internal stresses, or to achieve desired results in physical properties. Most commercial steels are normalized after being rolled or cast.

Spheroidizing is the process of producing a structure in which the cementite is in a spheroidal distribution. If a steel is heated slowly to a

temperature just below the critical range and held there for a prolonged period of time, this structure will be obtained. The globular structure obtained gives improved machinability to the steel. This treatment is particularly useful for hypereutectoid steels that must be machined.

Key Words and Expression

heat treatment 热处理	spheroidizing /ˈsfɪərɔɪdaɪzɪŋ/ 球化退火
hardening /ˈhɑːdənɪŋ/ 淬火	machinability /məˌʃiːnəˈbɪlɪtɪ/ 切削性能
quenching /ˈkwentʃɪŋ/ 淬火	hypereutectoid /ˌhaɪpəjuˈtektɔɪd/ 过共析的
hardenability /ˌhɑːdənəˈbɪlɪtɪ/ 淬透性	ferrite /ˈferaɪt/ 铁素体
brine /braɪn/ 盐水	pearlite /ˈpɜːlaɪt/ 珠光体
tempering /ˈtempərɪŋ/ 回火	martensite /ˈmɑːtɪnzaɪt/ 马氏体
annealing /əˈniːlɪŋ/ 退火	austenite /ˈɔːstənaɪt/ 奥氏体
normalizing /ˈnɔːməlaɪzɪŋ/ 正火	cementite /sɪˈmentaɪt/ 渗碳体

Exercises

1. Answer the following questions according to the text.

(1) How many types may be the heat treament classified?

(2) What is the heat treatment?

(3) What is the primary purpose of annealing?

2. Fill in the blanks according to the text.

(1) The hardness that can be obtained from a given treatment depends upon _____, _____, and _____.

(2) The maximum degree of hardness obtainable in steel by direct hardening is determined largely by _____.

(3) The three different types of annealing processes used in industry is _____, _____, and _____.

Classical Advertisement Word

Good to the last drop. 滴滴香浓，意犹未尽。（麦斯威尔咖啡）

Obey your thirst. 服从你的渴望。（雪碧）

钢的热处理

热处理是对固态金属进行加热和冷却，以改变其物理性能的操作。根据采用的手段不同，钢可以被硬化来抵抗切割和磨损，或者被软化以方便机加工。适当的热处理可以消除内部应力，细化晶粒，提高韧性，或者是提高表面硬度。

下面主要讨论被称为普通碳钢的普通商业钢的热处理。这个过程中冷却速率是控制因素，从高于临界温度迅速冷却可以产生坚硬的结构，而非常缓慢的冷却产生相反的效果。

淬火

淬火是将钢加热至或高于其临界温度，然后迅速冷却的过程。一个给定的热处理能够得到的硬度取决于淬火速率、碳含量，和工件尺寸。合金钢中的合金元素的种类和含量只影响钢的淬透性（工件的硬化深度），并不会影响除了在未固化的或部分硬化的钢的硬度。合金钢中合金元素的种类和数量只影响钢的淬透性（工件获得淬硬层深度的能力），并不会影响钢的硬度，除非是在没进行淬火或部分淬火的情况下。

热处理可获得的硬度主要与以下三个方面的因素有关：

(1) 淬火速度

(2) 含碳量

(3) 工件尺寸

中低碳钢的淬火需要迅速冷却，这类钢材常用水作为淬火介质。高碳钢或合金钢则采用油冷，油的冷却能力比水弱。如果需要极端的冷却速度，则要使用盐水。

钢材淬火后的最大硬度很大程度上取决于含碳量，低碳钢淬火后能够达到的硬度也不高。碳钢通常被认为是浅淬透性钢。不同钢材的淬火温度也不一样，这实际上是由钢的含碳量决定的。

回火

淬火后的钢材脆性很大，对于大多数的应用场合都不适用。通过回火，钢材的硬度和脆性都能够降低到工作状态的合适值。回火过程包括将淬火钢加热到低于临界温度的某一数值，然后以适当的速度冷却。淬火钢回火后得到的组织结构称为回火马氏体。

回火过程需要考虑时间和温度，虽然大多数的软化作用发生在达到合适温度后的最初几分钟，但如果再保温一段时间的话，硬度还会有一些额外的下降。通常的做法是将钢材加热到所需温度，并保温到获得均匀组织后即可。