船机工程专业英语

ENGLISH FOR MARINE ENGINEERING

程　东　严志军　刘一梅　编

朱新河　审

大连海事大

English for Marine Engineering

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前　言

本书是轮机工程专业（船机修造专业方向）的专业教材。全书内容涉及材料科学与工程、零件制造与加工工艺、维修理论和故障诊断技术、轮机工程（船舶柴油机、制冷装置、防污染设备、甲板机械、轴系、螺旋桨及其他轮机设备等）及船舶维修与安全技术等相关领域的内容。本书可供高等院校轮机工程专业（船机修造专业方向）的师生使用，也可供修造船企业和航运企业中从事船机维修及轮机管理工作的工程技术人员参考。

全书共分 5 部分，其中，Part I（Unit 1～Unit 5）、Part IV（Unit 17～Unit 26）和 Part V（Unit 27～Unit 30）由程东编写；Part II（Unit 6～Unit 10）由刘一梅编写；Part III（Unit 11～Unit 16）由严志军编写。全书由程东统稿。朱新河教授审阅了全书，并提出了许多宝贵意见。

由于编者水平有限，成稿时间仓促，书中难免存在错误和不足之处，恳请广大读者批评指正。

编　者

2005 年 9 月

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Part V Ship Repairing Interest

PART I MATERIALS SCIENCE AND ENGINEERING

Unit 1 Introduction

Topical Highlights

- The influence of materials to our everyday lives and engineering.
- The classification of materials.

Text

Historical Perspective

Materials are probably more deep-seated in our culture than most of us realize.[1] Transportation, housing, clothing, communication, recreation, and food production—virtually every segment of our everyday lives is influenced to one degree or another by materials. Historically, the development and advancement of societies have been intimately tied to the members' ability to produce and manipulate materials to full their needs. In fact, early civilizations have been designated by the level of their materials development (i.e. , Stone Age , Bronze Age).

The earliest humans had access to only a very limited number of materials, those that occur naturally: stone, wood, clay, skins, and so on. With time they discovered techniques for producing materials that had properties superior to those of the natural ones; those new materials included pottery and various metals. Furthermore, it was discovered that the properties of a material could be altered by heat treatments and by the addition of other substances. At this point, materials utilization was totally a selection process, that is, deciding from a given, rather limited set of materials the one that was best suited for an application by virtue of its characteristics. It was not until relatively recent times that scientists came to understand the relationships between the structural elements of materials and their properties.

The development of many technologies that make our existence so comfortable has been intimately associated with the accessibility of suitable material. For example, automobiles would not have been possible without the availability of inexpensive steel or some other comparable substitute. In our contemporary era, sophisticated electronic devices rely on components that are made from what are called semiconducting materials.

Classification of Materials

Solid materials have been conveniently grouped into three basic classifications: metals, ceramics, and polymers. This scheme is based primarily on chemical makeup and atomic structure, and most materials fall into one distinct grouping or another, although there are intermediates. In addition, there are two other groups of important engineering materials—composites and semiconductors.

Metals

Metallic materials are normally combinations of metallic elements. They have large numbers of nonlocalized electrons [2]; that is, these electrons are not bound to particular atoms. Many properties of metals are directly attributable to these electrons. Metals are extremely good conductors of electricity and heat and are not transparent to visible light; a polished metal surface has a lustrous appearance. Furthermore, metals are quite strong, yet deformable, which accounts for their extensive use in structural applications.

Ceramics

Ceramics are compounds between metallic and nonmetallic elements; they are most frequently oxides, nitrides, and carbides. The wide range of materials that falls within this classification includes ceramics that are composed of clay minerals, cement, and glass. These materials are typically insulative to the passage of electricity and heat, and are more resistant to high temperatures and harsh environments than metals and polymers. With regards to mechanical behavior, ceramics are hard but very brittle.

Composites

A number of composite material have been engineered that consist of more than one material type. Fiberglass is familiar example, in which glass fibers are embedded within a polymeric material. A composite is designed to display a combination of the best characteristics of each of the component materials. Fiberglass acquires strength from the glass and flexibility from the polymer. Many of the recent material developments have involved composite materials.

Semiconductors

Semiconductors have electrical properties that are intermediate between the electrical conductors and insulators. Furthermore, the electrical characteristics of these materials are extremely sensitive to the presence of minute concentrations of impurity atoms, which concentrations may be controlled over very small spatial regions. The semiconductors have make possible the advent of integrated circuitry[3] that has totally revolutionized the electronics and computer industries over the past two decades.

New Words and Expressions

1	deep-seated	['di:p'si:tid]	***adj.***	根深蒂固的，深层的
2	intimately	['intimətli]	***adv.***	密切地

3	clay	[klei]	*n.*	泥土，黏土
4	pottery	['pɔtəri]	*n.*	陶器，陶器场
5	sophisticated	[sə'fistikeitid]	*adj.*	高级的，尖端的，很复杂的
6	ceramic	[si'ræmik]	*n.*	陶瓷，陶土，陶瓷学
7	polymer	['pɔlimə(r)]	*n.*	聚合物，聚合体
8	nonlocalized	['nʌnləuklaizd]	*adj.*	非定域的，非局限的
9	lustrous	['lʌstrəs]	*adj.*	有光泽的，光辉的
10	oxide	['ɔksaid]	*n.*	氧化物
11	nitride	['naitraid]	*n.*	氮化物，渗氮
12	harsh	[ha:ʃ]	*adj.*	粗糙的，荒芜的，苛刻的，刺耳的
13	fiberglass	['faibəgla:s]	*n.*	玻璃纤维，玻璃丝
14	semiconductor	[semikən'dʌktə]	*n.*	半导体

Notes

[1] Materials are probably more deep-seated in our culture than most of us realize.材料对人类文明的影响或许比我们想象的还要根深蒂固。

[2] nonlocalized electrons 自由电子。

[3] integrated circuitry 集成电路。

Supplementary Readings

Materials Science and Engineering

The discipline of *materials science* involves investigating the relationships that exist between the structures and properties of material. In contrast, *materials engineering* is, on the basis of these structure-property correlations, designing or engineering the structure of a material to produce a predetermined set of properties.

In brief the structure of a material usually relates to the arrangement of its internal components. Subatomic structure involves electrons within the individual atoms and interactions with their nuclei. On an atomic level, structure encompasses the organization of atoms or molecules relative to one another. The next larger structural realm, which contains large groups of atoms that are normally agglomerated together, is termed "microscopic", meaning that which is subject to direct observation using some type of microscope. Finally, structural elements that may be viewed with the naked eye are termed "macroscopic".

The notion of "property" deserves elaboration. While in service use, all materials are exposed to external stimuli that evoke some of response. For example, a specimen subjected to forces will experience deformation; or a polished metal surface will reflect light. Property is a material trait in terms of the kind and magnitude of response to a specific imposed stimulus. Generally, definitions of properties are make independent of material shape and size.

Virtually all important properties of solid materials may be grouped into six different categories: mechanical, electrical, thermal, magnetic, optical, and deteriorative. For each there is a characteristic type of stimulus capable of provoking different responses. Mechanical properties relate deformation to an applied load or force; examples include elastic modulus and strength. For electrical properties, such as electrical conductivity and dielectric constant, the stimulus is an electric field. The thermal behavior of solids can be represented in terms of heat capacity and thermal conductivity. Magnetic properties demonstrate the response of a material to the application of a magnetic field. For optical properties, the stimulus is electromagnetic or light radiation; index of refraction and reflectivity are representative optical properties. Finally, deteriorative characteristics indicate the chemical reactivity of material.

Many times, a materials problem is one of selecting the right material from the many thousands that are available. There are several criteria on which the final decision is normally based. First of all, the in-service conditions must be characterized, for these will dictate the properties required of the material. On only rare occasions does a material possess the maximum or ideal combination of properties. Thus, it may be necessary to trade off one characteristic for another. The classic example involves strength and ductility; normally, a material having a high strength will have only a limited ductility. In such cases a reasonable compromise between two or more properties may be necessary.

A second selection consideration is any deterioration of material properties that may occur during service operation. For example, significant reductions in mechanical strength may result from exposure to elevated temperatures or corrosive environments.

Finally, probably the overriding consideration is that of economics; What will the finished product cost? A material may be found that has the ideal set of properties but is prohibitively expensive. Here again, some compromise is inevitable. The cost of a finished piece also includes any expense incurred during fabrication to produce the desired shape.

The more familiar an engineer or scientist is with the various characteristics and structure-property relationships, as well as processing techniques of materials, the more proficient and confident he or she will be to make judicious materials choices based on these criteria.

Modern Materials Needs

In spite of the tremendous progress that has been made in the understanding and development of materials within the past few years, there remain technological challenges requiring even more sophisticated and specialized materials.

Energy is a current concern. There is a recognized need to find new, economical sources of energy and, in addition, to use the present resources more efficiently. Materials will undoubtedly play a significant role in these developments. For example, the direct conversion of solar into electrical energy has been demonstrated. Solar cells employ some rather complex and expensive material.

Nuclear energy holds some promise, but the solutions to the many problems that remain will necessarily involve materials, from fuels to containment structures to facilities for the disposal of radioactive waste.

Furthermore, environmental quality depends on our ability to control air and water pollution. Pollution control techniques employ various materials. In addition, materials processing and refinement methods need to be improved so that they produce less environmental degradation.

Significant quantities of energy are involved in transportation. Reducing the weight of transportation vehicles (automobiles, aircraft, trains, etc.), as well as increasing engine operating temperatures, will enhance fuel efficiency. New high-strength, low-density structural materials remain to be developed, as well as materials that have higher-temperature capabilities, for use in engine components.

Many materials that we use are derived from resources that are nonrenewable, that is, not capable of being regenerated. These include polymers, for which the prime raw material is oil, and some metals. These nonrenewable resources are gradually becoming depleted, which necessitates either the discovery of additional reserves or the development of new materials having comparable properties and less adverse environmental impact. The latter alternative is a major challenge for the materials scientist and engineer.

New Words and Expressions

1	nuclei	['nju:kliai]	***n.***	（nucleus 的复数形）核，原子核
2	encompass	[in'kʌmpəs]	***v.***	包括，包含
3	realm	[relm]	***n.***	领域
4	agglomerate	[ə'glɔməreit]	***v.***	使成团，使成块，使凝聚
5	stimuli	['stimjulai]	***n.***	刺激
6	specimen	['spesimən]	***n.***	范例，标本，样品，样本，待试验物
7	polish	['pəuliʃ]	***v.***	擦亮，发亮，磨光，推敲
8	trait	[treit]	***n.***	显著的特点，特性
9	elastic modulus			弹性模数
10	dielectric	[daii'lektrik]	***adj.n.***	电介质的，非传导性的；绝缘体，介电
11	refraction	[ri'frækʃən]	***n.***	折光，折射
12	reflectivity	[riflek'tiviti]	***n.***	反射率
13	chip	[tʃip]	***n.***	片，芯片
14	proficient	[prə'fiʃənt]	***n.***	精通
15	degradation	[ˌdegrədeiʃən]	***n.***	降级，降格，退化
16	deplete	[di'pli:t]	***v.***	耗尽，使衰竭

Unit 2 Mechanical Properties of Metals

Topical Highlights

- The methods to ascertain the mechanical properties of materials.
- The definition of yield strength, tensile strength, ductility, toughness and hardness.

Text

Many materials, when in service, are subjected to forces or loads; examples include the aluminum alloy from which an airplane wing is constructed and the steel in an automobile axle. In such situations it is necessary to know the characteristics of the material and to design the member from which it is made such that any resulting deformation will not be excessive and fracture will not occur. The mechanical behavior of a material reflects the relationship between its response or deformation to an applied load or force. Important mechanical properties are strength, hardness, ductility, and stiffness.

The mechanical properties of materials are ascertained by performing carefully designed laboratory experiments that replicate as nearly as possible the service conditions. Factors to be considered include the nature of the applied load and its duration, as well as the environmental conditions. It is possible for the load to be tensile, compressive, or shear, and its magnitude may be constant with time, or it may fluctuate continuously. Application time may be for only a fraction of a second, or it may extend over a period of many years. Service temperature may be an important factor.

Elastic and Plastic Deformation

Deformation in which stress and strain are proportional is called **elastic deformation**; a plot of stress (ordinate) versus strain (abscissa) results in a linear relationship. The slope of this linear segment corresponds to the Young's Modulus .

Young's Modulus (sometimes referred to as Modulus of Elasticity, meaning "measure" of elasticity) is an extremely important characteristic of a material. It is the numerical evaluation of Hooke's Law, namely the ratio of stress to strain.

This modulus may be thought of as stiffness, or a material's resistance to elastic deformation. The greater the modulus, the stiffer the material, or the smaller the elastic strain that results from the application of a given stress.

For most metallic materials, elastic deformation persists only to strains of about 0.005. As the material is deformed beyond this point, the stress is no longer proportional to strain, and permanent, nonrecoverable, or **plastic deformation** occurs.

Yielding and Yield Strength

Most structures are designed to ensure that only elastic deformation will result when a stress is applied. It is therefore desirable to know the stress level at which plastic deformation begins, or where the phenomenon of **yielding** occurs. For metals that experience this gradual elastic-plastic transition, the point of yielding may be determined as the initial departure from linearity of the stress-strain curve; this is sometimes called the **proportional limit**. In such cases the position of this point may not be determined precisely. As a consequence, a convention has been established wherein a straight line is constructed parallel to the elastic portion of the stress-strain curve at some specified strain offset, usually 0.002. The stress corresponding to the intersection of this line and the stress-strain curve as it bends over in the plastic region is defined as the **yield strength** $\sigma_y^{0.2}$.

For those materials having a nonlinear elastic region, use of the strain offset method is not possible, and the usual practice is to define the yield strength as the stress required to produce some amount of strain (e.g., $\varepsilon=0.005$)

The magnitude of the yield strength for a metal is a measure of its resistance to plastic deformation.

Tensile Strength

After yielding, the stress necessary to continue plastic deformation in metals increases to a maximum, and then decreases to the eventual fracture. The tensile strength TS is the stress at the maximum on the engineering stress-strain curve. This corresponds to the maximum stress that can be sustained by a structure in tension; if this stress is applied and maintained, fracture will result. All deformation up to this point is uniform throughout the narrow region of the tensile specimen. However, at this maximum stress, a small constriction or neck begins to form at some point, and all subsequent deformation is confined at this neck. This phenomenon is termed “necking”, and fracture ultimately occurs at the neck.

Hardness

Hardness is the property of a material that enables it to resist plastic deformation, penetration, indentation, and scratching. Therefore, hardness is important from an engineering standpoint because resistance to wear by either friction or erosion by steam, oil, and water generally increases with hardness.

Quantitative hardness techniques have been developed over the years in which a small indenter is forced into the surface of a material to be tested, under controlled conditions of load and rate of application. The depth of size of the resulting indentation is measured, which in turn is related to a hardness number; the softer the material, the larger and deeper the indentation, and the lower the hardness index number. Measured hardness is only relative (rather than absolute), and care should be exercised when comparing values determined by different techniques.

Several methods have been developed for hardness testing. Those most often used are Brinell, Rockwell, Vickers, Tukon, Sclerscope, and the files test. The first four are based on indentation tests and the fifth on the rebound height of a diamond-tipped metallic hammer. The file test establishes the characteristics of how well a file takes a bite on the material.

Toughness

Loosely speaking, toughness is a measure of the ability of a material to absorb energy up to fracture. Specimen geometry as well as the manner of load application are important in toughness determinations. For dynamic (high strain rate) loading conditions and when a notch (or point of stress concentration) is present, notch toughness is assessed by using an impact test. Furthermore, fracture toughness is a property indicative of a material's resistance to fracture when a crack is present.

Toughness is measured by the Charpy test or the Izod test. Both of these tests use a notched sample. The location and shape of the notch are standard. The points of support of the sample, as well as the impact of the hammer, must bear a constant relationship to the location of the notch.

For the static (low strain rate) situation, toughness may be ascertained from the results of a tensile stress-strain test. For a material to be tough, it must display both strength and ductility; and often, ductile materials are tougher than brittle ones. Hence, even though the brittle material has higher yield and tensile strengths, by virtue of lack of ductility, it has a lower toughness than the ductile one.

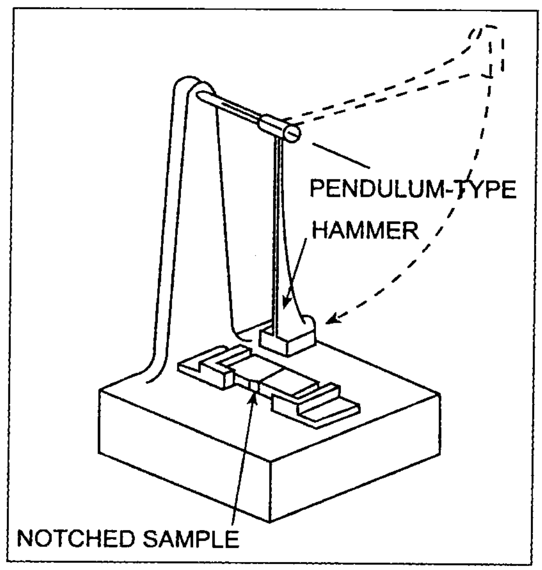

Figure 2.1 Charpy test equipment

Ductility

Ductility is another important mechanical property. It is a measure of the degree of plastic deformation that has been sustained at fracture. A material that experiences very little or no plastic deformation upon fracture is termed *brittle*.

A knowledge of the ductility of materials is important for at least two reasons. First, it indicates to a designer the degree to which a structure will deform plastically before fracture. Second, it specifies the degree of allowable deformation during fabrication operations. We sometimes refer to relatively ductile materials as being "forgiving", in the sense that they may experience local deformation without fracture should there be an error in the magnitude of the design stress calculation.[1]

Brittle materials are *approximately* considered to be those having a fracture strain of less than about 5%.

Fatigue

The majority of engineering failures are caused by fatigue. Fatigue failure is defined as the tendency of a material to fracture by means of progressive brittle cracking under repeated alternating or cyclic stresses of an intensity considerably below the normal strength. Although the fracture is of a brittle type, it may take some time to propagate, depending on both the intensity and frequency of the stress cycles. Nevertheless, there is very little, if any, warning before failure if the crack is not noticed. The number of cycles required to cause fatigue at a particular peak stress is generally quite large, but it decreases as the stress is increased. For some mild steels, cyclical stresses can be continued indefinitely provided the peak stress (sometimes called fatigue strength) is below the endurance limit value.

A good example of fatigue failure is breaking a thin steel rod or wire with your hands after bending it back and forth several times in the same place. Another example is an unbalanced pump impeller resulting in vibrations that can cause fatigue failure.

New Words and Expressions

1	axle	['æks(ə)l]	***n.***	轮轴，车轴
2	tensile	['tensail]	***adj.***	可拉长的，可伸长的，张力的，拉力的
3	deform	[di'fɔ:m]	***v.***	（使）变形
4	elastic deformation			弹性变形
5	plastic deformation			塑性变形
6	ordinate	['ɔ:dinit]	***n.***	纵坐标
7	abscissa	[əb'sisə]	***n.***	横坐标
8	stiffness	['stifnis]	***n.***	坚硬，硬度
9	deflection	[di'flekʃ(ə)n]	***n.***	挠曲
10	yield	[ji:ld]	***v.***	屈服
11	abruptly	[ə'brʌptli]	***adv.***	突然地，唐突地
12	fracture	['fræktʃə(r)]	***n.***	断裂
13	rupture	['rʌptʃə(r)]	***n.***	断裂，破坏，破裂
14	ductility	[dʌk'tiləti]	***n.***	延性，韧性，可塑性
15	brittle	['brit(ə)l]	***adj.***	脆的，易碎的
16	toughness	['tʌfnis]	***n.***	韧度，韧性
17	dynamic	[dai'næmik]	***adj.***	动力的，动力学的，动态的
18	notch	[nɔtʃ]	***n.***	凹口，切口，缺口

19	hardness	['ha:dnis]	*n.*	硬，硬度
20	dent	[dent]	*n.*	凹，凹痕
21	scratch	[skrætʃ]	*n.*	擦痕，划痕
22	Vickers	['vikə(r)s]	*n.*	维氏硬度计
23	Brinell	[bri'nel]	*n.*	布氏硬度
24	Rockwell	['rɔkwel]	*n.*	洛氏硬度

Notes

[1] We sometimes refer to relatively ductile materials as being "forgiving", in the sense that they may experience local deformation without fracture should there be an error in the magnitude of the design stress calculation. should 可能，万一。

Unit 3 Phase Diagrams

Topical Highlights

- The functions and components of phase diagrams.
- The definition of equilibrium.
- Describe the phase diagram of copper-nickel binary alloy.
- List the phases in the iron-carbon system.

Text

The understanding of phase diagrams for alloy systems is extremely important because there is a strong correlation between microstructure and mechanical properties, and the development of microstructure of an alloy is related to the characteristics of its phase diagram. In addition, phase diagrams provide valuable information about melting, casting, crystallization, and other phenomena.

Solubility Limit

For many alloy systems and at some specific temperature, there is a maximum concentration of solute atoms that may dissolve in the solvent to form a solid solution; this is called a **solubility limit**. The addition of solute in excess of this solubility limit results in the formation of another solid solution or compound that has a distinctly different composition.

Phase

Also critical to the understanding of phase diagram is the concept of a **phase**. A phase may be defined as homogeneous portion of a system that has uniform physical and chemical characteristics. Every pure material is considered to be a phase; so also is every solid, liquid, and gaseous solution. If more than one phase is present in a given system, each will have its own distinct properties, and a boundary separating the phases will exist across which there will be a discontinuous and abrupt change in physical and/or chemical characteristics. When two phases are present in a system, it is not necessary that there be a difference in both physical and chemical properties; a disparity in one or the other set of properties is sufficient. When water and ice are present in a container, two separate phases exist; they are physically dissimilar (one is a solid, the other is a liquid) but identical in chemical makeup. Also, when a substance can exist in two these structures in a separate phase because their respective physical characteristics differ.