Professional English (Materials)

专业英语（材料类）

何丽红 ◎ 主编

西南交通大学出版社

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Zhuanye Yingyu (Cailiaolei)

何丽红 / 主　编

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前言 ‖ PREFACE

“专业英语”是材料类专业学生在学完公共英语和专业基础课程后可选修的一门课程，主要目的是使学生通过学习，能掌握材料类专业常用的英语词汇，能较流畅地阅读、理解和翻译有关的科技英语文献和资料，并掌握英文论文的书写格式及英文论文摘要的写作技巧，从而使学生进一步提高英语应用能力，并为后期学习、科研和工作有意识地利用所学知识，通过阅读最新的专业英语文献，能跟踪学科的发展动态，为从事创新性的工作打下基础。

本书分两部分，第一部分是基础篇，根据材料总体介绍和材料类别（金属材料、陶瓷、聚合物和复合材料）分成五个单元，每个单元根据内容不同含若干课程，每个课程又由一篇课文和一篇阅读材料组成，共 30 篇，主要介绍材料类基础专业知识，使学生掌握相关专业英文词汇，锻炼阅读专业文献的能力；第二部分是提高篇，从学生掌握科技英语论文为出发点，分“查、读、写、投”四个单元，使学生对科技英语论文检索、阅读、撰写以及投稿有全面的认识与掌握。此外，在本书最后附录部分将材料专业常用元素、物质英文名称等进行了整理与总结，方便初学者对材料专业英语词汇的掌握。

本书内容较多，虽然作为校内自编教材已采用十一载，经过多次反复修订，但限于编者水平，书中仍可能出现错漏，还望读者不吝指正。

编 者

2019 年 4 月

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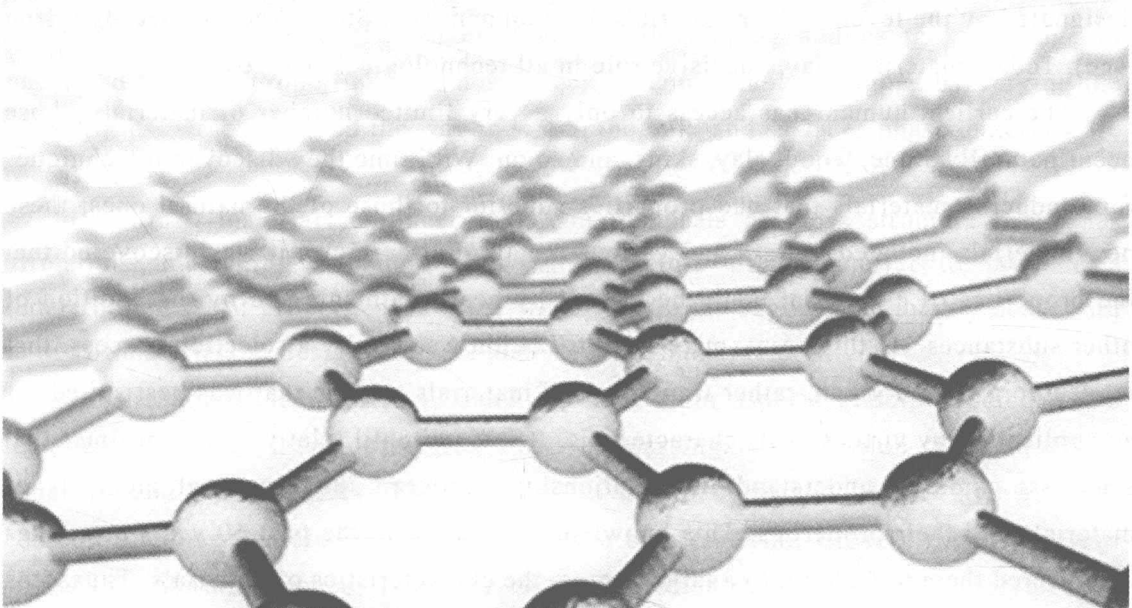
PART I



UNIT 1 INTRODUCTION TO MATERIALS

Lesson 1 Materials Science and Engineering

Life in the 21st century is ever dependent on an unlimited variety of ***advanced materials***. In our consumptive world, it is easy to take for granted the ***macro-***, ***micro-***, and ***nanoscopic*** building blocks that comprise any item produced. Materials are properly more deep-seated in our culture than most of us realize. Transportation, housing, clothing, communication, recreation and food production—virtually every segment of our everyday lives is influenced on one degree or another by materials. Historically, the development and advancement of societies have been intimately tied to the members' abilities to produce and manipulate materials to fill their needs. In fact, early civilizations have been designated by the level of their materials development (i.e. Stone Age, ***Bronze Age***, Iron Age). Today, materials play a decisive role in all technological changes.

The earliest humans has access to only a very limited number of materials, those 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; these 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 virtues of its characteristic. It was not until relatively recent times that scientists came to understand the relationships between the structural elements of materials and their properties. This knowledge, acquired in the past 60 years or so, has empowered them to fashion, to a large degree, the characteristics of materials. Thus, tens of thousands of different materials have evolved with rather specialized characteristics that meet the needs of our modern and complex society.

Materials

The term material may be broadly defined as any solid-state component or device that may be used to address a current or future societal need. For instance, simple building materials such as nails, wood, coatings, etc. address our need of shelter. Other more intangible materials such as nanodevices may not yet be widely proven for particular applications, but will be essential for the future needs of our civilization. Although the above definition includes solid nanostructural building blocks that assemble to form larger materials, it excludes complex liquid compounds such as crude oil, which may be more properly considered a precursor for materials.

Materials Science and Engineering

Materials science is an ***interdisciplinary*** study that combines chemistry, physics, ***metallurgy***, engineering and very recently life sciences. One aspect of materials science involves studying and designing materials to make them useful and reliable in the service of humankind. It strives for basic understanding of how structures and processes on the atomic scale result in the properties and functions familiar at the engineering level. Materials scientists are interested in physical and chemical phenomena acting across large magnitudes of space and time scales. In this regard it differs from physics or chemistry where the emphasis is more on explaining the properties of pure substances. In materials science there is also an emphasis on developing and using knowledge to understand how the properties of materials can be controllably designed by varying the compositions, structures, and the way in which the bulk and surfaces phase materials are processed.

In contrast, materials engineering is, on the basis of those structure properties correlations, designing or engineering the structure of a material to produce a predetermined set of properties. In other words, materials engineering mainly deals with the use of materials in design and how materials are manufactured.

As schematized in Figure1.1, there are four main aspects materials science and technology: synthesis, manufacturing and processing, composition and structure, properties and performances. The behavior in manufacture and in use coupled with economic factors characterizes the performance of a material. Closely linked are four aspects of materials science. The material is elaborated during synthesis (polymer) or manufacturing (metals, alloys, ***ceramics***, etc.). Processing concerns the shaping of a material and the preparation of a finished object according to its behavior. For example, the production of a car body involves successively rolling of the sheet steel from a bar of steel, the stamping of the sheet steel to form the body and a series of finishing operations (painting, etc.).

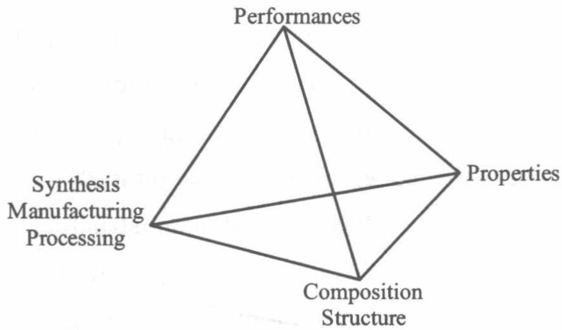


Figure 1.1 The four basic aspects of materials science and technology

To obtain optimal properties, it is essential to master the structure and composition of the materials and consequently to have access to a series of the ***sophisticated analysis techniques***.

It is the numerous contributions of Materials Science and Technology, which has completely remodeled the world, which supports us by freeing man of a huge number of constraints, linked to our environment. Our way of life has been radically transformed within a few decades largely due to the contributions of Materials Science and Engineering which lead to the creation of the tools of the modern life: automobiles, aircraft, bridge, cable cars, computers, ***telecommunications*** equipment, satellites etc.

New Words and Expressions

advanced materials [əd'vɑ:nst mə'tɪərɪəlz] 先进材料

Bronze Age [brɔnz eidʒ] 铜器时代

macro- ['mækrəʊ] 宏观的，大的

micro- ['maɪkrəʊ] 微观的，小的

nanoscopic 纳米级，纳米观

pottery ['pɒtəri] *n.* 陶器，陶器制造（术）

interdisciplinary [ˌɪntə'dɪsəplɪnəri] *adj.* 交叉学科的，跨学科的

metallurgy [mə'tælədʒi] *n.* 冶金学

ceramics [sɪ'ræmɪks] *n.* 陶瓷，陶瓷制品

sophisticated analysis technique 精密分析技术

telecommunication [ˌtelɪkəˌmju:nɪ'keɪʃn] *n.* 电信，长途通信，无线电通信

Reading Material

Classification of Materials

Materials are classified according to various criteria such as their composition, their structure or their properties. Here, distinction is made between three large groups of materials (Figure 1.2). This classification is based on the atomic structures and the nature of bonds:

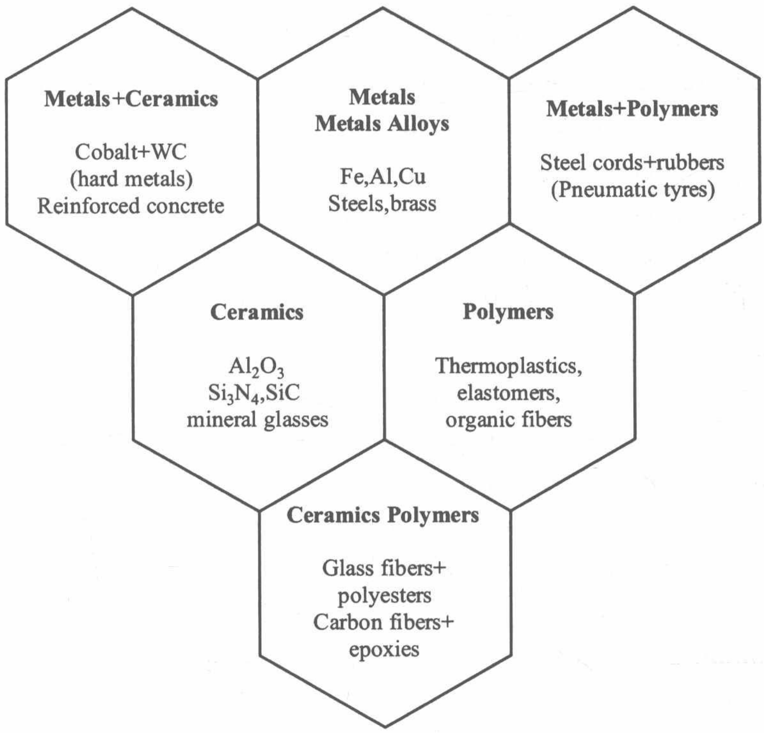


Figure 1.2 The three classes of materials: metals, ceramics and polymers With some possible combinations of composite materials

Metals and their alloys (metallic bonding);

Ceramics (ionic bonding and covalent bonding);

Polymers (covalent bonding and secondary bonding).

This classification can be examined with the help of ***the Periodic Table of the Elements***.

The majority of the elements are metals (approximately 70%) (to the left and in the centre of Mendeleev's table). The non-metals, such as oxygen occupy the right hand side of the Periodic Table. In the intermediate region between metals and non-metals, there occurs a certain number of elements such as carbon and silicon (***semiconductor***) which escape this simple classification.

Metals: Metals (including alloys) consist of atoms and are characterized by metallic bonding (i.e., the valence electrons of each atom are delocalized and shared among all the atoms). Most of the elements in the Periodic Table are metals. Examples of alloys are Cu-Zn (brass), Fe-C (steel), and Sn-Pb (solder). Alloys are classified according to the majority element present. The main classes of alloys are iron-based alloys for structures; copper-based alloys for piping, utensils, thermal conduction, electrical conduction, etc.; and aluminum-based alloys for lightweight structures and metal-matrix composites. Alloys are almost always in the ***polycrystalline*** form.

Ceramics: Ceramics are inorganic compounds such as Al_2O_3(for spark plugs and for substrates for microelectronics), SiO_2(for electrical insulation in microelectronics), Fe_3O_4(ferrite for magnetic memories used in computers), silicates (clay, cement, glass, etc.), and SiC (an ***abrasive***). The main classes of ceramics are oxides, carbides, nitrides, and silicates. Ceramics are typically partly crystalline and partly ***amorphous***. They consist of ions (often atoms as well) and are characterized by ionic bonding and often covalent bonding.

Polymers: Polymers in the form of thermoplastics (nylon, polyethylene, polyvinyl chloride, rubber, etc.) consist of molecules that have covalent bonding within each molecule and ***van der Waals' forces*** between them. Polymers in the form of ***thermosets*** (e.g., epoxy, ***phenolics***, etc.) consist of a network of covalent bonds. Polymers are amorphous, except for a minority of thermoplastics. Due to the bonding, polymers are typically electrical and thermal insulators. However, conducting polymers can be obtained by doping, and conducting polymer-matrix composites can be obtained by the use of conducting fillers.

Composites: Composite materials are ***multiphase*** materials obtained by artificial combination of different materials to attain properties that the individual components cannot attain. An example is a lightweight structural composite obtained by embedding continuous carbon fibers in one or more orientations in a polymer matrix.

Any classification of materials possesses such an arbitrary character, for there is no discontinuity between the three classes of materials. Other classifications, based on specific material properties such as semi-conductivity, can be justified.

Materials that are utilized in high-technology applications are sometimes termed advanced materials. By high technology we mean a device or product that operates or functions using relatively intricate and sophisticated principles; examples include electronic equipment (VCRs, CD players, etc.), computers, ***fiberoptic*** systems, spacecraft, air-craft, and military rocketry. These advanced materials are typically either traditional materials whose properties have been enhanced or newly developed, high-performance materials. Furthermore, they may be of all material types (e.g. metals, ceramics, polymers), and are normally relatively expensive.

New Words and Expressions

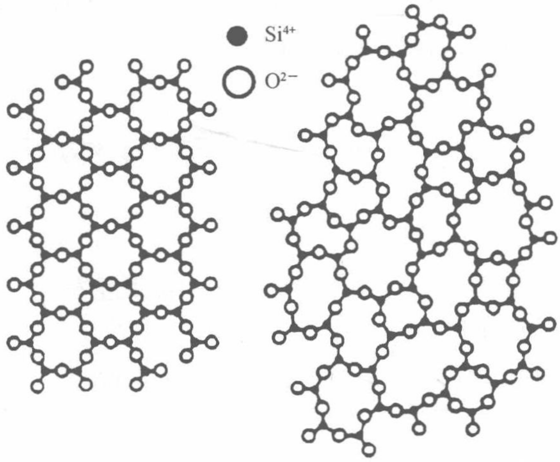
cobalt ['kəʊbɔːlt] *n.* 钴（符号为 Co）
reinforced concrete [ˌriːɪn'fɔːst, -'fəʊrst] *n.* 钢筋混凝土
brass [brɑːs] *n.* 黄铜
pneumatic tyre [nuː'mætɪk 'taiə] *n.* 气胎，内车胎
mineral ['mɪnərəl] *n.* 矿物，矿石；*adj.* 矿物的，似矿物的
thermoplastic [ˌθɜːməʊ'plæstɪk] *adj.* 热塑性的；*n.* 热塑性塑料
elastomer [ɪ'læstəmə(r)] *n.* 弹性体，人造橡胶
polyester [ˌpɒli'estə(r)] *n.* 聚酯
epoxy [ɪ'pɒksi] *adj.* 环氧的；*n.* 环氧树脂
the Periodic Table of the Elements 元素周期表
semiconductor [ˌsemikən'dʌktə(r)] *n.* 半导体
polycrystalline [pɒlɪ'krɪstəlaɪn] *adj.* 多晶的
abrasive [ə'breɪsɪv] *n.* 研磨剂
amorphous [ə'mɔːfəs] *adj.* 无定形的，无组织的，非结晶的
van der Waals' forces 范德华力
thermoset ['θɜːməset] *adj.* 热固性的；*n.* 热固性塑料
phenolics [fɪ'nɒlɪks] *n.* 酚醛塑料
multiphase ['mʌltɪfeɪz] *n.* 多相
fiberoptic ['fɪbəɒptɪk] *n.* 光纤

Lesson 2 Structural Characteristic of Materials

The arrangement of atoms in solids, in general, in particular, will exhibit ***long-range order***, only ***short-range order***, or a combination of both. Solids that exhibit long-range order are referred to as crystalline solids, while those in which that periodicity is lacking are known as amorphous, glassy, or ***noncrystalline*** solids.

The difference between the two is best illustrated schematically, as shown in Figure

1.3. From the figure it is obvious that a solid possesses long-range order when the atoms repeat with a periodicity that is much greater than the bond lengths. Most metals and ceramics, with the exception of glasses and glass-ceramics, are crystalline.



(a) Long-range order (b) Short-range order

Figure 1.3 The difference between long-range order and short-range order

Crystalline bodies remain solid, i.e. retain their shape, up to a definite temperature (***melting point***) at which they change from the solid to liquid state. During cooling, the inverse process of ***solidification*** takes place. In both cases, the temperature remains constant until the material is completely melted or respectively solidified.

Amorphous bodies, when heated, are gradually softened in a wide temperature range and become viscous and only then change to the liquid state. In cooling, the process takes place in the opposite direction.

The crystalline state of a solid is more stable than amorphous state.

Examples of such changes from amorphous to crystalline state are the turbidity effect appearing in ***inorganic*** glasses on heating or in optical glasses after a long use, partial crystallization of molten amber on heating, or additional crystallization and strengthening of ***nylon fibres*** on tension.

Crystalline bodies are characterized by an ordered arrangement of their elementary particles (ions, atoms or molecules). The properties of crystals depend on the electronic structure of atoms and the nature of their interactions in the crystal, on the ***spatial arrangement*** of elementary particles, and on the composition, size and shape of crystals.

The structure of crystals is described by using the concepts of fine structure and micro-and macro-structure depending on the size of structural components and the methods employed to reveal them.

Microscopic examinations make it possible to determine the size and shape of grains (crystals), the presence of crystals of different nature, their distribution and relative volume quantities, the shape of foreign inclusions and ***microvoids***, ***orientations*** of crystals, and some special ***crystallographic*** characteristics (twins, slip lines, etc.).

Macrostructure of crystals is studied by the naked eye or with a magnifying glass. This method can reveal the pattern of a fracture, shrinkage cavities and voids, and the shape and size of large crystals. It is also possible to detect cracks, chemical ***inhomogeneities***, fibrous textures, etc. by using specially prepared (polished and etched) specimens. Macrostructure examination is a valuable method for studying crystalline materials.

Crystal Structures

As noted above, long-range order requires that atoms be arrayed in a three-dimensional pattern that repeats. The simplest way to describe a pattern is to describe a ***unit cell*** within that pattern. A unit cell is defined as the smallest region in space that, when repeated, completely describes the three-dimensional pattern of the atoms of a crystal. Geometrically, it can be shown that there are only seven unit cell shapes, or ***crystal systems***, that can be stacked together to fill three-dimensional space. The seven systems, are ***cubic***, ***tetragonal***, ***orthorhombic***, ***rhombohedral***, ***hexagonal***, ***monoclinic***, and ***triclinic***. The various systems are distinguished from one another by the lengths of the unit cell edges and the angles between the edges, collectively known as the ***lattice parameters*** or ***lattice constants*** (a, b, c, α, β, and γ in Figure 1.4).

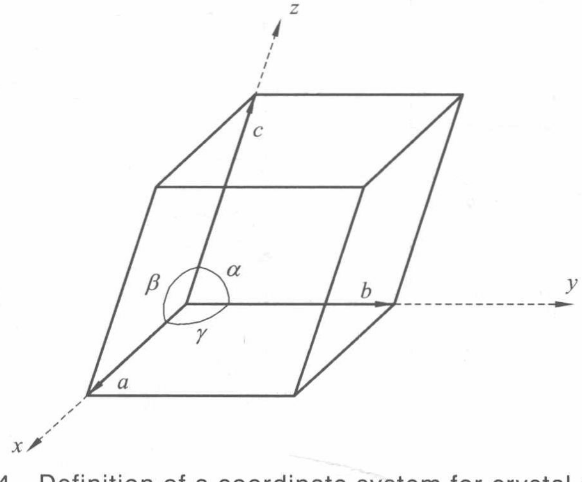
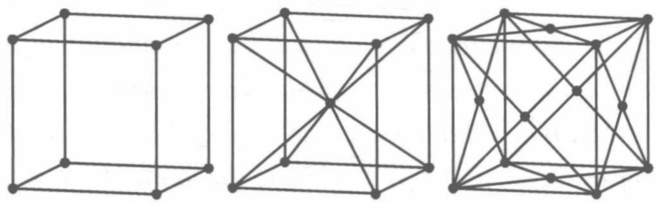
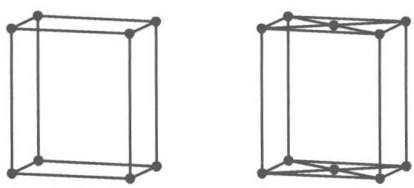
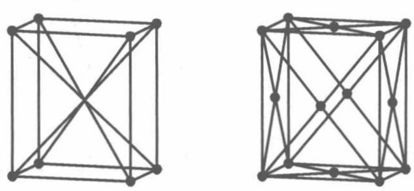


Figure 1.4 Definition of a coordinate system for crystal structures

It is useful to think of the crystal systems as the shape of the "bricks" that make up a solid. For example, the bricks can be cubes, hexagons, ***parallelepipeds***, etc. And while the shape of the bricks is a very important descriptor of a crystal structure, it is insufficient. In addition to the shape of the brick, it is important to know the symmetry of the lattice pattern within each brick as well as the actual location of the atoms on these lattice sites. Only then would the description be complete.

It turns out that if one considers only the symmetry within each unit cell, the number of possible ***permutations*** is limited to 14. The 14 arrangements, shown in Table 1.1, are also known as the Bravais lattices. A lattice can be defined as an indefinitely extending arrangement of points, each of which is surrounded by an identical grouping of neighboring points. To carry the brick brick analogy a little further, the ***Bravais lattice*** represents the symmetry of the pattern found on the bricks. Finally, to describe the atomic arrangement, one must describe the symmetry of the basis, defined as the atom or grouping of atoms located at each lattice site. When the basis is added to the lattices, the total number of possibilities increases to 32 ***point groups***.

Table 1.1 Geometric characteristics of the 7 crystal systems and 14 Bravais lattices

Crystal Structure	Lattice Parameters	Interaxial Angles	
Cubic	$a = b = c$	$\alpha = \beta = \gamma = 90°$	 Simple Body-centered Face-centered
Orthorhombic	$a \neq b \neq c$	$\alpha = \beta = \gamma = 90°$	 Simple Base-centered  Body-centered Face-centered
Rhombohedral	$a = b = c$	$\alpha = \beta = \gamma \neq 90°$, $<120°$