普通高等教育"十一五"国家级规划教材

高等学校规划教材

模具专业英语

黄义俊 主编　　王 伟 副主编

清华大学出版社

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内容简介

本书介绍了与模具设计与制造专业有关的英语知识，内容均选自英、美等国专业教材及专业刊物中的原文。本书共有8个单元，主要内容包括：模具材料及热处理、冷冲压工艺及模具设计、塑料及塑料模具设计、压铸模具、模具加工与制造、模具零件、特种加工工艺、冲压与塑压成形机械、模具CAD/CAM、数控加工技术和快速成形技术等。

本书内容新颖，图文并茂，与专业课程结合紧密，实用性强。全书由课文、单词与词组、注释、练习几部分组成。本书可作为高等院校模具专业英语教材或阅读材料，也可作为从事模具设计与制造方面工作的工程技术人员的自学参考用书。

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我国高等院校应用型人材培养的根本任务就是为企业培养生产、技术和管理所需要的高等技术的专门技术人才,学生在掌握一定专业知识的基础上,也要掌握本专业领域的专有知识和职业技能。

模具设计与制造专业是一门发展迅速、专业性很强的专业学科,《模具专业英语》是模具专业课程中的重要学习内容之一。本教材编写的目的就是适应企业国际化的要求、适应国内外模具专业发展与交流的需要,培养学生直接阅读技术文献和技术资料的实际能力,掌握和了解国外先进的模具设计和制造专业技术,特别可为未来在大型企业从事模具专业相关的工程技术和管理工作打下一定的专业英语基础。

本书内容均选自英国、美国等专业教材与专业技术刊物中的原文,按照模具专业课程教学的相应内容,本教材内容共有 8 个单元,每个单元都涉及特定的模具专业的知识内容,每单元之后均列出了一定数量专业性很强且实用的专业词汇和词组,并针对各单元内容附有思考练习题,对课文中出现的专业英语难句进行必要的解释。不同院校可根据各校实际情况和教学计划安排,对本教材的内容适当地进行删减和调整教学。

本书由宁波职业技术学院黄义俊任主编,并完成全部课文内容的编写工作,宁波职业技术学院王伟(副主编)完成了课文摘要的编写工作,宁波职业技术学院徐丹霞完成了全部的单词整理工作,杭州职业技术学院张俊完成了全部习题的编写工作。

本书的顺利出版,要感谢清华大学出版社职业教育分社的领导和编辑给予的大力支持和帮助,并提出了许多宝贵的修改意见。在本书的编写过程中,曾参考并引用了有关文献资料、插图等,作者在此对相关作者表示由衷的感谢。

由于作者水平有限、时间仓促,书中难免存在缺点与不妥之处,请读者批评指正,并提出宝贵意见。

编　者

2007 年 1 月

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Unit One

The Die and Mold Materials and Heat Treatment

1.1 Abstract

This unit mainly introduces the materials used for the parts of dies and molds, the processes and methods of material heat treatment, and the selection of typical mold steels and so on, which include several sections as follows:

1. Carbon steels,
2. Alloy steels,
3. Cold work die steels and hot work mold steels,
4. Selection of typical mold steels,
5. The purposes of heat treatment of materials,
6. Types of heat treatment of materials.

1.2 Die and Mold Materials

1.2.1 Carbon Steels

Carbon steels are used extensively in die and mold parts. Carbon steels are those steels which only contain iron and carbon, and small amounts of other alloying elements. Carbon steels are the most common and least expensive type of steel used for dies and molds. The three principal types of carbon steels used for die and mold parts are low carbon, medium carbon, and high carbon steels. Low carbon steel contains between 0.05% and 0.3% carbon. Medium carbon steel contains between 0.3% and 0.7% carbon. And high carbon steel contains between 0.7% and 1.5% carbon. As the carbon content is increased in carbon steel, the strength, toughness, and hardness also increase when the metal is heat treated.

Low carbon steels are soft, tough steels that are easily machined and welded. Due to their low carbon content, these steels cannot be hardened except by case hardening. Low carbon steels are well suited for the following applications: unimportant die and mold parts, upper and lower shoes, and similar situations where strength and wear resistance are not required.

Medium carbon steels are used where greater strength and toughness are required. Since medium carbon steels have a higher carbon content they can be heat-treated to make parts such as studs, plus, axles, and nuts. Steels in this group are more expensive as well as more difficult to machine and weld than low carbon steels.

High carbon steels are the most hardenable type of carbon steel and are used frequently for parts where wear resistance is an important factor. Other applications where high carbon steels are well suited include guide pin bushings, guide pins, punch, and wear pads. Since the carbon content of these steels is so high, parts made from high carbon steel are normally difficult to machine and weld.

1.2.2 Alloy Steels

Alloy steels are basically carbon steels with additional elements added to alter the characteristics and bring about a predictable change in the mechanical properties of the alloyed metal. The alloying elements used most often in steels are manganese, nickel, molybdenum and chromium. They can have the general name of manganese steel, nickel steel, molybdenum steel and chromium steel according as their specific content of the alloying elements in alloy steels.

Although alloy steels contain elements such as chromium, molybdenum and vanadium, two constituents are essential for heat treatment: iron, termed ferrite in metallography, and carbon, which combines with iron to form cementite, the hard intermetallic compound Fe_3C. These two constituents from a eutectoid structure known as pearlite when the steel is cooled slowly enough to reach equilibrium, but by rapid cooling the steel is hardened. When such a quenched steel is tempered, structures with mechanical properties intermediate between those of the slowly cooled and the quenched conditions are formed.

In recent year there has been a greater understanding of the complex structural changes taking place during heat treatment, with the help of phase transformation diagrams. Use of these diagrams can lead to better control of the heat treatment cycle which in turn will ensure optimum properties and maximum die life are achieved.

Stainless steel is a term used to describe high chromium and nickel-chromium steels.

These steels are used for molds which must resist high temperatures and corrosive atmospheres. Some high chromium steels can be hardened by heat treatment and are used where resistance to wear, abrasion, and corrosion are required. Typical applications where a hardenable stainless steel is sometimes preferred are plastic injection molds. Here the high chromium content allows the steel to be highly polished and prevents deterioration of the cavity from heat and corrosion.

1.2.3 Die and Mold Steels

The specific material selected for a particular dies or mold is normally determined by the mechanical properties necessary for the proper operation of the dies and molds. These materials should be selected only after a careful study and evaluation of the function and requirements of the proposed tool. In most applications, more than one type of material will be satisfactory, and a final choice will normally be governed by requirements from customers for dies and molds, such as performance and economic considerations for dies and molds.

The principal materials used for dies and molds can be divided into two major categories: cold work tool (die) steel and hot work tool (mold) steel, such as carbide steel, alloy tool steel, carbon tool steel, high-speed steel, high alloy steel, high carbon steel, low carbon steel, shock resistance tool steel and so on. To properly select a die or mold material, there are several physical and mechanical properties you should understand to determine how the materials you select will affect the function and performance of the die or mold[1].

Physical and mechanical properties are those characteristics of a material which control how the material will react under certain conditions. Physical properties are those properties which are natural in the material and cannot be permanently altered without changing the material itself.

These properties include weight, thermal and electrical conductivity, rate of thermal expansion, and melting point. The mechanical properties of a material are those properties which can be permanently altered by thermal or mechanical treatment. These properties include strength, hardness, wear resistance, toughness, brittleness, plasticity, ductility, malleability, and modulus of elasticity.

From a use standpoint, die and mold steels are utilized in working and shaping basic materials such as metals and plastics into desired forms. From a usefulness standpoint, die steels are of the performance which are capable of being hardened and tempered and wear resistance, high hardness, sufficient anti-impact strength. Mold steels are of the performance which are capable of being hardened and tempered and heat resistance, corrosion resistance and wear resistance.

Die and mold steels are relatively especial steel products, they have a very important application in production of the die and mold products, such as deep-drawing dies, stamping dies, extrusion dies, piercing dies, bending dies, pressure die-casting dies, forming dies, blanking dies and thermoplastic and thermosetting molds. They are playing a more and more important role in die and mold industry.

1.2.4 Selection of Typical Mold Steels

The processes developed for molding plastics and the different processing properties of the plastics lead to different loads, which must be taken into consideration not only in the design but also in the selection of the materials required for molds. Steel has the ideal qualifications, because its properties can be modified by alloying elements, special production processes, and heat treatment, and it can be adjusted to various requirements.

The most important requirements for the mold steels are:

- high compressive strength expected even at high temperatures,
- wear resistance,
- great toughness,
- corrosion resistance and good thermal conductivity.

Also, the mold maker expects the following properties:

- good machine ability,
- good hobbing capabilities (where required),
- dimensional stability during heat treatment,
- good polishing properties,
- surface texturing without difficulties (where required).

Finally, the mold steel should be readily available, and should be have a requirement that demands a standardization of sizes and universally suitable types of steel.

Considering the various stresses to which the mold material is subjected, it is understandable that not all conditions can be met with one grade of steel. The experience of many years and the close cooperation between steel producers and consumers have led to the development of mold steels that can be divided into the following groups: nitriding steels; case-hardened steels; prehardened steels; fully hardened steels, corrosion-resistant steels; maraging steels; hard material alloys.

1.3 Heat Treatment of Die and Mold Materials

1.3.1 The Purposes of Heat Treatment

The main purpose of heat treatment for die-making and mold-making materials is to control the properties of a specific metal or alloy through the alteration of the structure of the specific metal or alloy by heating it to definite temperatures and cooling at various rates. This combination of heating and controlled cooling determines not only the nature and distribution of the microconstituents, which in turn determine the properties, but also the grain size[2].

Heat treating should improve the alloy or metal for the service intended. Some of various purposes of heat treating are as follows:

1. To remove strains after cold working such as forging, rolling,
2. To remove internal stresses such as produced by drawing, bending, extruding or welding,
3. To increase the hardness of the material and wear-resisting properties,
4. To improve machinability,
5. To improve the comprehensive performance of material on purpose, such as normalizing,
6. To soften the material, as in annealing,
7. To improve or change properties of a material such as corrosion resistance, heat resistance, or others as required.

1.3.2 Types of Heat Treatment

Annealing—The process of annealing consists of heating the steel to an elevated temperature for a definite period of time and, usually, cooling it slowly. Annealing is done to produce homogenization and to establish normal equilibrium conditions, with corresponding characteristic properties. In view that die and mold steel is generally purchased in the annealed condition, sometimes it is necessary to rework a die or mold that has been hardened, and the die or mold must then be annealed.

The steel is heated slightly above its critical range and then cooled very slowly.

Normalizing—Involves heating the material to a temperature of about 55 – 100℃ above the critical range and cooling in still air. This is about 55℃ over the regular hardening temperature.

The purpose of normalizing is usually to refine grain structures that have been coarsened in forging. With most of the medium-carbon forging steels, alloy, normalizing is highly recommended after forging and before machining to produce more homogeneous structures, and in most cases, improved machinability[3].

High-alloy air-hardened steels are never normalized, since to do so would cause them to harden and defeat the primary purpose.

Tempering—This is the process of heating quenched and hardened steels and alloys to some temperature below the lower critical temperature to reduce internal stresses setup in hardening.

Hardening—This is the process of heating to a temperature above the critical range, and cooling rapidly enough through the critical range to reduce to appreciably harden the steel.

Case Hardening—The addition of carbon to the surface of steel parts and the subsequent hardening operations are important phases in heat treating. The process may involve the use of molten sodium cyanide mixtures, pack carburizing with activated solid material such as charcoal or coke, gas or oil carburizing, and dry cyaniding.

Spheroidizing—It is a form of annealing which, in the process of heating and cooling steel, produces a rounded or globular form of carbide—the hard constituent in steel.

Steels are normally spheroidized to improve machinability. This is accomplished by heating to a temperature of 749 – 760℃ for carbon steels and higher for many alloy tool steels, holding at heat one to four hours, and cooling slowly in the furnace.

Stress Relieving—This is a method of relieving the internal stresses set up in steel during forming, cold working, and cooling after welding or machining. It is the simplest heat treatment and is accomplished merely by heating to 649 – 732℃ followed by air or furnace cooling.

Large dies are usually roughed out, then stress-relieved and finish-machined. This will minimize change of shape not only during machining but during subsequent heat treating as well.

Welded sections will also have locked-in stresses owing to a combination of differential heating and cooling cycles as well as to changes in cross section. Such stresses will be the considerable movement in machining operations.

Surface Treatments—During the past 20 years, several processes have been introduced to obtain enhanced surface hardness of steels. Some of them have developed from case carburizing and nitriding, to obtain faster processing times with better environmental control of and improved properties. Various salt bath processes have been used and now a wide range of new methods is available.

In the die casting industry surface treatments are applied to steels to improve the properties of nozzle, ejector pins, cores and shot sleeves, to provide maximum resistance to erosion, pitting and soldering. Treatment of die cavities has received only limited acclaim, because the complex thermal patterns produced on large die components lead to stresses which are sufficiently high to break through the thin surface treated layers, leading to premature failure. Experience in drop forging has also indicated that surface treatments of the their dies have not been particularly successful.

New Words and Expressions

1. die and mold /dai ənd məuld/ *n.* 模具，冲模/铸模，塑模
2. stud /stʌd/ *n.* 销，螺栓，螺柱
3. pin /pin/ *n.* 针，钉，销，栓
4. nut /nʌt/ *n.* 螺母
5. punch /pʌntʃ/ *n.* 冲头，凸模冲压机，冲床，打孔机 *vt.* 冲孔，打孔
6. strength /streŋθ/ *n.* 力(量)，强度
7. toughness /ˈtʌfnis/ *n.* 韧性，韧度，塑性
8. hardness /ˈhɑːdnis/ *n.* 硬度，硬性，刚度
9. manganese /ˌmæŋgəˈniːz / ˈmæŋgəniːz/ *n.* 锰
10. nickel /ˈnikl/ *n.* 镍
11. molybdenum /məˈlibdinəm/ *n.* 钼
12. chromium /ˈkrəumjəm/ *n.* 铬
13. abrasion /əˈbreiʒən/ *n.* 磨损
14. evaluation /iˌvæljuˈeiʃən/ *n.* 估价，评价，鉴定，计算
15. satisfactory /ˌsætisˈfæktəri/ *adj.* 满意的，符合要求的
16. availability /əˌveiləˈbiliti/ *n.* 存在，具备，有效性，利用率
17. category /ˈkætigəri/ *n.* 种类，类别，范畴，类型
18. thermal /ˈθəːməl/ *adj.* 热(量)的，由热造成的 *n.* 上升暖气流
19. brittleness /ˈbritlnis/ *n.* 脆性，脆度，易碎性
20. plasticity /plæsˈtisiti/ *n.* 可塑性，塑性
21. ductility /dʌkˈtiliti/ *n.* 延展性，延伸度，可锻性
22. malleability /ˌmæliəˈbiliti/ *n.* 可锻性，延展性，韧性
23. modulus /ˈmɔdjuləs/ *n.* 模量，系数，模数
24. elasticity /iˌlæsˈtisiti/ *n.* 弹力，弹性
25. standpoint /ˈstændpɔint/ *n.* 立场，观点
26. sufficient /səˈfiʃənt/ *adj.* 充分的，足够的
27. hobbing /ˈhɔbiŋ/ *adj.* 压制的，模压的