Jixie Gongcheng Zhuanye Yingyu

机械工程专业英语

赵红霞　王淑珍　编

武汉理工大学出版社
WUHAN UNIVERSITY OF TECHNOLOGY PRESS

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图书在版编目(CIP)数据

机械工程专业英语/赵红霞,王淑珍编.—武汉:武汉理工大学出版社,2005
ISBN 7-5629-2078-8

Ⅰ.机…　Ⅱ.①赵…　②王…　Ⅲ.机械工程-英语-高等学校-教材　Ⅳ.H31

中国版本图书馆CIP数据核字(2005)第(098862)号

出版者:武汉理工大学出版社(武汉市武昌珞狮路122号　邮编:430070)
印刷者:荆州市鸿盛印刷厂
发行者:各地新华书店
开　本:787×1092　1/16
印　张:9.75
字　数:234千字
版　次:2005年9月第1版　2005年9月第1次印刷
印　数:1~1600册
定　价:16.00元

前　言

专业英语的教学目的是指导学生阅读与自己专业相关的英语书刊和文选，使学生以英语为工具，获得相关专业信息。在学习本书过程中，不仅仅学习专业词汇，还学习了英语在科技英语中的表达方法。本书的教学对象是高等工程专科学校教育和高等职业教育的机械工程类各专业的学生。

编写本教材的目的是为了让学生在经历了大学一、二年级的基础英语学习后，通过学习本教材，实现英语不断线，使英语水平再上一个新台阶。

本教材根据机械工程类学生所涉及到的专业内容，将全书分为六大部分，分别是工程材料、机械零件、机械加工方法、工程机械、机电工程及阅读材料。每部分内容都选自国外原版资料，教师可根据机械各专业方向的特点选讲有关内容。全书总阅读量约 100 000 词。教学时数 30～50 学时。本书附录介绍了科技论文的书写格式及科技英语阅读和翻译方法等。

本书内容选自国外原文资料，并兼顾英美多种体裁的不同文风，能反映科技英语的表达方法。在内容上与机械类各专业结合紧密，教师可以结合专业课的学习提高学生英语阅读与翻译的能力。

本书由洛阳工业高等专科学校赵红霞、王淑珍编写，洛阳工业高等专科学校朱晓春主审。

由于作者水平有限，难免有疏漏和不当之处，恳请读者批评指正。

作　者

2005.6

CONTENTS

PART 1 MATERIALS AND HEAT TREATMENT

Unit 1 Introduction to Materials

Introduction

All engineers are involved with materials on a daily basis. We manufacture and process materials, design and construct components or structures using materials, select materials, analyze failures of materials or simply hope the materials we are using perform adequately. [1]

As responsible engineers, we are interested in improving the performance of the product when we are designing or manufacturing. Electrical engineers want integrated circuits to perform properly, switches in computers to react instantly and insulators to withstand high voltages even under the most adverse conditions. Civil, structural, and architectural engineers wish to construct strong, reliable structures that are aesthetic and resistant to corrosion. Petroleum and chemical engineers require drill bits or piping that survive in abrasive or corrosive conditions. Automotive engineers desire lightweight yet strong and durable materials. Aerospace engineers demand lightweight materials that perform well both at high temperatures and in the cold vacuum of outer space. Metallurgical ceramic and polymer engineers wish to produce and shape materials that are more economical and possess improved properties.

The intent of this text is to permit the students to become aware of the types of materials available, to understand their general behavior and capabilities, and to recognize the effects of the environment and service conditions on material's performance. [2]

Types of Materials

We will classify materials into four groups—metals, ceramics, polymers, and composite materials.

Metals Metals and alloys, which include steel, aluminum, magnesium, zinc, cast iron, titanium, copper, nickel, and many others, have the general characteristics of good electrical and thermal conductivity, relatively high stiffness, ductility or formability, and shock resistance. They are particularly useful for structural or load-bearing applications. Although pure metals are occasionally used, combinations of metals called alloys are normally designed to provide improvement in a particular desirable property or permit better combinations of properties.

Ceramics Ceramics, such as brick, glass, tableware, insulators, and abrasives, have poor electrical and thermal conductivity. [3] Although ceramics may have good strength and hardness, their ductility, formability, and shock resistance are poor. Consequently, ceramics are less often used for structural or load-bearing applications than metals. However, many ceramics have excellent resistance to high temperatures and certain corrosive media and have a number of unusual and desirable optical, electrical, and thermal properties.

Polymers Polymers include rubber, plastics, and many types of adhesives. They are producted by creating large molecular structures from organic molecules, obtained from petroleum or agricultural products, in a process known as polymerization. [4] Polymers have low electrical and thermal conductivity, have low strengths and are not suitable for use at high temperature. Some polymer (thermoplastic) have excellent ductility, formability, and shock resistance while others (thermosets) have the opposite properties. Polymers are lightweight and frequently have excellent resistance to corrosion.

Composite Material Composites are formed from two or more materials, producing properties that cannot be obtained by any single material. [5] Concrete, plywood, and fiberglass are typical, although crude, examples of composite materials. With composites we can produce lightweight, strong, ductile, high temperature-resistant materials that are otherwise unobtainable, or produce hard yet shock-resistant cutting tools that would otherwise shatter. [6]

Example 1-1

You wish to select the materials needed to carry a current between the components inside an electrical "black box". What materials would you select?

Answer:

The material that actually carry the current must have a high electrical conductivity. Thus, we need to select a metal wire. Copper, aluminum, gold, or silver might all serve. However, the metal wire must be insulating from the rest of the "black box" to prevent short circuits or arcing. Although a ceramics coating would be excellent insulator, ceramics are brittle; the wire could not be bent without the ceramic coating breaking off. Instead we should select a polymer plastic coating with good insulating characteristics yet good ductility.

Example 1-2

What materials are used to make coffee cups? What particular property makes these materials suitable?

Answer:

Coffee cups are normally made of ceramic or plastic materials. Both ceramics and polymers have excellent thermal insulation due to their low thermal conductivity. Disposable polystyrene cups are particularly effective, since they contain many gas bubbles that further improve insulation. Actually we could consider the disposable cups to be made from a composite of a polymer and gas!

Metal cups, however, are seldom used because the high thermal conductivity permits the heat to be transferred, burning our hands.

New Words and Expressions

insulator *n*. 绝缘体,绝热器

voltage *n*. [电工]电压,伏特数

aesthetic *adj.* 美学的,审美的,有审美感的

petroleum chemical 石油化学制品

automotive *adj.* 汽车的,自动推进的

aerospace *n.* 航空宇宙

aluminum *n.* [化]铝

magnesium *n.* [化]镁

titanium *n.* [化]钛

nickel *n.* [化]镍,镍币,(美国和加拿大的)五分镍币
vt. 镀镍于

ductility *n.* 展延性,柔软性,顺从

tableware *n.* 餐具

abrasive *n.* 研磨剂
adj. 研磨的

formability 可模锻性,可成型性

corrosive *adj.* 腐蚀的,蚀坏的,腐蚀性的
n. 腐蚀物,腐蚀剂

optical *adj.* 眼的,视力的,光学的

polymer *n.* 聚合体

thermal property 热性质

adhesive *adj.* 带粘性的,胶粘
n. 粘合剂

molecular *adj.* [化]分子的,由分子组成的

polymerization *n.* 聚合

strength *n.* 力,力量;强度

thermoplastic *adj.* 热塑性的
n. 热塑性塑料

thermoset *n.* 热固树脂,热固塑料
adj. 热固的

plywood *n.* 夹板,合板

fiberglass *n.* 玻璃纤维,玻璃丝

crude *adj.* 天然的,未加工的,粗糙的
n. 天然的物质

shatter *n.* 粉碎,碎片,落花(叶,粒等)
vt. 打碎,使散开,粉碎,破坏
vi. 粉碎,损坏

brittle *adj.* 易碎的,脆弱的

disposable *adj.* 可任意使用的

polystyrene *n.* 聚苯乙烯

metallurgical *adj.* 冶金的,冶金学的

Notes

[1] We manufacture and process materials, design and construct components or structures using materials, select materials, analyze failures of materials or simply hope the materials we are using perform adequately.

我们制造和加工原材料,用它们来设计和构造部件或框架,我们选择原材料,分析其缺点或者希望我们使用的材料合格。

structures using materials 中,using 分词短语作状语修饰动词。

hope the materials we are using perform adequately 中, hope 后 the materials we are using perform adequately 为 design and construct 的宾语从句, we are using 为定语从句,修饰 materials.

[2] The intent of this text is to permit the students to become aware of the types of materials available, to understand their general behavior and capabilities, and to recognize the effects of the environment and service conditions on material's performance.

本文旨在让学生们了解各种类型材料以及它们的一般性质,从而理解环境和工作条件对各种材料性能的影响。

to become aware of ..., to understand their general behavior... and to recognize the effects of... 都是不定式短语,作 permit 的宾语补足语。to become aware 意为 being conscious 或 realize.

[3] Ceramics, such as brick, glass, tableware, insulators, and abrasives, have poor electrical and thermal conductivity.

陶瓷材料导电、导热性能差，如砖、玻璃、餐具、绝缘体和磨料。

[4] Polymers include rubber, plastics, and many types of adhesives. They are produced by creating large molecular structures from organic molecules, obtained from petroleum or agricultural products, in a process known as polymerization.

聚合材料包括橡胶塑料和其他粘合材料，它们是通过从石油或农产品的有机分子中制成较大的分子结构而成的，这个过程称之聚合。

[5] Composites are formed from two or more materials, producing properties that cannot be obtained by any single material.

复合材料由两种或两种以上材料组成，产生性能是任何一种单一材料无法得到。

[6] With composites we can produce lightweight, strong, ductile, high temperature-resistant materials that are otherwise unobtainable, or produce hard yet shock-resistant cutting tools that would otherwise shatter.

合成材料可用于制造质量轻、坚硬、可锻压、耐高温的材料，用其他材料是不行的。合成材料还可以制造坚硬而且防震的刃具，用其他材料会碎断。

Unit 2 Introduction to Materials (Continued 1)

Structure-Property-Processing Relationship

We are interested in producing a component that has the proper shape and properties, permitting the component to perform its task for its expected lifetime. The materials engineer meets this requirement by taking advantage of a complex three-part relationship between the internal structure of the material, the processing of material, and the final properties of the material (Fig. 2-1). [1]

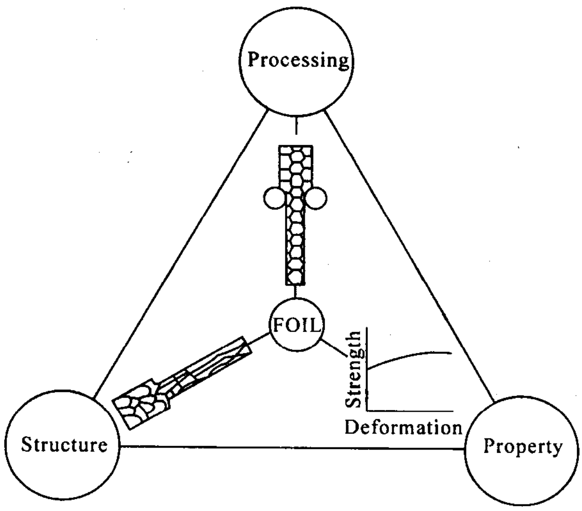

Fig. 2-1

When the materials engineer changes one of these three aspects of the relationship, either or both of the others also change. We must therefore determine how the three aspects interrelate in order to finally produce the required product. [2]

Properties We can consider the properties of a material in two categories—mechanical and physical.

The mechanical properties describe how material responds to an applied force or stress, is defined as the force divided by the cross-sectional area on which the force acts. The most common mechanical properties are the strength, ductility, and stiffness of the material. However, we are often interested in how the material behaves when it is exposed to a sudden intense blow (impact), continually cycled through an alternating force (fatigue), exposed to high temperatures (creep), or subjected to abrasive conditions[3] (wear). The mechanical properties not only determine how well the material performs in service, but also determine the ease with which the material can be formed into a useful shape. [4] A metal part formed by forging must withstand the rapid application of a force without breaking and have a high enough ductility to deform to the proper shape. Often small changes in the structure have a profound effect on the mechanical properties of the material.

Physical properties include electrical, magnetic, optical, thermal, elastic, and chemical behavior. The physical properties depend both on structure and processing of the material. Even their change in the composition cause a profound change on the electrical conductivity of many semiconduct metals and ceramics.

High firing temperatures may greatly reduce the thermal insulation characteristics of ceramic brick. Small amounts of impurities change the color of glass or polymer.

Example 2-1

Describe some of the key mechanical and physical properties we would consider in selecting a material for an airplane wing.

Answer:

First, let's look at mechanical properties. We obviously want the material to have a high strength to support the forces acting on the wing. We must also recognize that the wing is exposed to cyclical application of a force as well as vibration—this suggests that fatigue properties are important. Ordinarily, shock loading (impact), high temperature (creep) and abrasive conditions (wear) are not encountered.

Important physical properties are density and corrosion resistance. The wing should be as light as possible, so the material should have a low density.

Example 2-2

What properties are required for a solar cell used to generate electricity for a satellite?

Answer:

The optical properties are most important in this case. The materials for solar cells, such as silicon, must interact with radiation, or light, to change the electron configuration of the atom. This interaction and change in structure in turn produce the electrical current that is desired.

Structure The structure of a material can be considered on several levels, all of which influence the final behavior of the product. At the finest level is the structure of the individual atoms that compose the material. The arrangement of the electrons surrounding the nucleus of the atom significantly affects electrical, magnetic, thermal and optical behavior and may also influence corrosion resistance. Furthermore, the electronic arrangement influences how the atoms are bonded to one another and helps to determine the type of material—metal, ceramic, or polymer. [5]

At the next level, the arrangement of the atoms in space is considered. Metals, many ceramics, and some polymers have a very regular atomic arrangement, or crystal structure. The crystal structure influences the mechanical properties of metals such as ductility, strength, and shock resistance. Other ceramic materials and most polymers have no orderly atomic arrangement—these amorphous or glassy materials behave much differently from crystalline materials. For instance, glassy polyethylene is transparent while crystalline polyethylene is translucent. Defects in this atomic arrangement exist and may be controlled to produce profound changes in properties.

A grain structure is found in most metals, some ceramics, and occasionally in polymers. Between the grains, the atomic arrangement changes its orientation and thus influences properties.

The size and shape of the grains play a key role at this level.

Processing Materials processing produces the desired shape of a component from the initial formless material. Metals can be processed by pouring liquid metal into a mold (casting) , joining individual pieces of metal (welding, brazing, soldering, adhesive bonding), forming the solid metal into useful shapes using high pressures (forging, extrusion, rolling, bending) , compacting tiny metal powder into a solid mass (powder metallurgy), or removing excess material (machining). Similarly, ceramic materials can be formed into shapes by related processes such as casting, forming, extrusion, or compaction, often while wet, and heat treatment at high temperatures to drive off the fluids and to bond the individual constituents together. Polymers are produced by injection of softened plastic into molds (much like casting), drawing, and forming. Often a material is heat treated at some temperature below is melting temperature to effect a desired change in structure. The type of processing we use depends, at least partly, on the properties, and thus the structure, of the material.

Example 2-3

The first step in the manufacture of tungsten filaments for light bulbs is by powder metallurgy rather than casting. Explain:

Answer:

One of the physical properties of tungsten is its high melting temperature, 3 410℃ . In order to make a casting, the tungsten must be heated to an exceptionally high temperature. Powder metallurgy processing, by which powdered tungsten is compacted into a solid mass, is done at much lower temperatures.

Structure-property-processing interaction The processing of a material affects the structure. The structure of a copper bar is very different if it is produced by casting rather than forming (Fig. 2-2). The shape, size, and orientation of the grains may be different, the cast structure may contain voids due to shrinkage or gas bubbles, and nonmetallic particles (inclusions) may be trapped within the structure. The formed material may contain elongated nonmetallic particles and internal defects in the atomic arrangement. Thus, the structure and consequently the final proper-

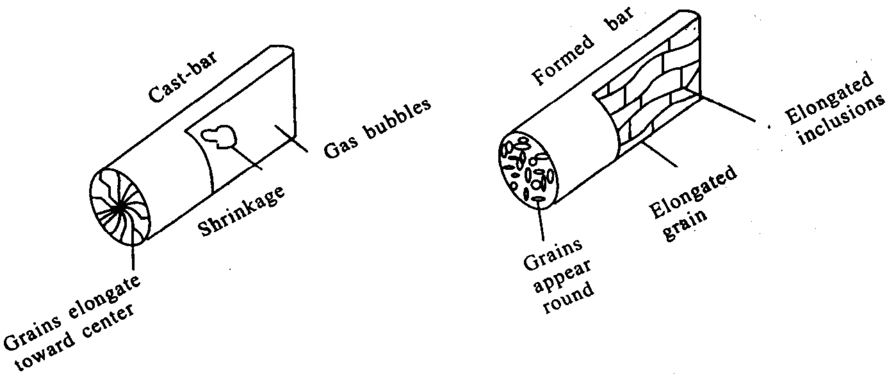

Fig. 2-2 The difference in structure between a copper bar produced by casting and a copper bar produced by forming

ties of the casting are very different from those of the formed product.

On the other hand, the original structure and properties determine how we can process the material to produce a desired shape. A casting containing large shrinkage voids may crack during a subsequent step. Alloys that have been strengthened by introducing imperfections in the structure also become brittle and fail during forming. Elongated grains in a metal may lead to no uniform shapes when subsequently formed. Thermosetting polymers cannot be formed, while thermoplastic polymers are easily formed.

New Words and Expressions

take advantage of *v.* 利用
aspect *n.* 样子,外表,面貌,(问题等的)方面
category *n.* 种类,别,[逻]范畴
cross-section *n.* 横截[断]面
impact *n.* 碰撞,冲击,冲突,影响,效果
vt. 挤入,撞击,压紧,对……发生影响
fatigue *n.* 疲乏,疲劳,累活,[军]杂役
vt. 使疲劳,使心智衰弱
vi. 疲劳
creep *vi.* 爬,蹑手蹑脚,蔓延,(材料)塑料变形,潜伸(移)
subject to *v.* 使服从,使遭受
wear *vt.* 穿,戴
v. (~ out)磨损,用旧;(~ out)穿着
forging *n.* 锻炼,伪造,锻造
deform *v.* (使)变形
magnetic *adj.* 磁的,有磁性的,有吸引力的
elastic *adj.* 弹性的
composition *n.* 作文,成分,合成物
impurity *n.* 杂质,混杂物,不洁,不纯
vibration *n.* 振动,颤动,摇动,摆动
encounter *v.* 遭遇,遇到,相遇
n. 遭遇,遭遇战
density *n.* 密度
solar cell *n.* 太阳能电池
silicon *n.* [化]硅(元素符号为: Si)
radiation *n.* 发散,发光,发热,辐射,放射,放射线,放射物
arrangement *n.* 排列,安排
crystal *adj.* 结晶状的
n. 水晶,水晶饰品,结晶,晶体
amorphous *adj.* 无定形的,无组织的
polyethylene *n.* [化]聚乙烯
orientation *n.* 方向,方位,定位,倾向性,向东方
brazing *n.* 铜焊(接)
welding *n.* 焊接法,定位焊接
soldering *n.* 软焊,锡焊,低温焊接,热焊接,软钎焊
extrusion *n.* 挤出,推出,[地]喷出的,突出的,赶出
compacting *n.* 压实,压制,(加)压(模)塑
powder *n.* 粉,粉末,火药,尘土
vt. 搽粉于,撒粉,使成粉末
vi. 搽粉,变成粉末
constituent *n.* 委托人,要素,组成部分,分力(支,量)
adj. 形成的,组成的
tungsten filament *n.* 钨丝
bulb *n.* 电灯泡
shrinkage *n.* 收缩
inclusion *n.* 包含,内含物
trapped 捕集的,捕获的,收集的,截留的
elongate *v.* 拉长,(使)伸长,延长
adj. 伸长的
n. 拉长,伸长
void *n.* 空间,空旷,空虚,怅惘
adj. 空的,无人的,空闲的,无效的,

无用的，没有的　　　　　　　　　　strengthen　*v.* 加强，巩固

Notes

[1]The materials engineer meets this requirement by taking advantage of a complex three-part relationship between the internal structure of the material, the processing of material, and the final properties of the material.

材料工程师利用材料的内部结构，加工过程以及最后性能三者间的复杂关系来满足此要求。

meet 意为 satisfy。

例：Does the raise of salary meet your hopes?

提高薪水是否满足了你的希望？

take advantage of 意为 make use of。

[2]We must therefore determine how the three aspects interrelate in order to finally produce the required product.

因此，我们必须找出这三方面是如何相互作用，才能最终生产出所需的产品。

interrelate 意为 to be connected to each other.

例：Wages and prices interrelate / are interrelated.

工资和价格相互关联。

[3]we are often interested in how the material behaves when it is exposed to a sudden intense blow (impact), continually cycled through an alternating force (fatigue), exposed to high temperatures (creep), or subjected to abrasive conditions.

我们常感兴趣的是：材料在受到突然冲击的效应（作用），在连续交变力作用时的效应（疲劳），在高温下的效应（蠕变）以及受到研磨条件下的效应时，材料的性能会怎样变化。

when it is exposed to... continually cycled... exposed to... or subjected to...是 how the material behaves 的时间状语。

[4]The mechanical properties not only determine how well the material performs in service, but also determine the ease with which the material can be formed into a useful shape.

机械性能不仅决定了材料在使用中的性能而且决定了材料是否容易加工成一定的形状。

[5]The arrangement of the electrons surrounding the nucleus of the atom significantly affects electrical, magnetic, thermal and optical behavior and may also influence corrosion resistance. Furthermore, the electronic arrangement influences how the atoms are bonded to one another and helps to determine the type of material—metal, ceramic, or polymer.

围绕原子核的电子排列极大地影响材料对电、磁、热和光的效应，并会影响其抗腐蚀能力。更进一步说，电子排列还会影响原子间的组合，这种现象还有助于我们确定材料的类型——金属、陶瓷或聚合材料。

Unit 3 Introduction to Materials (Continued 2)

Environmental Effects in Material Behavior

The structure-property-processing relationship is also influenced by the surroundings to which the material is subjected.

Loading The type of force, or load, acting on the material may dramatically change its behavior. Normally, the yield strength, above which the material suffers a permanent change in its dimensions, is the most critical property and is usually the most important consideration in the design of a material component[1]. However, a material that displays a high yield strength may fall rather easily at lower loads if the loading is cyclical (fatigue) or applied suddenly (impact), the engineer must recognize to which the material is exposed.

Temperature Changes in temperature dramatically alter the properties of materials. The strength of most materials decreases as the temperature increases. Furthermore, sudden catastrophic changes may occur when heating above critical temperatures. Metals that have been strengthened by certain heat treatments or forming techniques may suddenly close their strength when heated [2] (Fig. 3-1). Very low temperatures may cause a metal to fail in a brittle manner even though the applied loads are low. High temperatures can also change the structure of ceramics or cause polymers to melt or char.

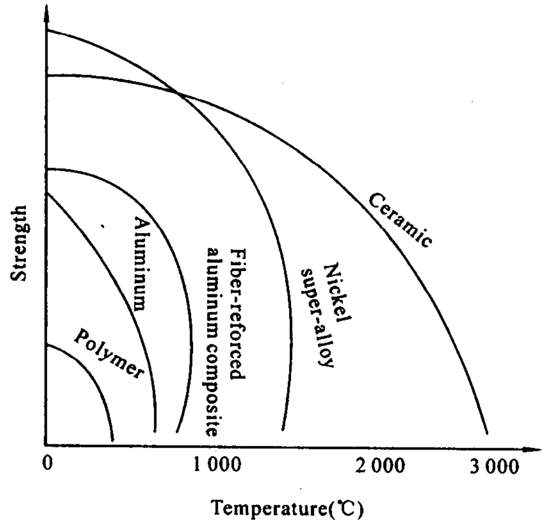

Fig. 3-1 Increasing temperature normally reduces the strength of a material

Polymers are suitable only at low temperatures. Some composites, special alloys, and ceramics have excellent properties at high temperatures.

Atmosphere Most metals and polymers react with oxygen or other gas, particularly at elevated temperatures. Metal and ceramics may catastrophically disintegrate or be chemically attacked while others may be protected. Polymers often are hardened or may even depolymerize, char, or burn[3]. Steels may react with hydrogen and become brittle.

Corrosion Metals are attacked by a variety of corrosive liquids. The metal may be uniformly or selectively consumed or may develop cracks or pits leading to premature failure. Ceramics can be attacked by other liquid ceramics, while solvents can dissolve polymers.

Radiation High-energy radiation, such as neutrons produced in nuclear reactors, can affect the internal structure of all materials, producing a loss of strength, embattlement, or critical alteration of physical properties. External dimensions may also change, causing swelling or even cracking.

Example 3-1

What precaution might have to be taken when joining titanium by a welding process?

Answer:

During welding, the titanium is heated to a high temperature. The high temperature may cause detrimental changes in the structure of the titanium; even eliminating some of the strengthening mechanisms which the obtained properties of the metal. Furthermore, titanium reacts rapidly with oxygen, hydrogen, and other gases at high temperatures. A welding process must supply a minimum of heat while protecting the metal from the surrounding atmosphere. Special gases, such as argon, or even a vacuum may be needed.

Table 3-1 Strength-to-weight ratio of various materials

Material	Strength (lb/in. 2) (lb/in. 2)	Density (in.)	Strength-to-weight-ratio
polyethylene	1 000	0.03	0.03 × 10
pure aluminum	5 500	0.098	0.07 × 10
pure copper	30 000	0.32	0.09 × 10
zinc-aluminum alloy	40 000	0.26	0.15 × 10
low-carbon steel	57 000	0.28	0.21 × 10
pure titanium	35 000	0.16	0.22 × 10
nylon	11 000	0.04	0.22 × 10
epoxy	15 000	0.05	0.28 × 10
high-carbon steel	39 000	0.28	0.32 × 10
heat-treated cube alloy	190 000	0.32	0.59 × 10
heat-treated magnesium alloy	40 000	0.32	0.63 × 10
heat treated alloy steel	240 000	0.28	0.86 × 10
heat-treated aluminum alloy	86 000	0.098	0.88 × 10
heat-treated titanium alloy	170 000	0.16	1.06 × 10
kevlar-epoxy	85 000	0.05	1.30 × 10