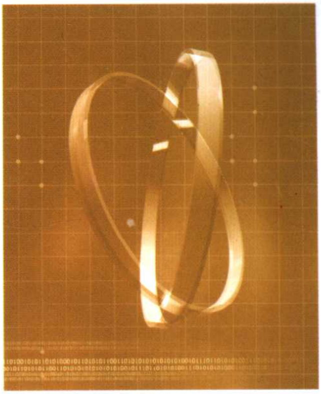

# 材料科学与工程专业英语

（第 3 版）

主编　刘爱国

# English in Material Science and Engineering

哈爾濱工業大學出版社

# 材料科学与工程专业英语

（第3版）

主编　刘爱国

主审　李洪涛　费维栋

哈爾濱工業大學出版社

# 内 容 提 要

本书是为提高从事材料科学与工程专业学习和研究人员的英语阅读能力而编写的。全书共分六部分:焊接工艺、铸造工艺、成型工艺、材料及热处理工艺、无机非金属材料及工艺以及一般科技英语。本书可作为有关专业的专业英语阅读教材,也可供有关人员阅读参考。

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# 前言(第3版)

本书是国家“九五”重点图书《材料科学与工程丛书》之一,是为材料科学与工程专业的三、四年级本科生而编写的专业英语教材。

编写本教材的目的是为了让本科生在经历了大学一、二年级的基础英语学习后,通过阅读本书,实现英语教学的不断线,使英语水平再上一个新台阶。

在第一、二版的基础上更新了焊接工艺部分,将焊接领域的新进展融入其中,同时,缩减了科技英语选读部分,强化本书的可读性。

本书选材新颖,覆盖面广,不仅包含了材料科学与工程领域的基础专业而且涉及除此之外的其他各学科的基础知识,从而开阔了学生的视野,丰富了学生的知识。

本书编排独具匠心,把一篇较长的文章分成若干段落,并在每段后提供了几个问题,供学生回答或讨论。这不仅有利于学生及时检查自己对文章的理解情况,还便于教师安排教学。书中用星号(*)把那些较生僻的词标在每个段落的后面并给出相应的汉语注释,以减少翻字典的次数,提高阅读效率。另外,文中的难句在段后进行了标注,这将更有助于学生对文章的理解。

本书由哈尔滨工业大学材料科学与工程学院刘爱国副教授主编,由崔成松、刘祖岩、张淑芝等人共同编写,由李洪涛,费维栋教授主审。因编者水平所限,错误之处在所难免,敬请批评指正。

编　者

2007年1月 于哈尔滨工业大学

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1

# Welding

## 1.1 Introduction to Welding Processes

### 1.1.1 Definition and Classification of Welding Processes

Welding is essential for the manufacture of a range of engineering components, which may vary from very large structures such as ships and bridges to miniature components for microelectronic applications.[1]

Several alternative definitions are used to describe a weld, for example:

> A union between two pieces of metal rendered* plastic or liquid by heat or pressure or both. A filler metal* with a melting temperature of the same order of that of the parent metal* may or may not be used.

or alternatively:

| |
|---|
| A localized coalescence* of metals or nonmetals produced either by heating the materials to the welding temperature, with or without the application of pressure, or by the application of pressure alone, with or without the use of a <u>filler metal</u>. |

Based on these definitions welding processes may be classified into those which rely on the application of pressure and those which used elevated temperatures to achieve the bond. The most important processes are shown in figure 1.1.

- Welding Processes
  - Fusion Welding
    - Shielded Metal Are
    - Gas Metal Arc
    - Gas Tungsten Arc
    - Plasma
    - Flux Cored Arc
    - Submerged Arc
    - Electron Beam
    - Laser
  - Welding with Pressure
    - Resistance Spot
    - Resistance Seam
    - Projection
    - Cold Pressure
    - Friction
    - Explosive
    - Diffusion Bonding
    - Magnetically Impelled Arc Butt

Figure 1.1 Important welding processes

Key words:

render [给予,提供]　　filler metal [填充金属]

parent metal [母材]　　coalescence [结合]

Note:

[1] 焊接在很多工程零部件的生产中都是必需的,大到船舶、桥梁,小到微电子应用的微小零件。

**Questions:**

1) A filler metal must be used in a welding process. (T/F)

2) Welding processes can be classified into two groups according to whether pressure is applied. (T/F)

### 1.1.2 Fusion Welding

The most widely used welding processes rely on fusion of the components at the joint line. In fusion welding*, a heat source melts the metal to form a bridge between the components.

A widely used heat source is electric arc, as shown in figure 1.2.

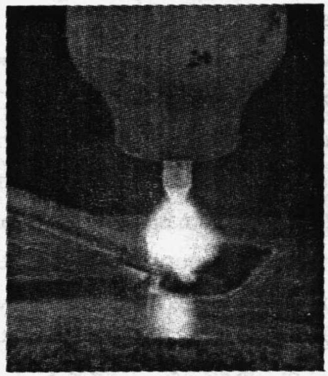

Figure 1.2 Welding arc

The molten metal must be protected from the atmosphere—absorption of oxygen and nitrogen leads to a poor quality weld. Air in the weld area can be replaced by a gas which does not contaminate the metal, or the weld can be covered with a flux*.

A large number of fusion welding* processes and techniques are available. No process is universally best. Each has its own special attributes and must be matched to the application. Choosing the most suitable process requires consideration of a number of factors, including type of metal, type of joint, material thickness, production constraints, equipment availability, labour availability, labour costs, costs of consumables, health, safety and the environment consideration.

Key words:

fusion welding [熔化焊]　　　　flux [焊剂]

### 1.1.2.1 Shielded Metal Arc Welding (SMAW)*

Shielded metal arc welding process, shown in figure 1.3, is also known as manual metal arc welding (MMA) in Europe.

Figure 1.3 Shielded metal arc welding

It has for many years been one of the most common techniques applied to the fabrication of steels. The process uses an arc as the heat source and shielding is provided by gases generated by the decomposition of the electrode* coating material and by the slag* produced by the melting of mineral constituents of the coating.[1] In addition to heating and melting the parent material the arc also melts the core of the electrode and thereby provides filler material for the joint*. The electrode coating may also be used as a source of alloying elements and additional filler material. The flux and electrode chemistry may be formulated to deposit wear- and corrosion-resistant layers for surface protection.

Significant features of the process are:

(1) equipment requirements are simple;

(2) a large range of consumables are available;

(3) the process is extremely portable;

(4) the operating efficiency is low;

(5) it is labour intensive.

For these reasons the process has been traditionally used in structural steel fabrication, shipbuilding and heavy engineering as well as for small batch production and maintenance.

Key words:
shielded metal arc welding (SMAW) [手工电弧焊]
electrode [焊条,电极]  slag [熔渣]  joint [接头]

Note:

[1] 该工艺采用电弧作为热源,由焊条药皮分解产生的气体和药皮中的矿物质成分熔化形成的熔渣提供保护。

**Questions:**

1) What are the features of the SMAW process?

2) How is the shielding realized in the SMAW process?

1.1.2.2 Gas Metal Arc Welding (GMAW)*

Gas metal arc welding, shown in figure 1.4 and figure 1.5, is also known as metal inert gas (MIG)* or metal active gas (MAG)* welding in Europe.

Figure 1.4 Gas Metal Arc Welding

Gas metal arc welding uses the heat generated by an electric arc to fuse the joint area. The arc is formed between the tip of a consumable*, continuously fed filler wire and the workpiece and the entire arc area is shielded by an inert gas. The principle of operation is illustrated in figure 1.6.

Some of the more important features of the process are summarized below:

(1) low heat input (compared with SMAW and SAW);

(2) continuous operation;

(3) high deposition rate;

(4) no heavy slag—reduced post-weld cleaning;

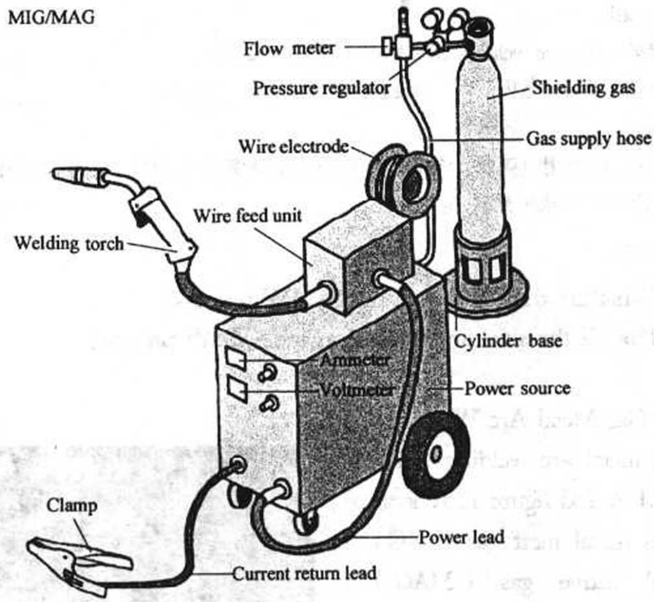


Figure 1.5 GMAW system

(5) low hydrogen—reduces risk of cold cracking.

Depending on the operating mode of the process it may be used at low currents for thin sheet or positional welding.

The process is used for joining plain carbon steel sheet from 0.5 to 2 mm thick in the following applications: automobile bodies, exhaust systems, storage tanks, tubular steel furniture, heating and ventilating ducts. The

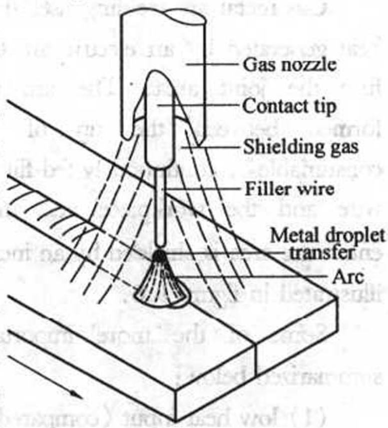


Figure 1.6 The operating principle of gas metal arc welding

process is applied to positional welding* of thick plain carbon and low alloy steels in the following areas: oil pipelines, marine structures and earth-moving equipment. At higher currents high deposition rates may be obtained and the process is used for downhand and horizontal-vertical welds in a wide range of materials—include earth-moving equipment, structural steelwork, weld surfacing with nickel or chromium alloys, aluminum alloy cryogenic vessels and military vehicles.

Key words:
gas metal arc welding (GMAW) [熔化极气体保护焊]
metal inert gas (MIG) welding [熔化极惰性气体保护焊]
metal active gas (MAG) welding [熔化极活性气体保护焊]
consumable [焊丝]
positional welding [全位置焊]

### 1.1.2.3 Gas Tungsten Arc Welding (GTAW)*

Gas tungsten arc welding, shown in figure 1.7, is also known as tungsten inert gas (TIG)* welding in most of Europe.

In the gas tungsten arc welding process the heat generated by an arc which is maintained between the workpiece and a non-consumable tungsten electrode is used to fuse the joint area. The arc is sustained in an inert gas which serves to protect the weld pool and the electrode from atmospheric contamination. The principle of operation is illustrated in figure 1.8.

The process has the following features:

(1) it is conducted in a chemically inert atmosphere;

(2) the arc energy density is relatively high;

(3) the process is very controllable;

(4) joint quality is usually high;

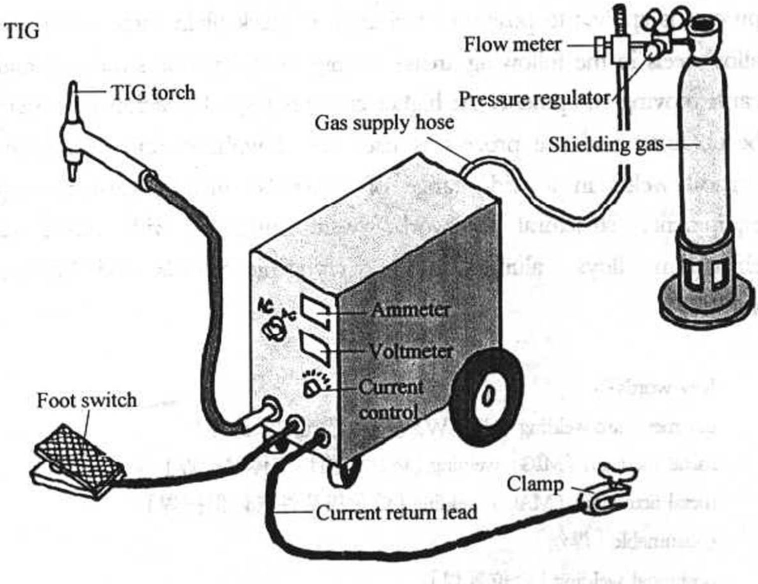


Figure 1.7 GTAW system

(5) deposition rates and joint completion rates are low.

The process may be applied to the joining of a wide range of engineering materials including stainless steel, aluminum alloys and reactive metals such as titanium. These features of the process lead to its widespread application in the aerospace, nuclear reprocessing and power generation industries as well as in the fabrication of chemical process plant, food processing and brewing equipment.

Key words:

gas tungsten arc welding (GTAW) [钨极惰性气体保护焊(钨极氩弧焊)]

tungsten inert gas (TIG) welding [钨极惰性气体保护焊(钨极氩弧焊)]

**Questions:**

1) What is the difference between GMAW process and GTAW process?

2) The GTAW process can be used to join titanium. (T/F)

### 1.1.2.4 Plasma Welding*

The arc used in TIG welding can be converted to a high energy jet by forcing it through a small hole in a nozzle. This constricts the arc and forms the plasma jet. Plasma welding uses the heat generated by the constricted arc to fuse the joint area, and the arc is formed between the tip of a non-consumable electrode and either the workpiece or the constricting nozzle, as shown in figure 1.9. A wide range of shielding gases are used depending on the mode of operation and the application.

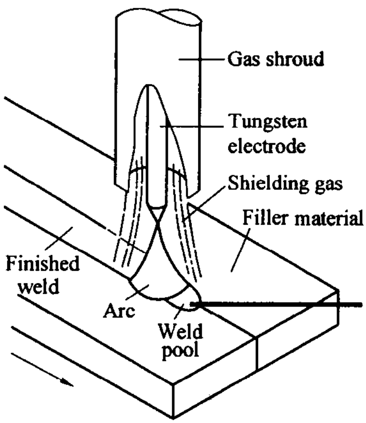


Figure 1.8 The operating principle of gas tungsten arc welding

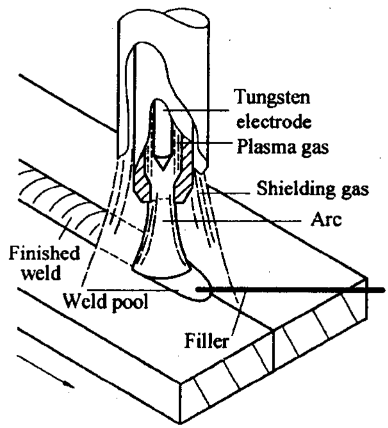


Figure 1.9 Plasma welding

In the normal transferred arc mode the arc is maintained between the electrode and the workpiece; the electrode is usually the cathode and the workpiece is connected to the positive side of the power supply. In this mode a high energy density is achieved and the process may be used effectively for welding.

Plasma welding relies on a special technique known as keyholing. First a hole is pierced through the joint by the plasma arc. As the torch is moved along the joint, metal melts at the front of the hole, swirls to the back and solidifies.

The features of the process depend on the operating mode and the current, but in summary the plasma process has the following characteristics:

(1) good low-current arc stability;

(2) improved directionality compared with TIG;

(3) improved melting efficiency compared with TIG;

(4) possibility of keyhole* welding.

These features of the process make it suitable for a range of applications including the joining of very thin materials, the encapsulation of electronic components and sensors, and high-speed longitudinal welds on strip and pipe.

Key words:

plasma welding [等离子焊]　　keyhole [匙孔,小孔]

**Questions:**

1) What are the relationship and differences between plasma welding and TIG welding?

2) A consumable electrode is used in plasma welding. (T/F)

### 1.1.2.5 Flux-cored Wire Welding (FCAW)

Flux-cored* wires consist of a metal outer sheath filled with a combination of mineral flux and metal powders, as shown in figure 1.10. The FCAW process is operated in a similar manner to GMAW welding and the principle is illustrated in figure 1.11. The

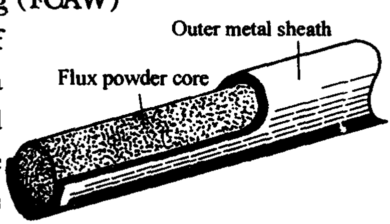


Figure 1.10 Construction of a flux-cored wire

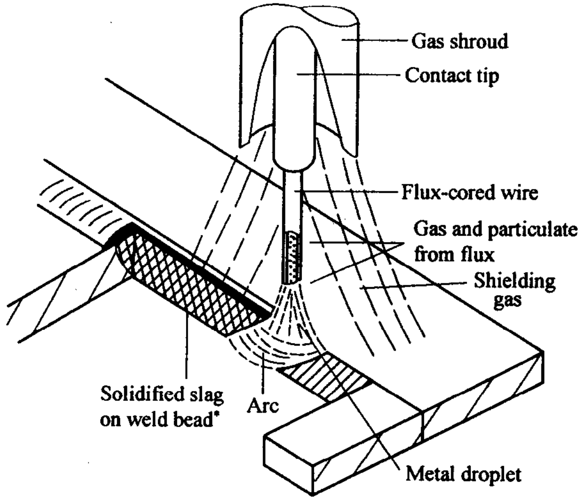


Figure 1.11 Principle of operation of FCAW

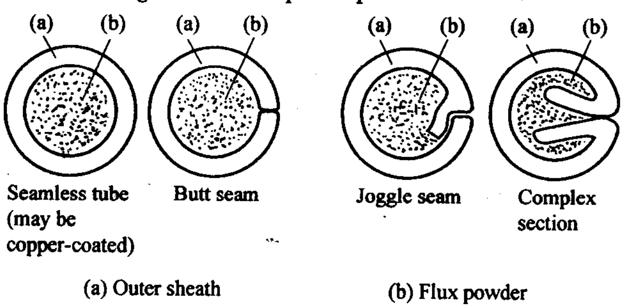


Figure 1.12 Alternative configurations of flux-cored wires

most common production technique used to produce the wire involves folding a thin metal strip into a U shape, filling it with the flux constituents, closing the U to form a circular section and reducing the diameter of the tube by drawing or rolling[1]. Alternative configurations, shown in figure 1.12, may be produced by lapping or folding the strip or the consumable may be made by filling a tube with