Materials Processing

Description

Materials processing is defined as the series of steps or "unit operations" used in the manufacture of raw-**materials** into finished goods. The operations involve a succession of industrial processes with various mechanical or chemical procedures, usually produced in large quantities or batches.

The purpose of cutting, forming, joining and surface processing of materials is to make products suit our needs.

Major Types Of Materials Processing

1. Material forming
2. Material cutting
3. Material joining
4. Material surface processing

Material Joining

Most Products consist of various components and hence joining becomes necessary. Joining can be categorized as permanent and semi-permanent.

(a) Permanent joining

Permanent joining is to join components firmly with fixed and inflexible form that makes it difficult for parts to be separated afterwards. Permanent joining has various forms such as metallic welding which includes electric arc welding, gas welding, soft soldering, hard soldering, riveting, seaming and gluing.

(i) Electric arc welding

Electric arc welding is to melt weld stick and metallic materials using energy emitted by electric arc to reach a permanent joining between metals (Fig. 1).

Joints formed by electric arc welding are very stiff since they are melted from metal (Fig. 2). Other merits of welding joints include high resistance to heat, time-saving and material-saving. Hence, electric arc welding is widely used in joining parts for cars, aircrafts and construction projects. However, the quality of welding joints may still be affected by factors such as welding stick materials, welding skills and oxides.

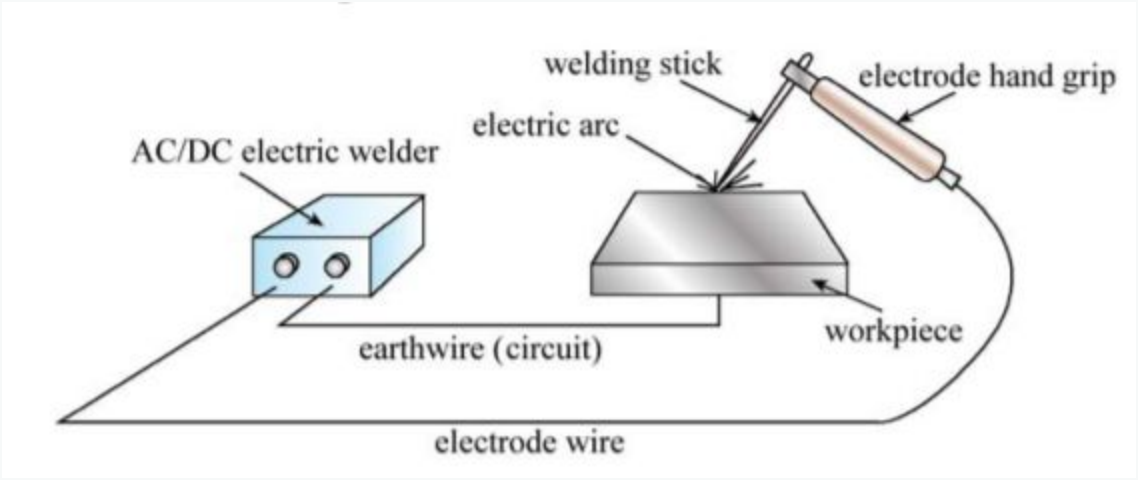

Fig 1

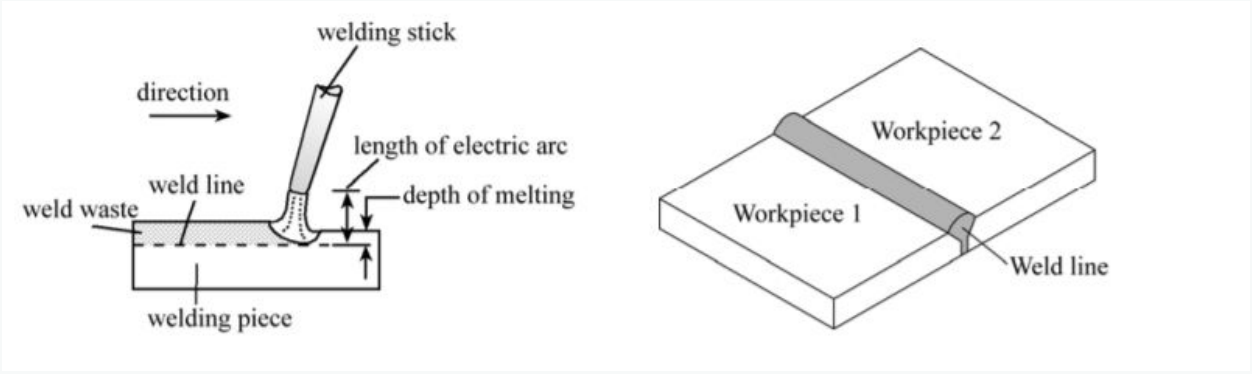

Fig 2

(ii) Gas welding

Gas welding Gas welding refers to the production of welding rod by melting welding stick and workpiece, using the flames produced by a mixture of oxygen and acetylene.

Properties of gas welding and electric welding are similar, but gas welding has lower operating temperature and hence is much easier to control(Fig 3). As a

result, this joining method is more preferable on meticulous work such as the joining of metallic sheets and pipes. Due to its cheaper devices, easy operation and convenience in transportation, gas welding is widely used.

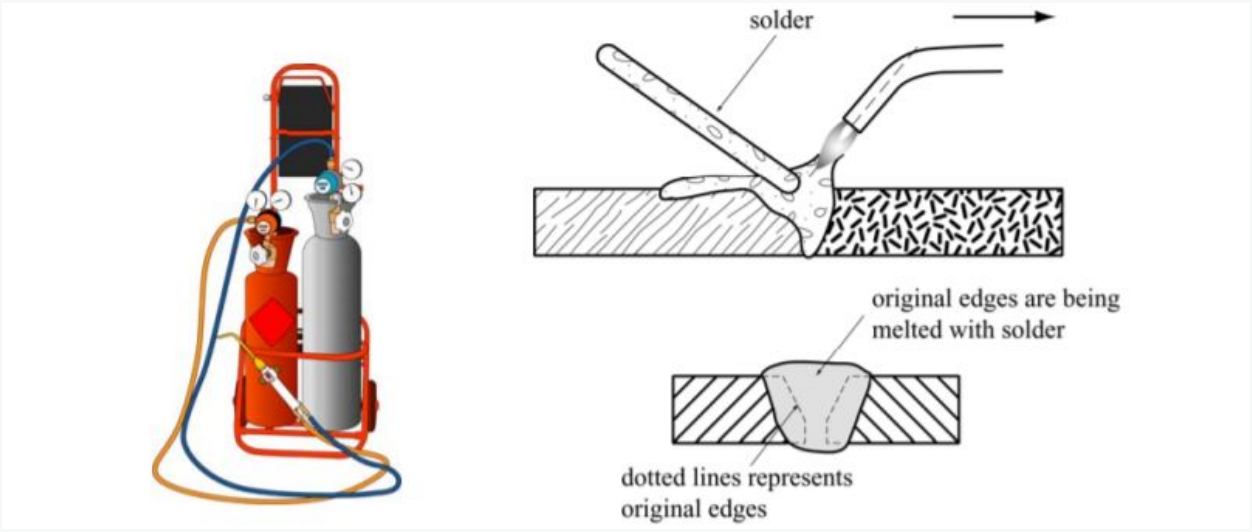

Fig 3

(iii) Soft soldering

Soft soldering is to produce welding joints by melting solder (e.g. aluminium) onto a workpiece under high temperature (Fig. 4). This is a common method of permanent joining for electronic circuits and putting high-temperature electric solder iron onto the junction point of wire with the melted solder. Since fluxes can melt oxides on metal surfaces, direct solder flow and clear workpiece surface, substances such as resin are usually added during soft soldering.

Fig 4

(iv) Hard soldering

Hard soldering is the method of joining metals by the use of alloy. Its joints are stiffer than soft soldering and it is generally applied to join steel workpieces. Fluxes are usually added in the process of soldering. Among various fluxes, borax is the most common one as it can smoothen soldering procedures by avoiding the formation and breakdown of oxides. Hard soldering is divided into two types, namely silver soldering and brazing.

Types of Soldering	Solders	Melting Points of Solders	Characteristics
Silver-soldering	Silver Solder (Copper + Zinc + Silver)	Lower Melting Point (600℃~630℃)	Firmer soldering effect; temperature needed is lower due to application on meticulous structure of ornaments.
Brazing	Brass Solder (Copper + Zinc)	Higher Melting Point (850℃~950℃)	Commonly applied to steel-made workpiece in industry, e.g. carbonized tips connecting to the front of cutting tools.

Table 1

(v) Riveting

Riveting is the technique of joining two or more workpieces together by rivets. There are various types of riveting for different uses. Metallic outer shells of cars, aircrafts and ships are all users of rivets (Fig. 5).

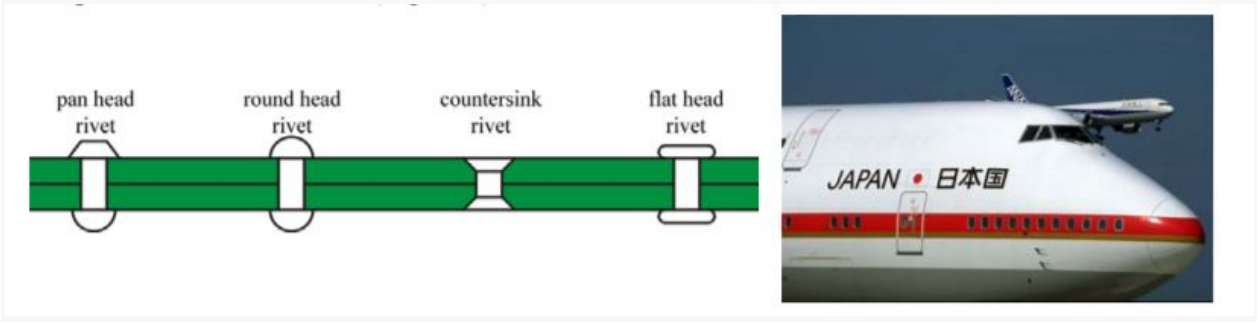

Fig 5

(vii) Seaming

Seaming is to join material edges together, for example, by folding a metallic sheet and linking the edges by welding. Seaming can be used to join two pieces of metallic sheets, the bottom of a can, etc. (Fig 6)

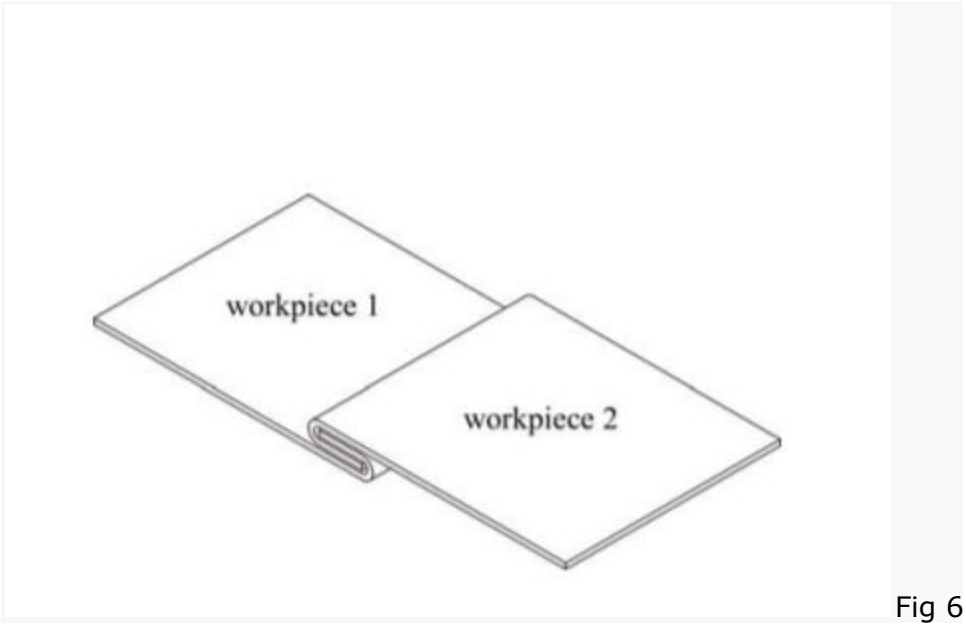

Fig 6

(viii) Gluing

Gluing is the technique of using adhesives to stick materials together. Most of the solid materials such as timber, plastics and metal can be joined by gluing. There are various types of adhesives, such as contact glue, all-purpose adhesive

and chloroform. Since adhesives usually carry great shearing force but poor tensile force, the joining surface of materials should be enlarged as much as possible to avoid easy tearing. Fig. 7 shows different gluing methods and their effects.

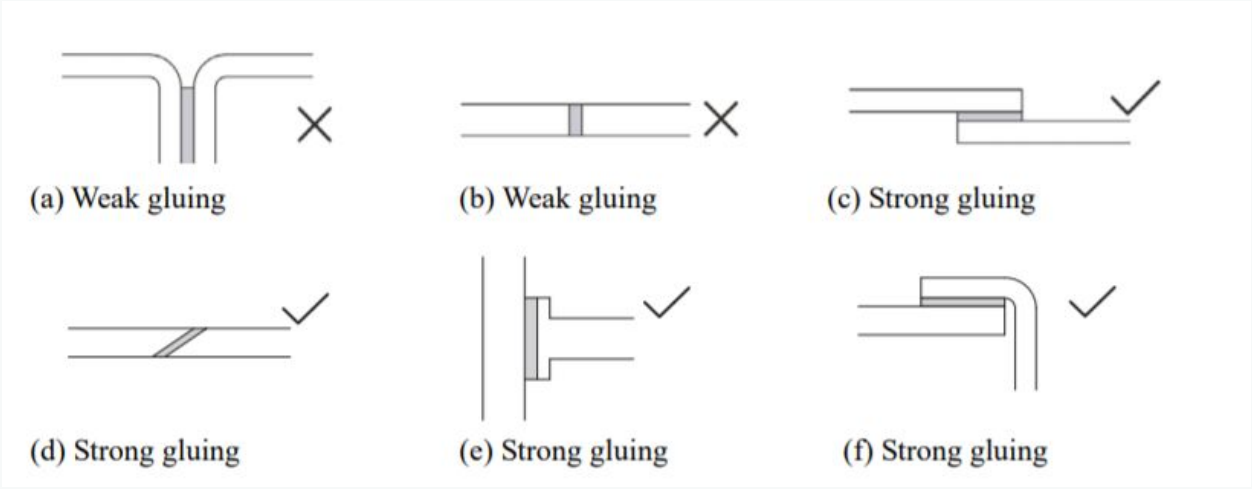

Fig 7

(b) Semi-permanent joining methods

Semi-permanent joining refers to joining in fixed shapes but easy separation afterwards. Methods of semi-permanent joining include screw thread joining and knock-down fitting.

(i) Screw thread joining

Screw thread joining is to use screws to join materials. When thread on a screw twists, screw bevels will generate a huge force which can tightly fasten two or more workpieces. This joining method can be used to fasten most of the materials such as metal, timber and plastics, for example, to hang a plastic sheet onto wooden materials. There are many types of screw components (Fig. 8). Table 2lists some of them.

Screw Components	Uses
Wood Screw	To fasten two wooden objects
Mechanical Screw	A widely used screw which has threads all over its body.
Machinery Screw	Mainly for fastening thicker workpieces of larger scale. Put the bolt through holes of two or more workpieces and fasten with a nut.
Set Screw	To fix two pieces of workpieces, e.g. to fix components on rotation axis of gears and propellers.
Stud	A tiny cylindrical rod with threads on its ends or its whole body.
Steel Screw	To press and produce threads on workpieces by using the firm and sharp threads on the body. Suitable for joining thin metals.
Anchor Screw	A screw set for hanging heavy objects onto the ceiling.

Table 2

(a) Mechanical screws (b) Machinery bolt

(c) Set screws (d) Stud

(e) Steel screws (f) Anchor screw

Fig 8

(c) Joining of different materials

Joining methods for different materials are similar to those of the same materials. However, collocation is different. For example, we may use stapler chips to fix leather or fabric onto wooden shelves when assembling sofa, and we may use bolts to install plastic handles onto cooking pots for insulation. Table 3 concludes joining methods for various materials.

Materials	Metal	Timber	Plastics	Fabrics/Leather	Concrete
Metal	/	A,B,R	A,B,R	/	B
Timber	A,B,R	/	A,B	S	B
Plastics	A,B,R	A,B	/	/	/
Fabrics/Leather	/	S	/	/	/
Concrete	B	B	/	/	/

Keys： A represents Adhesive gluing B represents Bolting
R represents Riveting and pop riveting S represents Stapler-gun chip joining

Table 3

Assignment

1, What are the complementing components for screws ant the different types
2, Which method can you use to join the following parts

- **Wood & Sheet metal**
- **Plastic and Metal sheet**
- **Plastic & plastic**