Low Temperature Joining Methods

• Brazing	A low melting point metal is melted, drawn into the space between two solid surfaces by capillary action and allowed to solidify.
• Soldering	A low melting point metal is melted, drawn into the space between two solid surfaces by capillary action and allowed to solidify.
• Adhesive Joining	Uses a polymeric resin which fills the space between the surfaces to be joined.

Brazing

- Heat --- joining of metals through heat
- Filler material, whose temperature > 425 °C, but less than the melting point of the base metal

Difference in welding and brazing:

1. composition of brazing alloy different from base metal
2. strength of the brazing alloy different from base metal
3. melting point of brazing alloy different from base metal
4. bonding requires capillary action

Advantages:

1. ideal for dissimilar metals (all metals can be joined)
2. quick and economical (less heat)
3. thinner and more complex assemblies can be joined successfully (temperature is less, little HAZ, less warping, distortion)
4. mass production of delicate assemblies (automation)

Disadvantages:

1. reheating of brazing material can cause the destruction of joint
2. low joint strength

Brazing joints: butt, scarf, lap, or shear

- strong metallurgical bond at the interfaces
- clean surfaces; good wetting (function of surface tension); good fluidity (function of filler metal, temperature)
- bind strength (function of material, processing, design, clearance)
- apply some pressure

Brazing metals:

- copper and its alloys
- silver and its alloys
- aluminum alloys

Fluxes: (e.g. borax)
role is:

- dissolving oxide that may be on the surface prior to heating
- prevent the formation of oxides during heating
- lowering the surface tension

Methods of brazing:

1. torch brazing - oxyacetylene or oxyhrogen or other gas flame (good for repair work)
2. furnace brazing - controlled atmosphere or vacuum, preload the brazing metal
3. salt bath brazing - parts are heated by dipping in bath of molten salt
4. dip brazing - assemblies are immersed in bath of molten brazing metal
5. induction brazing - high frequency induction current
6. resistance brazing - under pressure between two electrodes

Note: before application, the surface must be cleaned. Some flux are corrosive and must be removed after brazing.

Soldering

Soldering is a brazing-type operation where the filler metal has a melting temperature below 425 °C. bond strength is relatively low, the joining being the result of adhesion between the solder and the parent metal.

Solder metal:

- alloys of lead and tin
- tin-aluminum alloys are used in electric applications
- tin-zinc, cadnium-zinc, or aluminum-zinc is often used to solder aluminum
- lead-silver or cadnium silver --- high temperature application
- indium-tin alloys are used when joining metal to glass

Soldering fluxes:

- soldering fluxes are not intended to, and will not, remove any appreciable amount of contamination
- two types: corrosive (muriatic acid; mixture of Zn and ammonium chlorides, nickel, aluminum, copper, brass, zinc, steel) and non-corrosive (rosin in alcohol, aniline phosphate)

Heating for soldering:
Any method that is used for brazing can be used for soldering.

- furnace and salt-bath heating - seldom used
- dip soldering - for soldering wire ends, electronic work, automobile radiators and tinning
- induction heating - where identical parts are soldered

Design and strength of soldered joint:

- seldom develop shear strength in excess of 1.71 MPa
- never use butt joints
- hold together until solidification, otherwise full of cracks

Flux removal:

- to protect from corrosion
- for appearance

Adhesive Bonding

Potential areas:

- automobile industry
- aircraft industry

Adhesives:

- thermoplastics
- thermosetting resins
- artificial elastomers
- ceramics

Structural adhesives:
are composite systems with several components - liquids, pastes, solids, pellets, cartridges, tapes, or films.

Common adhesives:

1. epoxies
2. cyanoacrylates
3. anaerobics
4. acrylics
5. urethane or polyurethane
6. silicones
7. high-temperature adhesives
8. holt melts

Joint design and preparation:
two types:

1. continuous surface
2. core-to-face

Quality adhesive-bonded joint:

4 steps to obtain a quality joint:

1. cleaning
2. etching (to provide maximum wetting characteristics)
3. rinsing
4. drying

Advantages:

1. any material or combination or materials can be joined
2. very thin and quite delicate materials (e.g. foils) can be joined to each other or heavier sections
3. good load distribution and fatigue resistance (continuous bond)
4. smooth contours are also obtainable (no holes, rivets, bolts)
5. thermal and electrical insulation
6. cost savings (simplified machining, assembly, reduced finishing, elimination of mechanical fasteners, absence of high skilled labor)

Disadvantages:

1. most adhesive are not stable above 177 °C
2. it is difficult to determine quality of joint (with NDT methods)
3. surface preparation, adhesive preparation and curing are critical
4. life expectancy is hard to predict
5. assembly time greater (sometimes)
6. some contain objectionable chemicals