Description

Image



Image caption

(1) Soldering kit consisting of:
40 Watt Soldering iron, soldering iron stand and lead free solder © Oomlout at Wikimedia Commons (CC BY 2.0) (2) Soldering on PCB. © Tlapicka at Wikimedia Commons (CC BY 3.0) (3) Circuit board with solders © Blickpixel at Pixabay [Public domain]

The process

SOLDERING with lead-tin alloys has been practiced for at least 3000 years. It uses alloys that melt below 450 ℃. It can be thought of as low-temperature brazing, or - another analogy - as gluing with metal. Soldered joints are less strong than brazed joints - more like an adhesive - but the equipment needed to make them is simpler and the temperatures reached by the component are much lower, an essential for the assembly of electronic equipment. Soldering can be applied in the same way as braze, or - more like an adhesive - by pre-coating ('tinning') the metal surfaces to be joined before assembling and simply heating them with a torch, an electric soldering iron, or an array of infra-red lamps. In RE-FLOW SOLDERING, the components are heated by vapor from a boiling fluorinated hydrocarbon that condenses on components, releasing latent heat, and giving rapid, uniform heating. There are pressures to replace lead-based solders because of the potential toxicity of heavy metals, but viable alternatives are not yet widely available.

Process schematic

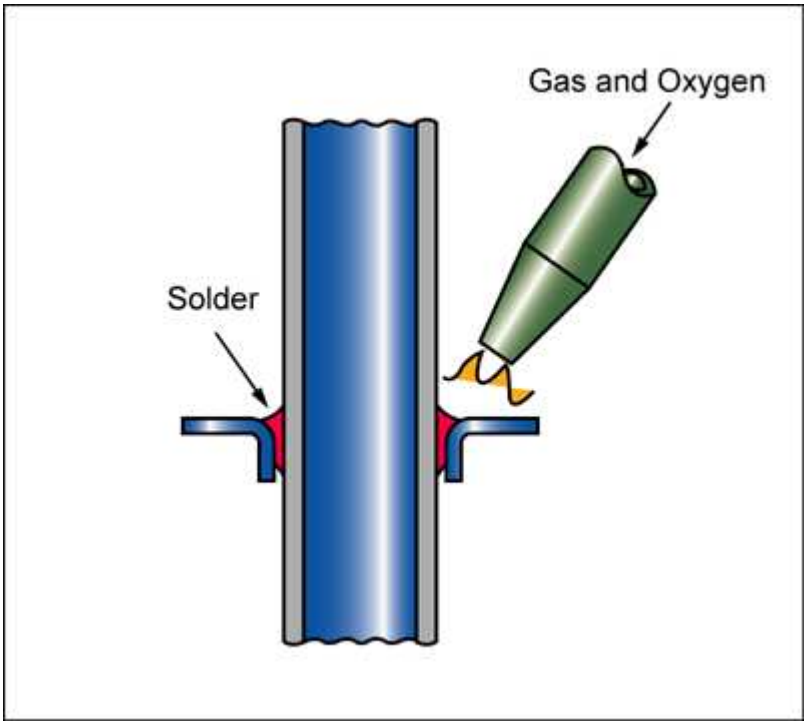

Figure caption

Soldering

Material compatibility

Metals - ferrous	✓
Metals - non-ferrous	✓

Function compatibility

Electrically conductive	✓
Thermally conductive	✓
Watertight/airtight	✓
Demountable	✓

Joint geometry compatibility

Lap	✓
Butt	✓
Sleeve	✓
Scarf	✓
Tee	✓

Load compatibility

Tension	✓
Compression	✓
Shear	✓
Bending	✓

Torsion	✓
Peeling	✓

Economic compatibility

Relative tooling cost	low
Relative equipment cost	low
Labor intensity	low

Physical and quality attributes

Range of section thickness	0.01 - 10 mm
Unequal thicknesses	✓
Processing temperature	180 - 245 ℃

Process characteristics

Discrete	✓
Continuous	✓

Supporting information

Design guidelines

Solders are electrical conductors - it is this that gives them their prominence in the electronics industry. From a mechanical viewpoint they are soft metals; it is the thinness of the soldered joint that gives it high tensile strength, but the shear strength is low (below 2 MPa) thus soldered joints should have an area large compared with the load-bearing section (as in lap or sleeve joints), or be given additional mechanical strength (as in locked lap joints). Solders can join dissimilar materials of very different thickness and size.

Technical notes

Solders are alloys of low melting temperature metals - lead, tin, zinc, bismuth, cadmium, indium. The lowest melting combination of any two metals is the "eutectic" composition; lead-tin solders for electrical connections have this composition (0.6 Sn, 0.4 Pb). Lead-tin solders for other applications range in composition from 0.2 - 0.6 Sn. Tin-antimony solders are used for electrical connection. Indium-tin solders are used for glass to metal joints. Lead-silver and cadmium-silver solders have useful strength above room temperature. Soldering requires fluxes. Some are merely solvents for grease, cleaning the surface: others are acids and must be removed after the joint is made or they cause trouble.

Typical uses

Solders are widely used to make electrical connections, to create printed circuit boards and attach logic chips to them, for domestic pipe-work, automobile radiators, precision parts in jewelry.

The economics

Like brazing, soldering is very flexible, allows high production rates, yet it is also economic when only one or a few products are wanted. The cost of both the equipment and the tooling are low, and no great skills are required.

The environment

Now we come to it. Heavy metals - lead and cadmium in particular - have a bad eco-reputation. There is mounting pressure to replace them. Alternatives are emerging, but they cost more and are harder to use.

Links

MaterialUniverse

Reference