

Copper and copper alloys and their weldability

Copper and copper alloys are often chosen because of their corrosion resistance and electrical and thermal conductivity. This introduction identifies the various types of copper alloys and gives information about the production process of these materials and their weldability.

Material types

Copper and copper alloys are grouped to their principal alloying element:

- C** Pure copper
- CH** Copper with small alloy additions
- CZ** Copper-zinc / brass
- NS** Copper-zinc-nickel / nickel silver
- PB** Copper-tinbronze (phosphor bronze alloys also contain phosphorous in their alloy)
 - G** Copper-tin-zinc, gun metal (some alloys contain lead)
- CA** Copper-aluminium, aluminium bronze (most alloys also contain iron and nickel)
- CN** Copper-nickel, cupronickel

Pure Copper (C)

Is normally supplied in one of three forms i.e. oxygen bearing, phosphorous deoxidised copper, oxygen-free copper. For welding jobs, oxygen free and phosphorous deoxidised copper should be selected as they are more easily welded. TIG and MIG are the preferred welding processes; OAW and SMAW can be used for repair jobs on oxygen bearing tough pitch copper. In order to counteract the high thermal conductivity He and NO-based gases can be used as an alternative to argon.

Copper with small alloy additions (CH)

Grades with additions of sulphur and tellurium are considered as not weldable. Copper with small additions of chromium, zirconium or beryllium can be welded but with care.

Copper-zinc alloys / brass (CZ) - Copper-zinc-nickel / nickel silver (NS)

Brasses can be separated into two weldable groups, low zinc ($\leq 20\%Zn$) and high zinc (30 - 40%Zn). Nickel silvers contain 20 to 45%Zn and nickel to improve strength. The main problem in fusion welding these alloys is the volatilisation of the zinc, which results in white fumes of zinc oxide and weld metal porosity. Only low zinc brasses are considered suitable for fusion welding using TIG and MIG.

Bronzes - Tinbronze, Phosphor bronze (PB), Silicon bronze and gun metal (G)

Tinbronze contain between 1 and 10%Sn, phosphorbronze contains up to 10% phosphorous. Gunmetal is essentially a tinbronze with up to 5%Zn and may also have 5% lead. Silicon bronze contains typically 3% Si and 1% Mn and is the easiest to weld.

Bronzes are weldable using matching filler metals. Gas welding of phosphor bronzes is subject to porosity which can be avoided by using a higher level of deoxidants. Gun metal cannot be welded.

Aluminium bronze (CA)

There are two types of aluminium bronzes: single phase alloys containing between 5 and 10% aluminium, with a small amount of iron or nickel, and, two phase alloys containing up to 12% aluminium and about 5% iron with specific alloys containing Ni, Mn, Si. Gas shielded welding processes are preferred, TIG welding requires AC under Argon gas shielding or DC with a Helium gas.

Cupro-Nickels (CN)

Cupro-nickel alloys contain between 5 and 30% nickel with specific alloys having additions of iron and manganese; 90-10 and 70-30 (Cu-Ni) are commonly welded grades. These alloys are single phase and are weldable using inert gas processes and SMAW. A matching filler metal is normally used but 70-30 is often regarded as an universal filler metal for these alloys.