

Materials

Copper

Introduction

Copper is available in three main forms: 'Pure' Copper, Brass and Bronze. Other copper alloys are available including Aluminium Bronze, Cupronickel, Beryllium-Copper, Gunmetal and Nickel Silver. In general, copper and its alloys exhibit the following properties: good electrical and heat conductivity, moderate strength and ductility, and good corrosion resistance.

Copper

Copper types are normally divided into four main groups: High Conductivity Copper, Deoxidised Copper, Oxygen Free High Conductivity Copper and Free Machining Copper. The purity of copper can be increased by electrolysis to provide a 99.25 to 99.99% or higher copper content.

High Conductivity Copper

This is used primarily for electrical conducting components, and is used to set the standard against which other electrical grade materials are measured. This standard is called the International Annealed Copper Standard (IACS). The ductile properties of this material allow it to be drawn into wires of very small diameters. These wires can be easily bent into shape and cut to length, providing a high degree of flexibility. 'Pure' Copper's main uses are for electrical wiring, electronic printed circuits and electrical contacts.

Deoxidised copper

This is produced by adding phosphorus or boron, depending on the application. The resulting material does not suffer significantly from embrittlement when brazed or welded. This copper is used for the manufacture of tubing for central heating systems, heat exchangers and chemical plant equipment.

Oxygen Free High Conductivity Copper

This is produced to reduce the possibility of embrittlement by casting the material in a controlled environment.

Free Machining Copper

This is usually produced by adding sulphur to significantly improve the cutting properties of the material. Sometimes tellurium is added instead of sulphur, the resultant copper being preferred for deep hole drilling. Another element added to copper to improve the machining properties is lead.

Brass

Brasses contain between 58 and 90% copper and between 10 and 40% zinc. Brasses are used for decorative architectural products and for components that require extremely good resistance to corrosion. Brass exhibits superior machining properties and free-cutting brass sets the standard for all other materials to be compared against. For applications exposed to

chlorides, acidic and polluted conditions, arsenic can be added to restrict the dezincification (removal of zinc from brass), otherwise a brass with a zinc content below 15% or nickel silver should be used. Naval Brass is used for applications that are exposed to sea water; it contains between 58 and 64% copper, 1% tin and the remainder is zinc. The resulting alloys exhibit superior resistance to corrosion.

Bronze

Bronze contains between 3 and 8% tin for wrought products and up to 12% tin for cast products. Bronzes provide high corrosion resistance, good tensile and fatigue strengths and good wear resistance. The two main types produced are phosphor and aluminium bronze.

Phosphor Bronze

A small addition of phosphorus (0.03 to 0.25%) to bronze provides a large improvement in strength and wear resistance. Used predominately for aggressive applications that require excellent resistance to wear and corrosion, phosphor bronze is used for bearing applications, providing a coefficient of friction in the region of 0.2 when run against itself.

Aluminium Bronze

Copper alloyed with between 5 and 10% aluminium produces aluminium bronze which can be used for condenser tubes, high strength (400 to 700MPa) castings and forgings. The resulting alloys provide good corrosion resistance in applications that are exposed to sea water.

Other Alloys

Copper-Nickel

Copper-Nickel, or Cupronickel, contains from 29 to 75% copper and 25 to 68% nickel. These alloys provide very good corrosion resistance and also have bio-fouling resistance properties. They are used for marine and water handling applications, condenser tubes and silver coins.

Beryllium-Copper

This copper alloy, with between 1.7 and 2.0% beryllium content, provides a material that is non-magnetic and can be heat treated to provide a wide range of strength and stiffness properties. Prior to heat treatment, it is ductile and can be easily formed to shape. After heat treatment, its high strength properties (up to 1,300MPa) are utilised in products such as springs and non-sparking tools. The limited resource of beryllium is reflected in its high price and so its use is restricted to high performance applications, such as measuring instrument elements, plastic moulding dies and fatigue sensitive aircraft components.

Nickel-Silver

This alloy contains between 42 and 63% copper, between 6 and 19% nickel, with the balance zinc. The addition of nickel improves upon the corrosion resistance. The resulting alloy provides an attractive yellow-silver finish that promotes its use in decorative architectural products. Another application of these alloys is in the manufacture of springs that require good corrosion resistance.

Gunmetal

A copper alloy containing tin and zinc, gunmetal is generally used for castings for valve and centrifugal pump bodies and general purpose applications. It provides good corrosion resistance and strength properties for a moderate cost material. Components made of gunmetal are used as a fixing medium in the construction industry.

Internet Resources

The UK [Copper Development Association](#) (CDA) promotes the use of copper and its alloys. The website contains extensive technical information regarding copper and alloy compositions, designations and applications. There is also a link to the [Brass Section](#) of the CDA.

The [International Copper Association](#) (ICA) provides a copper information website to promote the use of copper and its alloys on a global scale.

The [European Copper Institute](#) is a joint venture between the ICA and ten Copper Development Associations of Europe (of which the UK CDA is one).

The [International Copper Study Group](#) acts as a forum for promotion of the copper industry products and services, and for publication of copper related information.