



Glossary of Terms

Copper

**Admiralty Brass** A nominal 70% Copper / 30% Zinc Brass with 1% Tin added to improve corrosion resistance.

**Alloy** A combination of two or more metals, or of metals and other elements. An alloy is formed by adding the 'alloying elements' to the 'parent' metal in the molten state. The parent metal usually accounts for more than 50% of the resultant mixture. Brass is an alloy of Copper and Zinc whilst Bronze is an alloy of Copper and Tin.

**Alpha Brass** A Brass whose microstructure consists only of the 'alpha phase' in which the Zinc is in solid solution within the Copper matrix. This occurs in the range from pure Copper to about 64% Copper - 36% Zinc. Alpha Brasses have good cold-working properties.

**Alpha-Beta Brass** A Brass containing over 36% Zinc, or with other additions, that has both alpha and beta phases present in its microstructure. *Related terms: Duplex Brass*

**Aluminium Bronze** Not true Bronzes as they contain no Tin, Aluminium Bronzes are alloys of Copper with 5 - 12% Aluminium, some having additions of Iron, Nickel, Manganese and Silicon. They are available in cast and wrought form with designations such as CA104, Defence Standard (NES) 83. Aluminium Bronzes combine high strength with excellent corrosion and shock resistance. Widely used for stressed components in corrosive environments they are, in particular applications, frequently technically sound, cost effective, alternatives to Stainless Steels and Nickel Alloys.

**Annealing** Full Annealing is a heat treatment process for fully softening Copper and Copper Alloys. It involves heating to 500-550°C and holding for an appropriate time. Partial annealing is used to leave some residual temper such as quarter hard or half hard.

**Architectural Bronze** A confusing, loose, but widely used term used to describe a number of brasses.

- Those, whose colour mimics that of Bronzes, that are used in architectural applications, such as decorative shop fittings, window frames, etc,
- The Manganese containing brass CZ136, which is also incorrectly called Manganese Bronze, is a High Tensile Duplex Brass which extrudes well and has a warm 'chocolate' colour.
- The term is also applied to Gilding Metals which have been chemically toned to give a 'bronze' finish. *Related terms: Manganese Bronze*

**Arsenical Brass** A 70% Copper/30% Zinc alpha brass that contains Arsenic, and frequently Aluminium. It has better corrosion resistance than cartridge brass, but similarly excellent forming properties.

**ASTM** The American Society for Testing and Materials. ASTM produces Standards for materials and test methods that are widely used other than in the USA.

**Beryllium Copper** Copper alloys with 1.5 to 2% Beryllium additions that have the highest strengths of all Copper Alloys by both heat treatment (solution treatment and age hardening) and cold working.

**Beta Brass** A brass with very high Zinc content. It will have a predominantly beta phase microstructure, be brittle and used only as a brazing filler alloy.

**Beta Phase** A phase in the microstructure of brasses that contain more than about 36% Zinc. Beta phase adversely affects the cold formability of brasses and hot working processes, such as hot stamping, are preferred. *Related terms: Alpha-Beta Brass, Duplex Brass*

**Blister Copper** Copper of about 98% purity obtained by 'converting' copper matte. *Related terms: Copper Matte, Converting Process*

**Brass** Any alloy of Copper and Zinc. *Related terms: Alpha Brass, Alpha-Beta Brass, Architectural Bronze, Cartridge Brass, Dezincification Resistant Brass, Duplex Brass*

**Bronze** Any alloy of Copper and Tin.

**Cartridge Brass** A 'straight' 70% Copper / 30% Zinc brass with excellent cold forming and deep-drawing properties. So called because it was originally used deep-draw cartridge cases it now has a wide range of industrial applications, particularly if severe deformation, such as spinning or flanging, is involved. Arsenical Brass may be preferred because of its superior corrosion resistance.

**Casting, Ingot Casting** The pouring of molten metal into a mould or die where it is allowed to solidify. When solidified, the resultant 'casting' takes on the shape and approximate dimensions of the mould.

Examples

- Ingot for forging or other hot working
- Intermediate uses include extrusion billets, slabs for rolling, forging blanks.
- End use: valve body.

**Cathode Copper, Copper Cathode** The Copper, of at least 99.9% purity, produced by electrolytic refining. It is the feedstock for melting most Copper alloys and their subsequent manufacturing processes.

**CEN** Comité Européen de Normalisation, aka European Committee for Standardisation. The body responsible for developing European Standards, often referred to as 'Euro-Norms or EN for short.

**Chalcocite** A Sulphide ore of Copper with the chemical formula  $Cu_2S$ . It is a highly valued ore since it approaches 80% Copper by weight.

**Chalcopyrite** An important ore of Copper. It is a Copper Iron Sulphite with the chemical formula  $CuFeS_2$ .

**Common Brass** A very widely used brass containing 63% Copper plus 37% Zinc. It is also known as CZ108, Basis Brass and 63/37 Yellow Brass. It can be hot or cold worked, has good ductility permitting cold heading of wire and rods and cold presswork but not deep drawing.

**Converting Process** The process which transforms Copper Matte into Blister Copper. By reacting the Matte with Oxygen enriched air and silica slags both the Iron and Sulphur are removed leaving Copper metal of 98% purity known as Blister Copper. *Related terms: Chalcopyrite*

**Copper Matte** The mixture of Copper and Iron Sulphides which is the feedstock to the Converting Process that turns Chalcopyrite ore into Blister Copper. *Related terms: Chalcopyrite, Converting Process, Matte*

**Copper-Nickel, Cupro-Nickel** Alloys of Copper and Nickel, with between 10% - 45% Nickel, and usually small quantities of Iron and Manganese. Copper Nickels have outstanding resistance to sea-water corrosion.

**Creep** The tendency of a metal to flow or deform permanently at under an applied load that is lower than its yield point. It is time and temperature dependent, the rate always increases with temperature.

**Deep Drawing** A cold deformation process that uses a punch and die to produce hollow cylindrical components with a high length to diameter ratio (such as cartridge cases). It imparts significant cold work to the work piece.

**DEFSTAN, DSTAN** Defence Standards

**Deoxidised Copper** Copper with a deoxidiser added to reduce Oxygen. Phosphorus is usually added but other elements such as boron or magnesium may be used. Welding and brazing properties are improved, but conductivity is somewhat impaired.

**Dezincification** The selective corrosion of the beta phase of Duplex Brass. The result is a Copper residue with a porous layer of Zinc Oxide.

**Dezincification Resistant Brass, DZR** Duplex Brass (CW602N, CZ132) that has an Arsenic addition and a special heat treatment to prevent dezincification by soft, acidic, domestic water supplies. Sometimes the term is applied to Arsenical, Aluminium or Admiralty Brasses that also have Arsenic additions. These alloys need no special heat treatment as no beta phase is present.

**DGS** Director General Ships. An obsolete prefix for British Naval material standards, in turn became NES (Naval Engineering Standards), in turn replaced by DSTAN or DEFSTAN (Defence Standards).

**DIN** The prefix for German National Standards, also the German National Standards Organisation.

**Drawing** A process carried out at room temperature where extrusion is pulled through a die to improve tolerances, surface finish and mechanical properties.

**DTD** Director of Technical Development. The prefix for material standards used by the British Army, RAF and other defence applications.

**Ductility** The ability of a metal or alloy to deform without cracking or failing under tensile loads. Materials with low ductility exhibit brittle behaviour and fail at more modest loads. *Related terms: Malleability*

**Duplex Brass** Brasses with composition ranging from 58% to 62% Copper with 38% to 42% Zinc that have both alpha and beta phases present in their microstructure. Duplex Brasses are superior to Alpha Brasses for hot working, but inferior for cold working.

**Element** A pure chemical substance that consists of just one type of atom as defined by its atomic number (the number of protons in its nucleus). Elements combine to make compounds, e.g. Copper Sulphate which contains Copper, Sulphur and Oxygen. An Alloy, e.g. Brass, is a solid solution of two or more elements.

**EN** Euro Norm, European Standard.

**Engraving Brass** CW612N / CZ120 Brass formulated to be best suited for engraving - For example of nameplates and pet's collar identity discs.

**ETP** Electrolytic Tough Pitch, high conductivity, Copper, CW004A (C101).

**Extrusion** The process in which a preheated billet is constrained within a strong container in a press and then pushed by a ram through a shaped die.

The product, also called an extrusion, has the shape of the die along its whole length. Angles, rectangles, rounds and hexagons are common shapes of extruded bar, whilst tubes are frequently hollow extrusions.

With Copper Alloys, extrusion is very often followed by cold drawing to improve tolerances, surface finish and mechanical properties.

**Feedstock** A semi-finished material that is used to 'feed' the next process. For example continuously cast billet is the feedstock for extrusion and continuously cast rod or bar may be the feedstock for wire making.

**Flotation** A mineral beneficiation technique used to concentrate ore by blowing air through a tank in which ore particles are suspended in water that contains additions that make the ore more hydrophilic. The ore clings to the bubbles and is scraped off as 'froth'.

**Free Machining, Free Cutting, High Speed Machining** Terms that are used interchangeably to describe materials that can be turned, drilled or otherwise machined using high cutting speeds and feeds to leave a good surface finish with low tool wear and no appreciable build-up of swarf around the cutting tool.

The addition of Lead to Copper alloys usually improves machinability. The brass CW614N (CZ121 Pb3) has one of the fastest rates of metal removal, but ductility is compromised. This brass sets the machinability standard against which the machinability of all other alloys are measured.

**Gliding Metals** Alpha Brasses with 80% to 90% Copper content and no other alloying constituents apart from Zinc.

They have good ductility and are easily brazed or enamelled. They are used for decorative purposes such as jewellery and architectural hardware.

**Gunmetal** A Casting Bronze alloy of Copper with Tin (10%) and Zinc (2%). Historically it was used to cast cannons so it is sometimes called Admiralty Gun Metal.

It has excellent corrosion resistance in seawater and steam. Leaded Gunmetal containing slightly less Tin, more Zinc and up to 7% Lead is a very useful plain bearing metal.

**Heat Treatable Alloy** The description applied specifically to a Copper Alloy whose mechanical properties can be increased by heat treatment, typically solution treatment and age hardening e.g. for Beryllium Copper. *Related terms: Beryllium Copper, Heat Treatment of Copper and its Alloys*

**Heat Treatment of Copper and its Alloys** A range of heat treatment processes are applied to copper and its alloys including

- Homogenising
- Annealing

- Stress Relieving
- Solution Treatment and Ageing
- Quench and Temper Hardening

It is important to recognise that not all processes are appropriate for all alloys.

Homogenising in which prolonged soaking at elevated temperature is used to reduce solidification chemical segregation in castings particularly in Phosphor Bronzes, Copper Nickels and Silicon Bronzes that have long freezing ranges.

Annealing is used to soften and increase ductility and toughness in wrought alloys.

Stress relieving is used to relieve internal stresses without significantly affecting mechanical properties.

Solution Treatment and Ageing is used on Beryllium Copper, Copper/Chromium, Copper /Zirconium and Copper/Nickel/Silicon/Chromium alloys to increase mechanical properties.

Quench and Temper Hardening is applied to certain Aluminium Bronzes, Nickel Aluminium Bronzes and some cast Manganese Bronzes to increase their mechanical properties.

**High Tensile Brasses** An important group of brasses whose strength has been increased by modifications to their chemical composition by additions of Iron, Nickel, Manganese and/or Aluminium. Aluminium or Tin additions also improve corrosion resistance, Silicon additions are beneficial to wear properties.

**IACS** International Annealed Copper Standard - a measure of electrical conductivity agreed in 1913 with "pure" Copper set as 100%. Advances in copper refining mean that now the pure Copper can attain 103% IACS. The minimum requirement for High Conductivity Copper now is 101% IACS.

**ISO** The International Standards Organisation responsible for the ISO range of standards.

**Machinability** An important, but difficult to quantify, property of a material.

It relates to the ease by which material can be removed from a work-piece by a cutting tool, in turning, drilling, shaping or milling, etc., to leave a satisfactory surface finish. Materials with good machinability permit fast cutting speeds, high feeds with low tool wear and produce a bright, smooth surface. Free Machining Brass CW614N (CZ121 Pb3) has one of the fastest rates of metal removal and sets the machinability standard against which the machinability of all other alloys are measured.

**Malleability** The ability of a metal to deform into a useful shape, without breaking or cracking, under a compressive load. It is therefore the analogue of ductility which measures these effects in tension. A ductile material is invariably malleable and, hence, ductility and malleability are, incorrectly, often used interchangeably. Malleability is improved by annealing.

**Manganese Bronze** A frequently, but incorrectly, used term to describe the duplex, high tensile, Brasses (e.g. CW721R / CZ114) that contain Manganese.

**Matte** The mixture of Copper and Iron Sulphides produced by smelting the concentrated ore

**Mega Pascals** The SI unit for measuring the strength of a material and is abbreviated to MPa. Numerically it is exactly equivalent to Newtons/square millimetre (N/mm<sup>2</sup> or Nmm<sup>-2</sup>).

An approximate, rule of thumb, conversion to the Imperial measure of ton/in<sup>2</sup> is: 1 ton/in<sup>2</sup>. = 15 MPa.

**MIL** The prefix given to U.S. military specifications.

**Naval Brass** A nominal 62% Copper / 37% Zinc Brass that has a 1% Tin addition to improve its corrosion resistance in marine environments.

**NES** The prefix for the, now obsolete, Naval Engineering Standards. It replaced DGS and in turn was replaced by Defence Standards. *Related terms: DGS*

**Nickel Silver** Copper, Nickel and Zinc alloys. Their Copper content is similar to that of Brasses but up to 20% of the Zinc is replaced by Nickel.

Silvery white in colour they have good corrosion resistance and remain "springy" at moderate temperatures.

**Noble** A term used to indicate the corrosion resistance, or the lack of it, of a material.

If metals are listed in order of their general corrosion resistance, most resistant at the top and going down to the least at the bottom, the higher a metal is in the list the more "noble" it is said to be.

When two different metals are connected in a corrosive environment then the least "noble" will be attacked preferentially. This effect can be used to protect structures from corrosion by using a "sacrificial anode" of a less noble metal.

**Ore** A mineral that contains a metal, in combination with other elements, which is mined as a source of that metal. *Related terms: Chalcocite, Chalcopyrite*

**Patina** The greenish layer that naturally develops on Copper exposed to the atmosphere. Chemically it is a complex mixture of Chlorides, Carbonates and Sulphides.

Pre-patinated sheet is used for roofing applications.

**Phosphor Bronze, Leaded Phosphor Bronze** Hard and strong cast and wrought Copper/Tin alloys with small, deliberate, Phosphorus additions.

Wrought alloys such as PB102 contain 4% to 8% Tin, whilst cast alloys contain 9% to 12% Tin.

Leaded Phosphor Bronzes, with Lead contents up to 20% ,are usually available only as castings – Examples are PB1 and SAE660.

**Refining** The further purification of Blister Copper by removal of its Oxygen content and recovery of any rare or precious metals that were present in the ore by either:

- a) fire refining in a furnace
- b) electrolytic refining, in which the blister Copper is cast into anodes, suspended in an acid solution and deposited on to plates at the cathode by electrolysis.

**Riveting Brass** CW606N / CZ131 Brass formulated to be most suitable for riveting.

**SAE, SAE600** The US Society of Automobile Engineers -the body that develops standards and specifications for the U.S. motor industry.

The value and applicability of SAE standards is widely appreciated and they are now used in other industries and countries. For example, Cast Leaded Gunmetal to specification SAE660 is popular in the UK.

**Season Cracking** So called because it was first observed, in the rainy season in India, on deep drawn 70/30 brass cartridge cases that had been stored in horse stables where the atmosphere contained Ammonia. *Related terms: Stress Corrosion*

**Smelting** A stage in the extraction of Copper from its ores. The ore concentrate is melted, with a flux, in a reverberatory furnace to produce Copper Matte, a mixture of Copper and Iron Sulphides that contains 30% to 40% Copper. *Related terms: Copper Matte, Matte*

**Solid Solution** If alloying elements are retained in the lattice of the parent metal instead of forming a different phase they are said to be in solid solution.

Alloys which that are multi-phase at room temperature can usually be made single phase by heating to a suitable temperature below the melting point, by holding at this temperature, then quenching in water, oil or cold air. The alloying element(s) have been taken into solid solution by the heating and retained there by the rapid cooling. They can be precipitated out by heating again, to a lower temperature, a process called ageing. The two stages are a useful heat treatment cycle for many alloys including Beryllium Copper.

**Stamping Brass, Hot Stamping Brass** CW617N / CZ122 Brass formulated to be most suitable for hot stamping.

**Stress Corrosion** Stress Corrosion is the rapid and often abrupt failure of a normally ductile metal or alloy caused by residual or other stresses in the work-piece and in the presence of specific corroding agents. It is temperature dependent.

Alpha Brasses are susceptible in atmospheres that contain Ammonia. The effect can be mitigated to some extent by a stress relieving heat treatment but, if the service conditions pose any risk of stress corrosion, an alternative alloy such as Aluminium Bronze is preferred.

**Temper** A term used to describe the degree of work hardening in a cold worked, usually rolled, material. The range is from "fully annealed" to "fully hard".

For Alpha Brasses the intermediate quarter hard or half hard tempers are usually achieved by temper annealing fully hard material. Copper sheet and strip can be given the correct temper by temper rolling, starting with fully annealed material. *Related terms: Annealing*

**Tough Pitch Copper** An obsolete term for Copper that has been cast with a deliberate Oxygen addition (typically 0.01 % - 0.05%) to improve electrical conductivity.

The metal may have first been either the electrolytically or fire refined.

**Work Hardening** The process of increasing the strength and hardness of a metal or alloy by cold deformation e.g. cold rolling, deep drawing, cold forging, hammering or cold extrusion.

Work-hardening is sometimes referred to as 'cold work'.

**Wrought Product** A product that has shaped, after casting, by either hot or cold deformation by rolling, forging or extrusion.

## CONTACT

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