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PRODUCT DATA SHEET

Electrolytic Tough Pitch Copper (ETP Copper) Alloy 110 UNS C11000

Copper Alloys

Composition, AS2738.2-1984 Copper 99.90+%, oxygen by agreement, usually 0.04%

Equivalent Alloy Specifications

Specification	Designation
UNS	C11000
BSI	C101
JIS	C 1100
ISO	Cu-ETP

Australian Standard Product Specifications

(Other product specifications available on enquiry)

Specification	Product Form
AS1566	Rolled flat products
AS1567	Wrought rods, bars & sections
AS1568	Forging stock & forgings
AS1569	Seamless tubes for heat exchangers
AS1571	Seamless tubes for air conditioning & refrigeration
AS1572	Seamless tubes for engineering purposes

ASTM Product Specifications

Specification	Title
B5	High Conductivity Tough Pitch Copper Refinery Shapes
B124	Copper and Copper Alloy Forging Rod, Bar, and Shapes
B152	Copper Sheet, Strip, Plate, and Rolled Bar
B187	Copper Bar, Bus Bar, Rod and Shapes
B188	Seamless Copper Bus Pipe and Tube
B283	Copper and Copper Alloy Die Forgings (Hot Pressed)
B447	Welded Copper Tube
B577	Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper
B694	Clad Alloy Steel (CAS) Sheet and Strip for Electrical Cable Shielding

Mechanical Properties

(AS1566, Sheet & Strip)

Property	Units	Temper		
		Annealed* (soft)	Half hard	Hard
Tensile Strength, min	MPa	210*	245	310
Elongation, min	%	40*	10	7
Hardness	HV	55 max*	75 - 90	90 - 115

Notes: 1. Properties marked * are typical, for information only
2. Other tempers are available for sufficient quantity on request

Finish Annealed or cold rolled to temper.

Available Forms Austral Wright Metals can supply this alloy in sheet, strip, coil, plate, circles, bar, sections, wire.

General Description Electrolytic tough pitch (ETP) copper, alloy 110, has excellent ductility and high electrical and thermal conductivity, higher than for any other copper metal except oxygen free grades such as C10200. The electrical conductivity is at least 100% IACS ($0.5800 \mu\text{ohm}^{-1} \cdot \text{cm}^{-1}$) and is often as high as 101.5% IACS. Electrical and heat exchanger uses are common.

The dominant use of this alloy is in electrical conductors. It is also used widely for gaskets, switches, terminals and connectors, transformers, electronic parts, ball floats, drawn and spun holloware.

The technical advice and recommendations made in this Product Data Sheet should not be relied or acted upon without conducting your own further investigations, including corrosion exposure tests where needed. Please consult current editions of standards for design properties.

Austral Wright Metals assumes no liability in connection with the information in this Product Data Sheet.

PHYSICAL PROPERTIES

<u>Property</u>	<u>Metric Units</u>	<u>Imperial Units</u>
Melting Point (Liquidus)	1083°C	1981°F
Melting Point (Solidus, eutectic)	1065°C	1950°F
Density	8.89 gm/cm ³ @ 20°C	0.301 lb/in ³ @ 68°F
Specific Gravity	8.89	8.89
Coefficient of Thermal Expansion	17.7 x 10 ⁻⁶ /°K (20 - 300°C)	9.8 x 10 ⁻⁵ /°F (68 - 572°F)
Thermal Conductivity	388 W/m.°K @ 20°C	224 BTU/ft ³ /ft/hr/°F @ 68°F
Thermal Capacity (Specific Heat)	385 J/kg.°K @ 20°C	0.092 BTU/lb/°F @ 68°F
Electrical Resistivity (Annealed) 68°F	1.724 microhm.cm @ 20°C	10.3 ohms (circ mil/ft) @ 68°F
Electrical Conductivity (Annealed)	0.58 – 0.59 microhm ⁻¹ .cm ⁻¹ @ 20°C	100.0 – 101.5 % IACS @ 68°F
Modulus of Elasticity (tension)	115 GPa	17 x 10 ⁶ psi
Modulus of Rigidity (shear)	44 GPa	6.4 x 10 ⁶ psi
Poisson's Ratio	0.33	0.33

FABRICATING PROPERTIES

Cold Working Capacity	Excellent
Hot Working Capacity	Excellent
Hot Forging Rating	65% of forging brass
Hot Working Temperature	750-875°C
Annealing Temperature	375-650°C
Machinability Rating	20% of free

JOINING PROPERTIES

Soldering	Excellent
Brazing	Good
Oxy-Acetylene Welding	Not recommended
Carbon Arc Welding	Fair
Gas Shielded Arc Welding (GTAW/TIG, GMAW/MIG)	Fair
Coated Metal Arc Welding (Manual electrodes)	Not recommended
Resistance Welding	Not recommended

CORROSION RESISTANCE

C11000 has excellent corrosion resistance to weathering and very good resistance to many chemicals. It is often used specifically for corrosion resistance. It is suitable for use with most waters, and can be used underground because it resists soil corrosion. It resists non-oxidising mineral and organic acids, caustic solutions and saline solutions.

Depending on concentration and specific conditions of exposure, copper generally resists:

Acids: mineral acids such as hydrochloric and sulphuric acids; organic acids such as acetic acid (including acetates and vinegar), carbolic, citric, formic, oxalic, tartaric and fatty acids; acidic solutions containing sulphur, such as the sulphurous acid and sulphite solutions used in pulp mills.

Alkalies: fused sodium and potassium hydroxide; concentrated and dilute caustic solutions.

Salt solutions: aluminium chloride, aluminium sulphate, calcium chloride, copper sulphate, sodium carbonate, sodium nitrate, sodium sulphate, zinc sulphate.

Waters: all potable waters, many industrial and mine waters, seawater and brackish water.

Other media: The corrosion resistance of C11000 is not adequate for: ammonia, amines and ammonium salts; oxidizing acids such as chromic and nitric acids and their salts; ferric chloride; persulphates and perchlorates; mercury and mercury salts. Copper may also corrode in aerated non oxidising acids such as sulphuric and acetic acids, although it is practically immune from these acids if air is completely excluded. Copper is not suitable for use with acetylene, which can react to form an acetylide which is explosive. C11000 is considered to be immune to stress corrosion cracking in ammonia and the similar media which cause season cracking in brass and other copper alloys. Consult Austral Wright Metals for your specific application.

WELDING

C11000 contains about 0.04% oxygen, as cuprous oxide. This intentional residue reduces the adverse effect on electrical conductivity of traces of impurity metals. The internal oxide renders the alloy subject to hydrogen embrittlement if heated in reducing atmospheres above about 370°C (dull red heat). C11000 is therefore unsuitable for gas welding and high temperature brazing. Oxygen free copper, C10200, or the deoxidised alloy C12200 is preferred where welding is required.

EFFECT OF COLD WORK ON MECHANICAL PROPERTIES

Copper in the annealed condition is among the most ductile of the engineering metals. Cold work, either cold rolling or deformation in fabrication, leads to rapid work hardening. The tempered grades of copper are produced by cold work, and the commercially pure coppers cannot be hardened by heat treatment.

Change of mechanical properties with cold reduction by rolling.

