

1. Product Overview

C11000 (ETP - electrolytic tough pitch copper) is the highest-purity, highest-conductivity commercial wrought copper grade. It contains $\geq 99.90\%$ Cu with a controlled oxygen content of 0.02-0.05%, present as finely dispersed cuprous oxide (Cu_2O) particles that provide dispersion strengthening without significantly reducing conductivity. C11000 is the reference material for the International Annealed Copper Standard (IACS = 100% conductivity). It is supplied as sheet, plate, strip, bar, rod, wire, busbar, sections and forgings, in annealed, half-hard or hard tempers. Its excellent electrical and thermal performance, good corrosion resistance and cold formability make it the standard choice for electrical conductors, transformers, switchgear, electronics and architectural applications.

1.1 Key Features

- Highest-conductivity commercial copper - the IACS 100% reference standard.
- Oxygen-strengthened microstructure - slightly higher strength than oxygen-free grades.
- Excellent cold workability: deep-drawing, stamping, bending, heading.
- Superior electrical and thermal performance for power, signal and heat transfer.
- Lead-free chemistry verified to NSF/ANSI 61 & 372 for potable water contact.
- Full heat-lot traceability with EN 10204 3.1 / 3.2 mill test certificates.
- Third-party inspection (SGS, BV, TUV) available on request.

1.2 Typical Applications

Application	Description
Electrical	Busbars, conductors, terminals, switchgear, transformer windings
Electronics	PCB traces, lead frames, connectors, contacts
Power transmission	Trolley wire, distribution cable, winding wire
Heat transfer	Heat-exchanger fins, radiator cores, cooling fins
Architecture	Roofing, flashing, gutters, domes, spires, façades
Decorative	Furniture, hardware, art, signage, trim
Industrial	Gaskets, fasteners, stamped and deep-drawn parts
Plumbing (note)	Not recommended for brazed/soldered tubes in reducing atmosphere

1.3 At-a-Glance Specification

Attribute	Value
UNS designation	C11000 (ETP)
Cu content	≥ 99.90% (incl. Ag)
O content	0.02 – 0.05% (typical ~0.04%)
Product forms	Sheet, plate, strip, bar, rod, wire, busbar, sections
Tempers	O (annealed), 1/4H, 1/2H, 3/4H, H (hard)
Density	8.89 g/cm ³ (0.321 lb/in ³)
Conductivity	≥ 100% IACS (annealed)
Melting range	1 065 – 1 083 °C
Max service temp.	200 °C continuous (200 °C air, <400 °C in H ₂)
Surface finish	Bright, mill, brushed / polished
Certificates	MTC EN 10204 3.1 / 3.2, SGS, BV, TUV
Lead-free	NSF/ANSI 61 + 372 compliant
MOQ	500 kg per specification

Composition limits conform to ASTM B152 / B187. Exact limits may vary slightly by product form and standard.

2. Chemical Composition & Standards

C11000 is electrolytically refined tough-pitch copper: cathode copper melted and cast with a controlled oxygen content of 0.02-0.05%, present as fine Cu₂O particles. The Cu₂O dispersion provides strengthening without significantly reducing conductivity - this alloy defines the IACS 100% reference conductivity. Unlike deoxidized grades (e.g. C12200 DHP), no phosphorus is added; the residual oxygen is beneficial for electrical and atmospheric service but creates a risk of hydrogen embrittlement when the material is heated above ~400 °C in a hydrogen-containing or reducing atmosphere.

2.1 Chemical Composition (wt%)

Element	Symbol	Content (% mass)	Note
Copper (incl. Ag)	Cu	≥ 99.90	Balance / matrix
Oxygen	O	0.02 – 0.05	ETP dispersion strengthener
Phosphorus	P	≤ 0.003	Not intentionally added
Lead	Pb	≤ 0.005	NSF/ANSI 372 limit
Iron	Fe	≤ 0.005	Trace
Nickel (incl. Co)	Ni	≤ 0.005	Trace
Zinc	Zn	≤ 0.005	Trace
Antimony	Sb	≤ 0.002	Trace
Arsenic	As	≤ 0.002	Trace
Total other impurities	—	≤ 0.03	Combined residual

Composition limits conform to ASTM B152/B187. Oxygen content is characteristic of ETP grade; exact limits may vary slightly by product form and standard. Verify against MTC.

2.2 Applicable Standards by Product Form

Product form	Common standards
Sheet / Plate / Strip	ASTM B152; EN 1172 / 1652; JIS H3100; GB/T 2040 / 2059
Bar / Rod / Section	ASTM B124, B187; EN 12163 / 12165 / 12167; JIS H3250; GB/T 4423
Wire	ASTM B1 (hard) / B2 (med) / B3 (annealed); GB/T 21652
Busbars	ASTM B187; IEC 60289 / GB/T 5585.1
Forgings / Shapes	ASTM B124
Tube (general)	Not recommended for brazed plumbing; use C12200 DHP

2.3 ETP vs DHP Comparison

Property	C11000 ETP	C12200 DHP
Oxygen content	0.02-0.05%	< 10 ppm (deoxidized)
Hydrogen embrittlement	Risk in H ₂ atmosphere	Immune
Typical conductivity	≥ 100% IACS	≥ 85% IACS
Brazing / gas welding	Requires deoxidized filler	Excellent
Strength (same temper)	Slightly higher	Lower
Plumbing tube	Not for brazed plumbing	Lead-free certified
Best for	Busbar, wire, roofing	Tube, deep-drawn parts

3. Physical, Thermal & Electrical Properties

The values below are typical room-temperature properties for C11000 in the annealed condition. C11000 is the IACS reference copper - its annealed electrical conductivity defines 100% IACS. Values are representative of all wrought product forms; slight differences may occur between sheet, bar and wire due to cold-work level and texture.

Property	Symbol	Value	Unit
Density	ρ	8.89	g/cm ³
Melting point (liquidus)	—	1 083	°C
Melting point (solidus)	—	1 065	°C
Specific heat capacity	cp	0.385	J/(g·K)
Thermal conductivity	λ	391	W/(m·K)
Thermal expansion coeff.	α	17.0	× 10 ⁻⁶ / K
Electrical conductivity	σ	≥ 100	% IACS
Electrical resistivity	ρ	0.0172	μΩ·m
Modulus of elasticity	E	117	GPa
Shear modulus	G	44	GPa
Poisson's ratio	ν	0.33	—
Magnetic permeability	μ	≈ 1.0	non-magnetic
Max continuous service temp.	—	200	°C (air)

Sources: ASTM B152/B187 property tables; CDA Alloy Data Sheet C11000; typical annealed values at 20 °C unless noted.

4. Mechanical Properties by Temper

Mechanical properties vary with temper and product form. The table below summarizes typical values for wrought C11000 sheet, plate, bar and wire per ASTM B152 / B187. ETP copper is slightly stronger than deoxidized grades (e.g. C12200) at the same temper due to Cu₂O dispersion strengthening. Exact limits should be verified against the relevant material certificate for each order.

Temper	Tensile (min)	Yield (min)	Elongation (min)	Hardness (typ.)
O (annealed)	≥ 220 MPa	≥ 69 MPa	≥ 45%	40-50 HRF
1/4 Hard (H01)	250-290 MPa	≥ 205 MPa	≥ 25%	65-75 HRF
1/2 Hard (H02)	275-325 MPa	≥ 240 MPa	≥ 15%	70-80 HRF
3/4 Hard (H03)	290-350 MPa	≥ 250 MPa	≥ 12%	80-90 HRF
Hard (H04)	325-385 MPa	≥ 270 MPa	≥ 6%	85-95 HRF

Note: Wire tempers per ASTM B1/B2/B3 use different designation ranges (hard / medium-hard / soft). Hardness values are indicative only; verify against ASTM B152 / B187 specification limits.

5. Product Forms & Size Range

Gnee Metal supplies C11000 in the common wrought forms listed below. Custom dimensions, cut lengths, edge conditioning and surface finishes are available on request.

5.1 Product Forms

Product form	Typical size range	Common surface / edges
Sheet / Plate	Thick. 0.2 – 50 mm; width ≤ 1 500 mm	Mill, bright, brushed, polished, PVC one/both sides
Strip / Coil	Thick. 0.05 – 3.0 mm; width ≤ 600 mm	Bright, mill, slit edges, oscillate wound
Round bar / rod	Dia. 3 – 120 mm; length 1 – 6 m	Peeled, polished, ground
Flat bar / busbar	Thick. 3 – 25 mm; width 20 – 200 mm	Mill, punched, radius/chamfer edges
Wire	Dia. 0.1 – 8.0 mm; coil / spool	Bright, annealed, hard-drawn
Sections / Forgings	Custom profiles to drawing	Mill, machined, finished

5.2 Packaging

- Sheets / strips: interleaved paper + wooden pallet + steel strapping + corner guards.
- Bars / rods: bundled with steel straps, oiled if required, packed in crates or pallets.
- Coils: eye-to-sky on wooden pallets with moisture-proof wrapping.
- Wire: spools / coils wrapped in PE, palletized for export shipment.

6. Tolerances, Finish & Quality Control

Dimensional verification is performed on each production lot in accordance with the governing ASTM / EN / JIS standard. For C11000, electrical conductivity testing is mandatory on every lot because conductivity is the primary specification criterion. Test certificates report measured values and confirm compliance with the ordered specification.

6.1 Dimensional Tolerances

Parameter	Typical tolerance class
Sheet / plate thickness	± 0.03 – 0.30 mm per ASTM B152 / EN 1172
Strip width	± 0.10 – 0.50 mm per slit-edge requirements
Bar diameter / width	± 0.05 – 0.30 mm per ASTM B187 / EN 12163
Busbar thickness / width	± 0.10 – 0.50 mm per ASTM B187
Wire diameter	± 0.5 – 2% of nominal per ASTM B1/B2/B3
Length	± 5 – 25 mm or custom-cut to drawing
Straightness	≤ 1 mm per metre, or as agreed

6.2 Surface Finish & Cleanliness

- Smooth, bright metallic surface free from cracks, slivers, burrs, dents and deep scratches.
- Optional finishes: bright-annealed (BA), mill, brushed, polished or passivated.
- Electrical conductor surfaces are free of insulating oxides that could raise contact resistance.
- Surface cleanliness meets ISO 16232 for critical oil & grease residue limits.

6.3 Quality Control Test List

Test	Standard / method	Frequency
Chemical analysis	ASTM E478 / ICP-OES	Each heat
Electrical conductivity	ASTM B193 / E100 (% IACS)	Each lot (mandatory)
Tensile / elongation	ASTM E8 / E8M	Each lot
Rockwell hardness	ASTM E18	Each coil / batch
Hydrogen embrittlement	ASTM B577 / B776	On request
Dimension & ovality	Calipers / micrometers / CMM	Each lot
Surface cleanliness	ISO 16232	Each lot

7. Corrosion Resistance & Service Conditions

C11000 offers excellent corrosion resistance in natural waters, atmospheric exposure, neutral saline solutions and many industrial chemicals. The key limitation compared to deoxidized grades is hydrogen embrittlement: when heated above ~400 °C in a hydrogen-containing or reducing atmosphere, the dispersed Cu₂O reacts with hydrogen to form steam, which causes blistering and internal cracking.

7.1 Suitable Environments

- Atmospheric exposure: rural, urban, industrial and marine climates (excellent).
- Potable water (cold service; lead-free per NSF/ANSI 61 & 372).
- Soils with neutral pH and low sulfide / chloride content.
- Most organic acids, alcohols and neutral salt solutions.
- Refrigerants and HVAC working fluids (R410A, R32, R134a compatible).

7.2 Design Considerations

- Avoid exposure to hydrogen or reducing atmospheres above 400 °C - $\text{Cu} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O}$ (steam) causes blistering and cracking (hydrogen embrittlement).
- For brazed / soldered joints and gas-welded assemblies, use C12200 DHP (deoxidized) instead of C11000.
- Avoid direct galvanic coupling with aluminium, steel or stainless steel without isolation.
- Avoid continuous contact with ammonia, amines, mercury or strong oxidizing acids.
- For electrical conductor applications, ensure adequate cross-section to limit temperature rise per IEC / IEEE standards.

7.3 Maximum Service Temperature

200 °C continuous is generally accepted for C11000 in pressure / structural applications in air. For electrical conductors, the insulation class (e.g. 105 °C / 150 °C) often governs. Avoid hydrogen-containing atmospheres above 400 °C; if elevated-temperature reducing-atmosphere service is required, select an oxygen-free or deoxidized grade instead.

8. About Gnee Metal

Gnee Metal is a trusted supplier of copper and copper-alloy products for export markets. Our ISO 9001 / 14001 / 45001 certified plants serve customers in North America, Europe, the Middle East and Southeast Asia with C11000 sheets, bars, strips, busbars, wire and custom-machined components.

We provide project-specific mill test certificates (EN 10204 3.1 / 3.2), third-party inspection by SGS / BV / TÜV, and value-added services including precision cutting, surface finishing, edge conditioning and technical consultation. Contact us for a quote or for help selecting the right temper and specification for your application.

Item	Detail
Website	chinacopperalloys.com
Email	sales@gneemetal.com
Certificates	ISO 9001 / ISO 14001 / ISO 45001
Third-party	SGS, Bureau Veritas, TÜV