

Pure copper **OF-Cu** (Cu-OFE) alloy 0110

OF-Cu is a pure, oxygen-pure copper, melted from selected cathodes under an inert gas atmosphere, without the use of deoxidising agents. Therefore, OF-Cu is practically free of elements that are volatile in a vacuum. It has the highest conductivity or lowest resistance of all copper materials. OF-Cu is hydrogen resistant and can be processed in reducing atmospheres. The material passes the scale adhesion test according to ASTM F 68 for metal-glass joints. The residual resistance ratio RRR from room temperature 293 K to the temperature of boiling helium 4.2 K is at least 400. OF-Cu is suitable for low-temperature applications.

ZOLLERN brand	OF-Cu
EN designation	Cu-OFE
EN material no:	CW009A

EN 13604:2013 for vacuum technology
EN 12420:1999 (CW008A Forging)
EN 13601:2013 (CW008A Profiles)

// National designations / ISO

DIN	OF-Cu
DIN	2.0040
ISO	Cu-OFE
USA	C10100
GB	OFHC BS3839
F	Cu-c2

// Composition weight by per cent in %

Cu	Ag	As,Mn,Pb	Bi,Se,Te	Cd,Zn
min. 99.99	max. 0.0025	max. 0.0005	max. 0.00020	max. 0.0001
Fe,Ni	S	Sb	Sn	O
max. 0.0010	max. 0.0015	max. 0.0004	max. 0.0002	max. 0.0005 ¹⁾

¹⁾The oxygen content shall be adjusted to comply with the hydrogen resistance requirements of EN 1976.

// Strength properties at room temperature

(minimum values)				
[1] EN 12420:1999 !!! (like CW008A) [2] EN 13601:2013 (as CW008A) [2] Values also for forged parts	R _{p0.2} N/mm ²	R _m N/mm ²	A ₅ %	HB
[1] Forgings and die-forged parts (F20)	40	200	35	45
[2] Soft (F20)	<120	200	35	35 - 65
Medium hard (F22)	160	220 ²⁾	18	65 - 90 ³⁾
Hard (F25) (up to Ø 120 mm)	220	250 ²⁾	12	75 - 100 ³⁾

²⁾ Deviating from standard EN 13601 10 N/mm² lower

³⁾ Hardness values may deviate slightly +/- 10 HB

// Physical properties

Density at 20 °C	8.90 kg/dm ³
Melting temperature/range	1083°C
Coefficient of linear expansion	
from -191 ° to 16°C	14.1 x 10 ⁻⁶ °C ⁻¹
from 20° to 100°C	16.8 x 10 ⁻⁶ °C ⁻¹
from 20° to 200°C	17.3 x 10 ⁻⁶ °C ⁻¹
from 20° to 300°C	17.7 x 10 ⁻⁶ °C ⁻¹
Specific heat capacity at 20°C	0.386 J/g x °C
Thermal conductivity at 20°C	3.94 W/cm x°C
at 100°C	3.85 W/cm x°C
at 200°C	3.81 W/cm x°C
at 300°C	3.77 W/cm x°C

Electr. conductivity at 20°C (with higher strength from F22)	> 58.6 MS/m > 101 % IACS > 57.0 MS/m > 98 % IACS
--	---

Electr. resistance at 20°C	(F20) < 0.01707 Ω mm ² /m
----------------------------	--------------------------------------

Temperature coefficient of the electrical resistance at 20°C (valid from -100 to 200°C)	0.00393 °C ⁻¹
---	--------------------------

Permeability μ	< 1.01
----------------	--------

Young's modulus at 20°C	cold formed 130 KN/mm ² annealed 110 KN/mm ²
-------------------------	---

// Dynamic strength values at room temperature (reference values)

Rotational bending fatigue strength R _{bw} at 20 x 10 ⁶ load cycles	70 N/mm ²
---	----------------------

Notched impact energy (ISO - V/KV)	130 joules
------------------------------------	------------

Pure copper **OF-Cu** (Cu-0FE) alloy 0110

OF-Cu is a pure, oxygen-pure copper, melted from selected cathodes under an inert gas atmosphere, without the use of deoxidising agents. Therefore, OF-Cu is practically free of elements that are volatile in a vacuum. It has the highest conductivity or lowest resistance of all copper materials. OF-Cu is hydrogen resistant and can be processed in reducing atmospheres. The material passes the scale adhesion test according to ASTM F 68 for metal-glass joints. The residual resistance ratio RRR from room temperature 293 K to the temperature of boiling helium 4.2 K is at least 400. OF-Cu is suitable for low-temperature applications.

Application examples

Due to its high purity, high electrical conductivity and freedom from elements that are volatile in a vacuum,

OF-Cu is used for the production of

- sockets for vacuum interrupters,
- radio and television transmitter tubes as well as for other high-frequency tubes.
- parts for high vacuum technology and low-temperature applications (cryogenics).
- accelerator tubes made of several segments soldered together,
- klystrons,
- beam stoppers in accelerator facilities for elementary particle research.
- parts for glass-metal connections.
- heat exchangers, cooling elements and crucibles for vacuum processes.
- production of superconductors and high-performance transmission cables.
- parts that operate at elevated temperatures in reducing hydrogen atmosphere.
- anodes for electroplating.

Machinability

OF-Cu has very good hot and cold formability.

All common types of semi-finished products such as bars, bushings, rings or open-die and drop forgings can be produced. The machinability in the soft state is classified as moderate to poor, as long flow chips form due to the high toughness of the material.

Cold forming achieves a hardness of up to over 100 HB for thin rods or tubes, and 65-90 HB for forgings, depending on the cross-section and shape of the part. From a wall thickness of approximately 120 mm, the core areas are softer after strain hardening.

Relaxation annealing 150 – 250°C

Soft annealing 250 - 500°C

Temperature range for hot forming 750 – 950°C

Machinability moderate to difficult to machine, (long flow chips are formed)

Soft soldering very good

Brazing good (preferably inert gas brazing)

Welding Due to the high thermal conductivity preheating up to approx. 600 °C is necessary for larger pieces, no danger of hydrogen brittleness. Electron beam welding is easily possible

Galvanisability good

