Oxygen-free copper for industrial applications

LUVATA

Pure, flexible, connective and unbeatable

Luvata is a pioneering company in the development and production of oxygen-free copper, which is the purest commercial copper grade. Its unique qualities of purity, conductivity, malleability and consistency make it the material of choice for many applications in the electrical, electronic, heat transfer and other industries.

Partnerships beyond metals
At Luvata we work together with our customers to find the most suitable and cost-effective oxygen-free copper solution for any given application. We call this approach 'Partnerships Beyond Metals' and it has helped countless customers to improve their efficiency and increase their bottom-line profits. We have successfully shortened manufacturing processes, reduced scrap and reduced costs by tailoring the most suitable oxygen-free copper solution for their needs.

A material for every application
In very special applications such as superconducting wires or laser mirrors, every detail matters. A minor defect in the copper may cause the loss of several days' or even weeks' work. For these applications our certified grade of oxygen-free copper is the answer. From electronics and printed circuit boards or wherever superior connectivity is needed, to the precise requirements of vacuum interrupters, X-ray tubes or scientific instruments, we know we have the oxygen-free copper products that can deliver consistently high quality time and time again.

Luvata OF-OK® Copper

Luvata's Oxygen-Free Copper was originally developed specifically for electrical, electronic and heat transfer applications. It is an extremely pure copper alloy, with a maximum oxygen content of 5 ppm (0.0005%) and has a unique combination of high-performance properties.

Electrical and Thermal conductivity
As a result of its purity, Luvata OF-OK® copper has high electrical conductivity (typically 101 – 102% IACS) and high thermal conductivity (390 W/Km). The higher conductivity values compared with other materials mean that equipment made of Luvata OF-OK® copper operates more efficiently and at lower temperatures, which increases their service life and reliability.

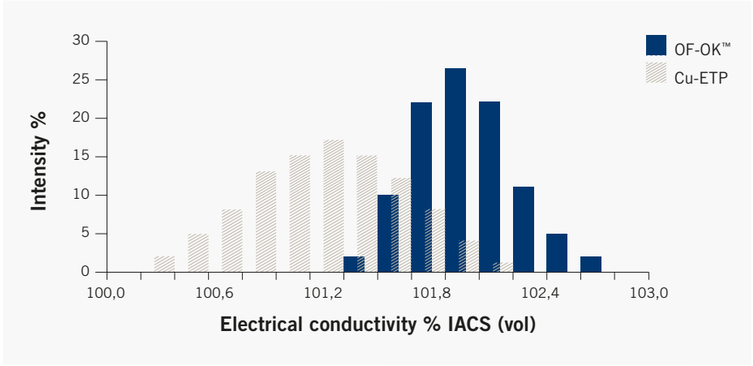


Diagram of electrical conductivity

Azipod propulsion

Azipod rotor

Luvata rods, bars and busbars

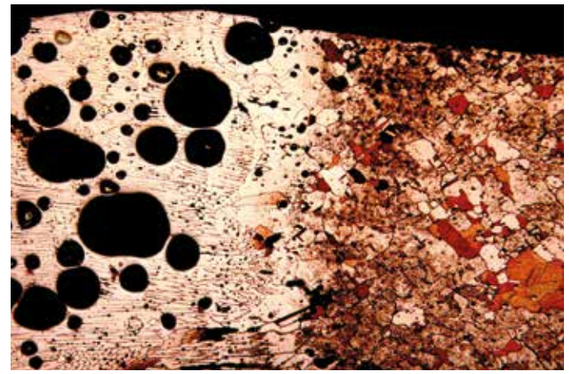
Immunity to Hydrogen embrittlement
At high temperature, hydrogen ions can diffuse into copper and form water with the oxygen atoms in the copper. The resulting water vapour has a high enough pressure to form pores in the copper. This is known as hydrogen embrittlement and it can occur when copper components are brazed or welded in a moist or a reducing atmosphere containing hydrogen. In commercial copper grades which usually contain 200-600 ppm (0.02-0.06%) of oxygen, the result is a completely brittle metal. In Luvata OF-OK® copper, we guarantee a maximum of 5 ppm (0.0005%) oxygen content, which makes it immune to hydrogen embrittlement and ensures safe joining with all brazing and welding methods.

Consistency
High quality raw materials, melting and casting in electric furnaces, and the strictly controlled manufacturing process used in manufacturing Luvata OF-OK®, guarantee that the material is consistent from the first to the last piece, and from batch to batch.

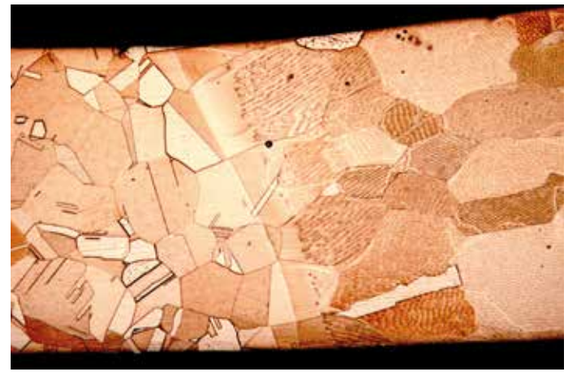
Consistency means less time consumed for machine set-up and less waste. By using silver bearing oxygen-free copper, alloying copper with a small amount of silver, its softening temperature can be increased significantly without compromising its high conductivity or formability. Silver bearing Luvata OF-OK® (Ag) is perfectly suited to commutators, generator rotor bars and welding components.

Applications
Luvata OF-OK® is the ideal material for a large number of applications:

– Rotor bars and stator winding for power generators
– Components for electrical equipment
– Coils for electrical magnets and induction furnaces
– Commutators
– Heat sinks for semiconductor bases

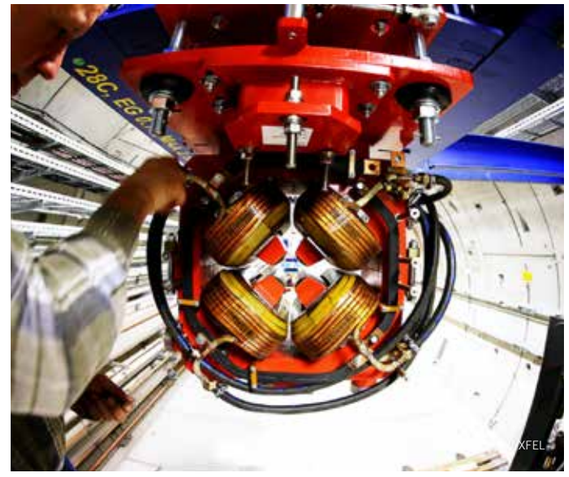


Hydrogen embrittlement in TIG welded, ETP



TIG welding seam in oxygen-free OF-OK® copper

Luvata hollow conductors



XFEL corrector quadropole

Luvata OFE-OK® Certified Grade Copper

In extreme environments such as those with high vacuums or cryogenic temperatures, even the smallest variations in the purity or properties of a material can make a big difference. Luvata's OFE-OK® oxygen-free electronic grade copper is tested at every stage of the manufacturing process, from selecting the raw material to signing the inspection certification. That is why we call it Certified Grade Copper.

Grain size measurement

Laser mirrors

A higher grade material for specialist applications
For the most demanding electronic, cryogenic and optical applications, a higher grade oxygen-free copper is needed. Luvata OFE-OK® copper is a high-purity copper grade with total impurities of less than 40 ppm (0.0040%), with no single impurity exceeding 25 ppm (0.0025%). OFE-OK® copper is manufactured, controlled and inspected separately from standard Luvata OF-OK® copper. For the certified grade, only specially selected cathode copper is used and every ingot is inspected to ensure compliance with ASTM F68 Oxygen-Free Copper in Wrought Forms for Electron Devices specification and other international specifications for OFE copper.

Vacuum Applications
Luvata OFE-OK® Certified Grade Copper has an extremely low content of highly volatile low melting elements such as Phosphorus (P), Lead (Pb), Sulphur (S), Zinc (Zn), Cadmium (Cd) and Mercury (Hg). In a number of vacuum applications in the electronic industry, glass is directly bonded to copper, requiring an adherent oxide film on the copper surface. This oxide film can be rendered non-adherent and brittle if phosphorus, which is often used as oxidant, is present. To prevent this, Luvata OFE-OK® contains less than 3 ppm (0.0003%) of phosphorus, and can be directly bonded to glass and ceramic materials. The low volatility and limited phosphorus content in Luvata OFE-OK® ensure the smooth functioning and long service life for vacuum components such as vacuum interrupters, X-ray tubes and radio transmitters.

Integrity
Luvata OFE-OK® is tested during all steps of the manufacturing process; casting, extrusion, drawing and once again at the end of the process to ensure the integrity of the material. Even small impurities or defects from extrusion may cause scattering of the beam from the optical component and cause rejection after a great deal of time and effort has been spent. Using OFE-OK® ensures the highest possible yield in the process.

All Luvata OFE-OK® copper carries a test certificate which guarantees that the impurities are below the specified limits, that electrical conductivity is at least 101.5% IACS and that the material integrity complies with the requirements of the most demanding applications.

Vacuum interrupter

X-ray tube

Cryogenic applications

Cryogenic Properties
At cryogenic temperatures, the electrical and thermal properties of Luvata OFE-OK® copper are superior to any other copper grade. With the high purity of Luvata OFE-OK® combined with the special thermal treatment in the manufacturing process, the RRR (Residual Resistance Ratio) value of Luvata OFE-OK® can be guaranteed minimum 400. With specific high purity copper grades even higher RRR values up to 2000 can be obtained.

Since RRR is very sensitive for common processing treatments and can be lost using unsuitable processing Luvata experts are pleased to advise the best thermomechanical treatment to meet the optimum RRR value in the final component. Unlike oxygen-containing copper alloys with high RRR values, Luvata OFE-OK® can readily be electron beam welded or annealed in a reducing atmosphere without the risk of hydrogen embrittlement.

Luvata also provide copper materials having RRR within specific range and alloyed copper grades with very low RRR value.

Luvata copper at work

Medical X-ray units

E-mobility

High-speed train

Wind electric power generators

Proton therapy (for cancer treatment)

Hydroelectric power generators

Solar panels

Weather radar

MRI scanners

High-voltage applications

CERN accelerator

Technical information

Alloys

Alloys	Luvata Alloy	Purity	EN	ASTM
Cu-OF	OF-OK®	99.95 min	CW008A	C10200 OF
Cu-OFE	OFE-OK®	99.99 min	CW009A	C10100 OFS, ASTM F68
CuAg0.04 (OF)	HK003	Cu + Ag min 99.98	CW017A	C10400 OFS
CuAg0.10 (OF)	HK015	Cu + Ag min 99.98	CW019A	C10700 OFS

Size range

Rods mm	Mill Length mm	Temper
3 – 25	3500 – 4000	hard, soft annealed
25 – 60	3500 – 4000	hard, soft annealed
50 – 125	2000 – 3000	hard, soft annealed
125 – 190	1000 – 2000	extruded, forged
190 – 350	500 – 1500	cast, forged

Busbars

Width mm	Min Thickness mm
10 – 20	2
20 – 40	3
40 – 70	4
70 – 250	5

Hollow conductors

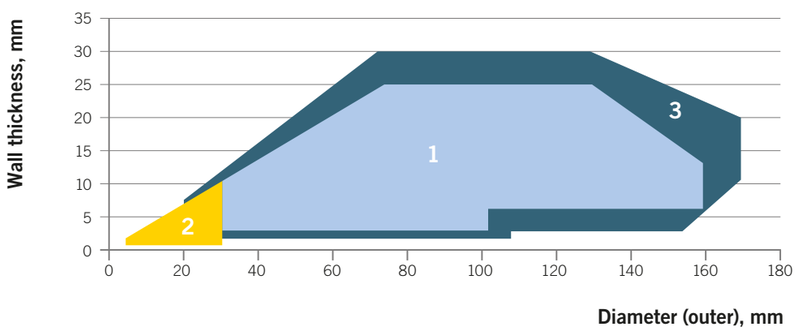
Size range: Different shapes from 3 x 2 mm up to 100 x 100 mm.

Delivery forms: Straight lengths up to 12 m
Loose coils
Mileon® continuous coils in wooden reels up to 2500 kg
Pancake coils
LWC (Level Wound Coil) coils

See list of tools of profile tubes: **www.luvata.com/hollow-conductors**

Tubes

Deliver forms: Straight lengths up to 12 m
Loose coils up to 120 kg
Mileon® continuous coils in wooden reels up to 2500 kg
LWC (Level Wound Coil) coils



Region No.1 – tubes in straight length.
Region No.2 – tubes in coil
Region No.3 – special dimensions (available upon request)
Other dimensions – check availability from Luvata

About Luvata

What does Luvata see for the future?
We will use our unique technology know-how to influence the development of a sustainable modern world. We have always aimed to improve our customers' products and processes, and to help them increase the efficiency of their businesses. But our vision is bigger than that. If human society is going to maintain the lifestyle that we all enjoy today AND offer it to emerging societies, we will all need to become much more efficient and to take much less from the planet. We are helping companies to make their products, processes and production more sustainable: do more, waste less, and pollute less.

What's Luvata's plan for getting there?
Luvata looks to build on its distinct strengths, bringing expertise and dedication to high growth regions and adjacent markets around the world. We are stepping into niche and specialist markets with our high-value, engineered solutions, and we are developing new solutions in partnership with our customers to conquer challenges at the front end of market demand.

How does Luvata behave?
In doing all this, we resolve to be the partner of choice for our customers, the employer of choice for our staff, and to be a positive and responsible friend to everyone else. We strive to be open-minded and focused on getting results; and when we promise, we deliver.

Where in the world are we?
Our global footprint stretches across the Americas, Europe and Asia. Our diversity of locations, cultures and markets gives us access to a wealth of knowledge and expertise that simply keeps growing. It means that we are local to our customers, wherever in the world they are and can be responsive to their needs, including fast local delivery straight to the door.

1400 employees, 10 locations, 6 countries

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About Luvata

Luvata is a world leader in metal solutions manufacturing and related engineering services to industries such as renewable energy, automotive, healthcare, and power generation and distribution. The company's continued success is attributed to its longevity, technological excellence and strategy of building partnerships beyond metals. Employing over 1,400 staff in 6 countries, Luvata works in partnership with customers such as ABB, CERN, Siemens and Toyota. Luvata is a group company of Mitsubishi Materials Corporation.

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