

| Designation | Cu-OF | DIN<br>CW008A | EN Nr.<br>2.0040 | UNS (ASTM)<br>C10200 | AISI<br>- | LMSA<br>B110 |
|-------------|-------|---------------|------------------|----------------------|-----------|--------------|
|-------------|-------|---------------|------------------|----------------------|-----------|--------------|

## Chemical composition

| Cu         | Bi          | Pb         | Others    |
|------------|-------------|------------|-----------|
| 99.95 min. | 0.0005 max. | 0.005 max. | 0.03 max. |

Values (Weight %). In order to achieve maximum homogeneity and consistent quality, the actual manufacturing tolerances are tighter and more precise than the composition indicated.

## Main technical properties and features

Cu-OF (Oxygen Free) is a high-purity copper grade, free from oxygen. It is characterized by a minimum copper content of 99.95% and a minimum electrical conductivity of 101% IACS (International Annealed Copper Standard). After cold working, the electrical conductivity of Cu-OF decreases slightly. Nevertheless, it remains high, with values generally ranging between 98 and 100% IACS depending on the degree of cold work. The quality of oxygen-free copper is maintained throughout the casting process without the addition of deoxidizing elements such as phosphorus, which provides excellent electrical and thermal conductivity. Due to its very low impurity content, it is perfectly suited to the demanding requirements of the electronics industry, low-temperature superconducting applications, and vacuum environments. It is free from elements that may evaporate under vacuum conditions.

Cu-OF has a slightly higher allowable impurity level compared with Cu-OFE (Oxygen Free Electronic Grade). However, Cu-OFE provides better performance under high-vacuum conditions than Cu-OF. Cu-OF contains no oxygen and is insensitive to hydrogen embrittlement. In the presence of hydrogen, oxygen-containing copper grades such as Cu-ETP may suffer significant internal damage due to the reduction of copper oxides by hydrogen. Cu-OF can therefore be heat treated in reducing atmospheres. Cu-OF is easily weldable using inert gas welding processes; however, laser welding is more challenging. Its suitability for electroplating and immersion tinning is excellent. It is also readily brazable and exhibits excellent cold and hot forming capabilities.

Thanks to its strongly adherent oxide layer, Cu-OF also provides good oxidation resistance in certain polluted atmospheres, as well as resistance to water, water vapor, and neutral saline solutions. However, its corrosion resistance is insufficient in oxidizing environments, in the presence of wet ammonia, or in seawater.

## Typical uses

Due to its excellent electrical and thermal conductivity, Cu-OF is frequently used in the electronic and superconducting industries: lead frame for semiconductors, heat sinks, coaxial cables, underwater fiber optic cables, waveguides, hollow conductors, vacuum seals, anodes, microwaves tubes, etc.

## Typical manufacturing range

|                                                      | Thickness (mm) | Width (mm)   | Length (mm) |
|------------------------------------------------------|----------------|--------------|-------------|
| <b>Rolled products</b> Strip in coils <sup>[1]</sup> | 0.010 - 2.000  | 1.5 - 200.0  | -           |
| Strip as sheets <sup>[1]</sup>                       | 0.010 - 1.500  | 10.0 - 200.0 | 100 - 3000  |

<sup>[1]</sup> Not all our production possibilities are presented here. Other dimensions or product forms available upon request. Some combinations of thicknesses and widths are not possible.

## Mechanical properties of strips

| Temper    | R <sub>p0.2</sub><br>(N/mm <sup>2</sup> ) | R <sub>m</sub><br>(N/mm <sup>2</sup> ) | A <sub>50mm</sub><br>(%) | Hardness<br>HV |
|-----------|-------------------------------------------|----------------------------------------|--------------------------|----------------|
| R200 H45  | 140 max.                                  | 200 - 260                              | 33 min.                  | 45 - 65        |
| R240 H65  | 180 min.                                  | 240 - 300                              | 8 min.                   | 65 - 95        |
| R240 H90  | 250 min.                                  | 290 - 360                              | 4 min.                   | 90 - 110       |
| R360 H110 | 320 min.                                  | 360 min.                               | -                        | 110 min.       |

## Physical properties

|                               |                        |                                               |
|-------------------------------|------------------------|-----------------------------------------------|
| Modulus of elasticity         | kN/mm <sup>2</sup>     | 127                                           |
| Poisson ratio                 |                        | 0.34                                          |
| Density                       | g/cm <sup>3</sup>      | 8.94                                          |
| Melting point / Melting range | °C                     | 1084                                          |
| Linear dilatation coefficient | 10 <sup>-6</sup> ./ °C | 17.7 from 0 to 300°C                          |
| Thermal conductivity at 20°C  | W/m °K                 | 394                                           |
| Electrical resistivity        | μΩcm                   | 1.71 ( Annealed ) / 17.2 - 17.6 ( cold work ) |
| Electrical conductivity       | MS/m                   | 58,5 ( Annealed ) / 56.8 - 58.0 ( cold work ) |
| Electrical conductivity       | % IACS                 | 101 ( Annealed ) / 98 - 100 ( cold work )     |
| Specific heat at 20°C         | J/(kg. K)              | 385                                           |
| Magnetic properties           |                        | Nonmagnetic                                   |

## Tolerances (strip and foil)

| Thickness                                                                                                                                                                                                           | Thickness (mm)                                                                                                                                                                    |       | EN Standard        |                 | Lamineries MATTHEY |                |              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------|-----------------|--------------------|----------------|--------------|
|                                                                                                                                                                                                                     | ≥                                                                                                                                                                                 | <     | 10140 Precision    | 10258 Precision | LMSA Standard      | LMSA Precision | LMSA Extreme |
| <p>The table shown is an outline of our typical thickness tolerances available. They are tighter than industry standards.</p> <p>Our "LMSA Precision" and "LMSA Extreme" tolerances are available upon request.</p> | -                                                                                                                                                                                 | 0.025 | -                  | -               | -                  | -              | ± 0.001      |
|                                                                                                                                                                                                                     | 0.025                                                                                                                                                                             | 0.050 | -                  | -               | ± 0.003            | ± 0.002        | ± 0.0015     |
|                                                                                                                                                                                                                     | 0.050                                                                                                                                                                             | 0.065 | -                  | ± 0.003         | ± 0.003            | ± 0.0025       | ± 0.002      |
|                                                                                                                                                                                                                     | 0.065                                                                                                                                                                             | 0.100 | -                  | ± 0.004         | ± 0.004            | ± 0.0035       | ± 0.003      |
|                                                                                                                                                                                                                     | 0.100                                                                                                                                                                             | 0.125 | ± 0.005            | ± 0.006         | ± 0.005            | ± 0.004        | ± 0.003      |
|                                                                                                                                                                                                                     | 0.125                                                                                                                                                                             | 0.150 | ± 0.005            | ± 0.006         | ± 0.005            | ± 0.005        | ± 0.004      |
|                                                                                                                                                                                                                     | 0.150                                                                                                                                                                             | 0.250 | ± 0.010            | ± 0.008         | ± 0.008            | ± 0.006        | ± 0.004      |
|                                                                                                                                                                                                                     | 0.250                                                                                                                                                                             | 0.300 | ± 0.010            | ± 0.009         | ± 0.009            | ± 0.007        | ± 0.005      |
|                                                                                                                                                                                                                     | 0.300                                                                                                                                                                             | 0.400 | ± 0.010            | ± 0.010         | ± 0.010            | ± 0.007        | ± 0.005      |
|                                                                                                                                                                                                                     | 0.400                                                                                                                                                                             | 0.500 | ± 0.015            | ± 0.012         | ± 0.012            | ± 0.008        | ± 0.006      |
|                                                                                                                                                                                                                     | 0.500                                                                                                                                                                             | 0.600 | ± 0.015            | ± 0.014         | ± 0.014            | ± 0.010        | ± 0.007      |
|                                                                                                                                                                                                                     | 0.600                                                                                                                                                                             | 0.800 | ± 0.015            | ± 0.015         | ± 0.015            | ± 0.010        | ± 0.007      |
|                                                                                                                                                                                                                     | 0.800                                                                                                                                                                             | 1.000 | ± 0.015            | ± 0.018         | ± 0.018            | ± 0.012        | ± 0.009      |
|                                                                                                                                                                                                                     | 1.000                                                                                                                                                                             | 1.200 | ± 0.020            | ± 0.020         | ± 0.020            | ± 0.015        | ± 0.012      |
|                                                                                                                                                                                                                     | 1.200                                                                                                                                                                             | 1.250 | ± 0.020            | ± 0.020         | ± 0.020            | ± 0.015        | ± 0.012      |
|                                                                                                                                                                                                                     | 1.250                                                                                                                                                                             | 1.500 | ± 0.020            | ± 0.020         | ± 0.020            | ± 0.015        | ± 0.014      |
| <b>Width</b>                                                                                                                                                                                                        | Our width tolerances "Standard" is +0.2, -0.0 (or ± 0.1 mm upon request). They are available for slit widths < 125 mm and thicknesses < 1.00 mm. Special tolerances upon request. |       |                    |                 |                    |                |              |
| <b>Camber</b>                                                                                                                                                                                                       | Width (mm)                                                                                                                                                                        |       | Camber max. (mm/m) |                 |                    |                |              |
|                                                                                                                                                                                                                     | >                                                                                                                                                                                 | ≤     | LMSA Standard      |                 | LMSA Extreme       |                |              |
|                                                                                                                                                                                                                     |                                                                                                                                                                                   |       | ≤ 0.5 mm           | > 0.5 mm        | ≤ 0.5 mm           | > 0.5 mm       |              |
|                                                                                                                                                                                                                     | 3                                                                                                                                                                                 | 6     | 12                 | -               | 6                  | -              |              |
|                                                                                                                                                                                                                     | 6                                                                                                                                                                                 | 10    | 8                  | 10              | 4                  | 5              |              |
| <p>Our tolerance "LMSA Standard" respects the EN Standard 1654 (Length of measurement 1000 mm).<br/>Other tolerances upon request.</p>                                                                              | 10                                                                                                                                                                                | 20    | 4                  | 6               | 2                  | 3              |              |
|                                                                                                                                                                                                                     | 20                                                                                                                                                                                | 250   | 2                  | 3               | 1                  | 1.5            |              |
| <b>Surface</b>                                                                                                                                                                                                      | Special surface qualities upon request                                                                                                                                            |       |                    |                 |                    |                |              |
| <b>Flatness</b>                                                                                                                                                                                                     | Special requirement on the longitudinal or transversal flatness upon request                                                                                                      |       |                    |                 |                    |                |              |

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