Material Data Sheet

# Cu-Alloy CuNi2SiCr

## General

The low-alloyed copper-alloy CuNi2SiCr is a thermally hardenable alloy with a high stiffness, even at elevated temperatures. In addition, CuNi2SiCr offers a balanced combination of electrical and thermal conductivity as well as a very high resistance to wear. Due to the addition of nickel and silicon, this alloy has a high corrosion resistance, especially against stress-corrosion cracking.

This property profile predestines CuNi2SiCr for use under mechanical, thermal or tribological stresses with simultaneously good conductivity. Typical areas of application are, for example, toolmaking, conductive contacts in electrical engineering or valves. This copper alloy is also completely free of beryllium.

## Material Structure

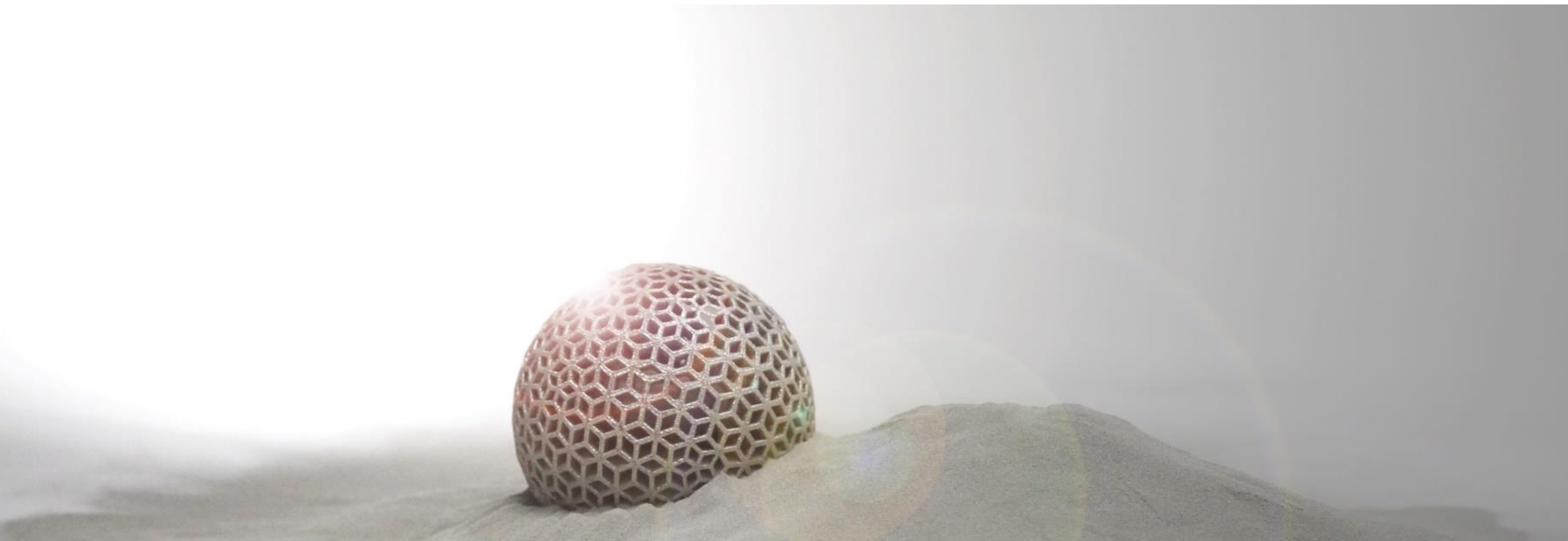
Components made of low-alloyed copper alloys with the SLM® process have a homogenous, almost pore-free structure, which allows mechanical values to be in range of the material specification. CuNi2SiCr crystallizes in a face-centered cubic lattice structure. The component properties can be adapted to individual requirements by subsequent heat treatment. Precipitation strengthening – comprising the heat treatment steps solution annealing, quenching and artificial aging – leads to improved strength properties and increases electrical conductivity likewise. Strengthening of CuNi2SiCr is based on the temperature-dependent solubility of the intermetallic phases $Ni_2Si$ and $Ni_5Si_2$ ($Ni_{31}Si_{12}$)

## Chemical composition [Mass fraction in %][6]

| Cu | Ni | Si | Cr | Nb + Ta | O | Fe | Mn | Pb | C | N | Others Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Balance | 2.0 – 3.0 | 0.5 – 0.8 | 0.2 – 0.5 | / | / | 0.15 | 0.1 | 0.02 | / | / | 0.1 |

## Powder properties

| | | | |
|---|---|---|---|
| Particle size[7] | 20 – 63 µm | Particle shape[8] | Spherical |
| Mass density[1] | 8.84 g/cm3 | Thermal conductivity | |



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| 30 µm / 400 W[2] | | | | As-built | | Heat-treated [12] | |
|---|---|---|---|---|---|---|---|
| Build-up rate [6] | [cm³/h] | | | 11.7 cm³/h | | | |
| Component density[4] | [%] | | | > 99.5 % | | | |

| **Tensile test[9]** | | | | M | SD | M | SD |
|---|---|---|---|---|---|---|---|
| Tensile strength | $R_m$ | [MPa] | H | 314 | 2 | 666 | 5 |
| | | | V | 281 | 4 | 613 | 3 |
| Offset yield strength | $R_{p0,2}$ | [MPa] | H | 260 | 4 | 580 | 5 |
| | | | V | 239 | 2 | 543 | 4 |
| Elongation at break | A | [%] | H | 36 | 2 | 18 | 1 |
| | | | V | 40 | 1 | 23 | 2 |
| Reduction of area | Z | [%] | H | 79 | 4 | 41 | 4 |
| | | | V | 88 | 3 | 65 | 9 |
| Young's modulus | E | [GPa] | H | 98 | 8 | 114 | 6 |
| | | | V | 95 | 5 | 105 | 2 |

| **Hardness test[10]** | | M | SD | M | SD |
|---|---|---|---|---|---|
| Vickers hardness | HV10 | 105 | 1 | 214 | 3 |

| **Conductivity measurement[5]** | | | |
|---|---|---|---|
| Electrical conductivity | [MS/m] | 8 | 23 |
| | [%IACS] | 14 | 40 |

| **Roughness measurement[11]** | | | As-built | | Corundum blasted | | Corundum- and Glass-bead blasted | |
|---|---|---|---|---|---|---|---|---|
| | | | M | SD | M | SD | M | SD |
| Roughness average | Ra | [µm] | 15 | 1 | 5 | 1 | 4 | 1 |
| Mean roughness depth | Rz | [µm] | 86 | 4 | 32 | 5 | 28 | 2 |

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| 60 µm / 700 W[3] | | | | As-built | | Heat-treated [12] | |
|---|---|---|---|---|---|---|---|
| Build-up rate [6] | [cm³/h] | | | 25.7 cm³/h | | | |
| Component density[4] | [%] | | | > 99.5 % | | | |

| **Tensile test[9]** | | | | M | SD | M | SD |
|---|---|---|---|---|---|---|---|
| Tensile strength | $R_m$ | [MPa] | H | 318 | 4 | 674 | 20 |
| | | | V | 280 | 4 | 633 | 13 |
| Offset yield strength | $R_{p0,2}$ | [MPa] | H | 249 | 3 | 584 | 15 |
| | | | V | 226 | 3 | 551 | 9 |
| Elongation at break | A | [%] | H | 37 | 2 | 18 | 1 |
| | | | V | 34 | 2 | 22 | 1 |
| Reduction of area | Z | [%] | H | 67 | 5 | 40 | 3 |
| | | | V | 85 | 3 | 71 | 5 |
| Young's modulus | E | [GPa] | H | 102 | 14 | 110 | 9 |
| | | | V | 87 | 4 | 102 | 2 |

| **Hardness test[10]** | | M | SD | M | SD |
|---|---|---|---|---|---|
| Vickers hardness | HV10 | 109 | 3 | 225 | 1 |

| **Conductivity measurement[5]** | | | |
|---|---|---|---|
| Electrical conductivity | [MS/m] | 8 | 22 |
| | [%IACS] | 14 | 38 |

| **Roughness measurement[11]** | | | As-built | | Corundum blasted | | Corundum- and Glass-bead blasted | |
|---|---|---|---|---|---|---|---|---|
| | | | M | SD | M | SD | M | SD |
| Roughness average | Ra | [µm] | 21 | 1 | 11 | 2 | 7 | 1 |
| Mean roughness depth | Rz | [µm] | 121 | 8 | 63 | 10 | 45 | 7 |

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## Cu-Alloy CuNi2SiCr

The properties and mechanical characteristics apply to powder that is tested and sold by SLM Solutions, and that has been processed on SLM Solutions machines using the original SLM Solutions parameters in compliance with the applicable operating instructions (including installation conditions and maintenance). The part properties are determined based on specified procedures. More details about the procedures used by SLM Solutions are available upon request.

The specifications correspond to the most recent knowledge and experience available to us at the time of publication and do not form a sufficient basis for component design on their own. Certain properties of products or parts or the suitability of products or parts for specific applications are not guaranteed. The manufacturer of the products or parts is responsible for the qualified verification of the properties and their suitability for specific applications. The manufacturer of the products or parts is responsible for protecting any third-party proprietary rights as well as existing laws and regulations.

[1] Material density varies within the range of possible chemical composition variations.

[2] Material data file: CuNi2SiCr_SLM_MBP3.0_30_400W_CE2_V1.0
Maximum oxygen content in the process: 500 ppm

[3] Material data file: CuNi2SiCr_SLM_MBP3.0_60_700W_CE2_V1.0
Maximum oxygen content in the process: 500 ppm

[4] Optical density determination by light microscopy.

[5] Electrical conductivity measurement according to DIN EN 2004-1, ASTM E 1004.

[6] Theoretical build-up rate for each laser = layer thickness x scan speed x track distance.

[7] With respect to powder material.

[8] According to DIN EN ISO 3252:2001.

[9] Tensile test according to DIN EN ISO 6892-1:2017 B (DIN 50125:2016 – D6x30); orientation: 0°, 90°.

[10] Hardness testing according to DIN EN ISO 6507-1:2018.

[11] Roughness measurement according to DIN EN ISO 4288:1998; λc = 2,5 mm.

[12] Heat treatment: solution annealing at 930 °C, hold for 15 min, followed by water quenching. Aging at 540 °C for 2 h with subsequent cooling in air.

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