



AGH



CuPHC

UNS:C10300
EN:CW020A

Manufactures list:

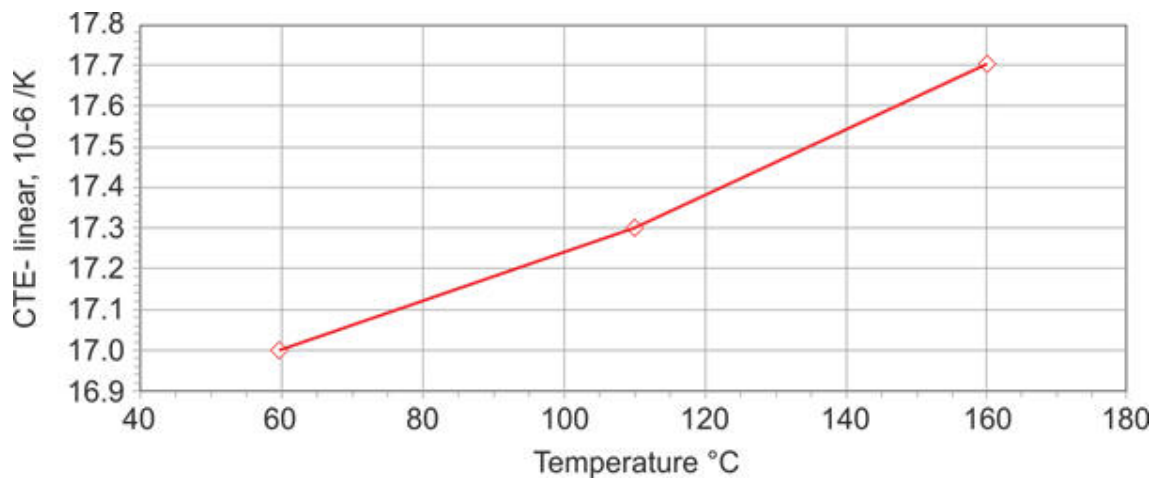
Aurubis (<http://www.aurubis.com/en/>) - PNA 209
Halcor S.A. (<http://www.halcor.gr/en/>) - CuPHC
KGHM Polska Miedź S.A. (<http://www.kghm.pl/>) - CuPHC
KM Europa Metal AG (<http://www.kme.com/>) - KME159
Luvata (<http://www.luvata.com/>) - CuPHC
Nexans (<http://www.nexans.us/>) - CuPHC
Wieland-Werke AG (<http://www.wieland.de/>) - K14

Cu-PHC combines good electrical conductivity with excellent hot and cold fabricability and joining characteristics (welding and brazing). C10300 has 99% IACS electrical conductivity, excellent hot and cold workability. C10300 is not hardenable by heat treatment. It may be joined by gas shielded arc with excellent results. Soldering and brazing performance is also excellent. Butt resistance welding is good and oxyacetylene weldability, fair. Common fabrication processes include: blanking, coining, coppersmithing, drawing, etching, forming and bending, heading and upsetting, hot forging and pressing, piercing and punching, roll threading and knurling, shearing, spinning, squeezing and swaging, stamping.

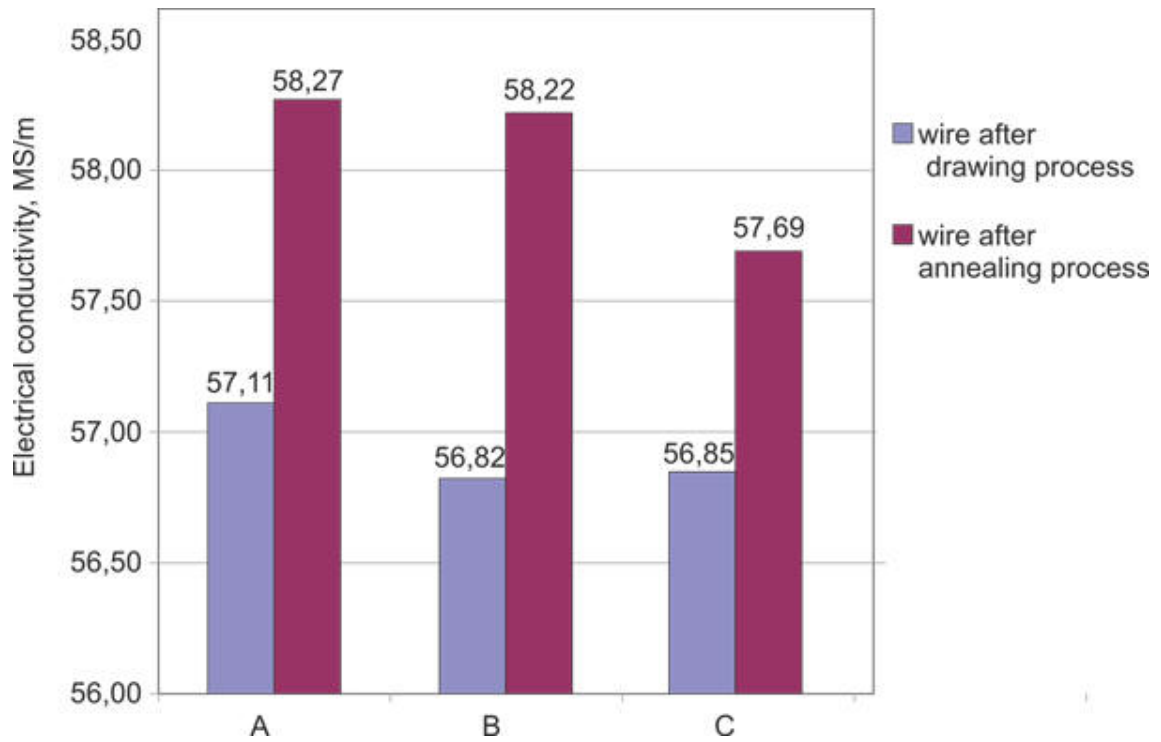
Basic properties

| Basic properties | Value | Comments |
|--|-----------|----------------|
| Density [g/cm ³] | 8,76-8,94 | |
| Specific heat capacity [J/(kg*K)] | 385 | |
| Temperature coefficient of electrical resistance (0...100°C) [10 ⁻³ /K] | 3,7 | 20-300°C |
| Electrical conductivity [T=20°C, (% IACS)] | 100 99 | CuPHC CuHCP |
| Thermal conductivity [W/(m*K)] | 386 | |
| Thermal expansion coefficient 20...300°C [10 ⁻⁶ /K] | 17,6 | |

[Ref: 305, 306, 307, 308, 309, 310, 252, 268, 267, 254, 255, 256]



Thermal expansion coefficient of Cu-PHC vs temperature [Ref: 267]



Electrical conductivity of Cu-PHC wires (diameter 2.00 mm) after drawing process and after annealing process [Ref: 567]

Chemical composition of Cu-PHC wires (diameter 2.00 mm) [Ref: 567]

| No of alloy | Chemical composition, wt% | | | | | | | | | | |
|-------------|---------------------------|-----|-----|-----|-----|-----|-----|-----|---|----------------|----|
| | Bi | Pb | Sb | As | Fe | Ni | Sn | Zn | S | O ₂ | P |
| A | 0,5 | 0,5 | 1 | 0,5 | 8,4 | 2,2 | 0,4 | 1 | 5 | 22 | 34 |
| B | 0,5 | 0,5 | 1 | 0,7 | 8,2 | 2,6 | 0,4 | 1 | 7 | 26 | 24 |
| C | 0,3 | 1,4 | 0,9 | 0,9 | 2,6 | 2 | 0,5 | 1,3 | - | 3,7 | 15 |

Applications

Main applications

Standard material for longitudinally welded cables, Wave Guide Tubing, Commutators, Applications Requiring High Conductivity, Tubular Bus, Electrical Conductors, Clad Products, Busbars, Terminals, Thermostatic Control Tubing Applications Requiring Good Brazing, Applications Requiring Good Weldability, Pressure Vessels, Billet Mold Tube, Extrusion Cans for Powder Metallurgy. *Literature:* [Ref: 305, 306, 307, 308, 310, 268, 254]

Kinds of semi-finished products/final products

| Product | Specification | Literature |
|-----------------------------------|-----------------------|----------------------|
| Bar | ASTM B152 | [Ref: 254, 268, 257] |
| Bar, Bus | ASTM B187 | |
| Brazing Filler Metal | FEDERAL QQ-B-650 | |
| Nipples | ASTM B687 | |
| Pipe | ASTM B698, B42 | |
| Pipe, Bus | ASTM B188 | |
| Pipe, Threadless (Seamless) | ASTM B302 | |
| Plate | ASTM B152 | |
| Plate, Clad | ASTM B432 | |
| Rod, Bus | ASTM B187 | |
| Shapes, Bus | ASTM B187 | |
| Sheet | ASTM B152 | |
| Strip | ASTM B272, B152 | |
| Tube | ASTM B698 | |
| Tube, Bus | ASTM B188 | |
| Tube, Coils | ASTM B743 | |
| Tube, Condenser | ASTM B111 | |
| Tube, Finned | ASTM B359 | |
| Tube, Rectangular Waveguide | ASTM B372 | |
| Tube, Seamless | ASTM B75, B641 | |
| Tube, Seamless Bright Annealed | ASTM B68 | |
| Tube, Seamless for Torpedo Use | MILITARY MIL-T-3235 | |
| Tube, U-Bend | ASTM B395 | |
| Tube, Welded | ASTM B641, B447, B716 | |
| Wire, Flat | ASTM B272 | |

Chemical composition

| Chemical composition | Value | Comments |
|----------------------|-------------|------------|
| Cu [wt.%] | 99,94-99,95 | Calculated |
| P [wt.%] | 0,001-0,005 | |
| Pb [wt.%] | 0-0,005 | |
| Others [wt.%] | 0,05 | |
| [Ref: 254, 268] | | |

Chemical composition of Cu-HCP according to [Ref: 254, 268]

| Chemical composition, wt.% | | | | | | | | | | | | |
|----------------------------|----|----|----|----|----|----|----|-------------|-----------|----|----------|-----------|
| Ag | Mg | Sn | Ni | Si | Cr | Zr | Fe | P | Pb | Zn | other | Cu |
| - | - | - | - | - | - | - | - | 0.002-0,007 | Max 0.005 | - | Max 0.05 | min. 99.5 |

Mechanical properties

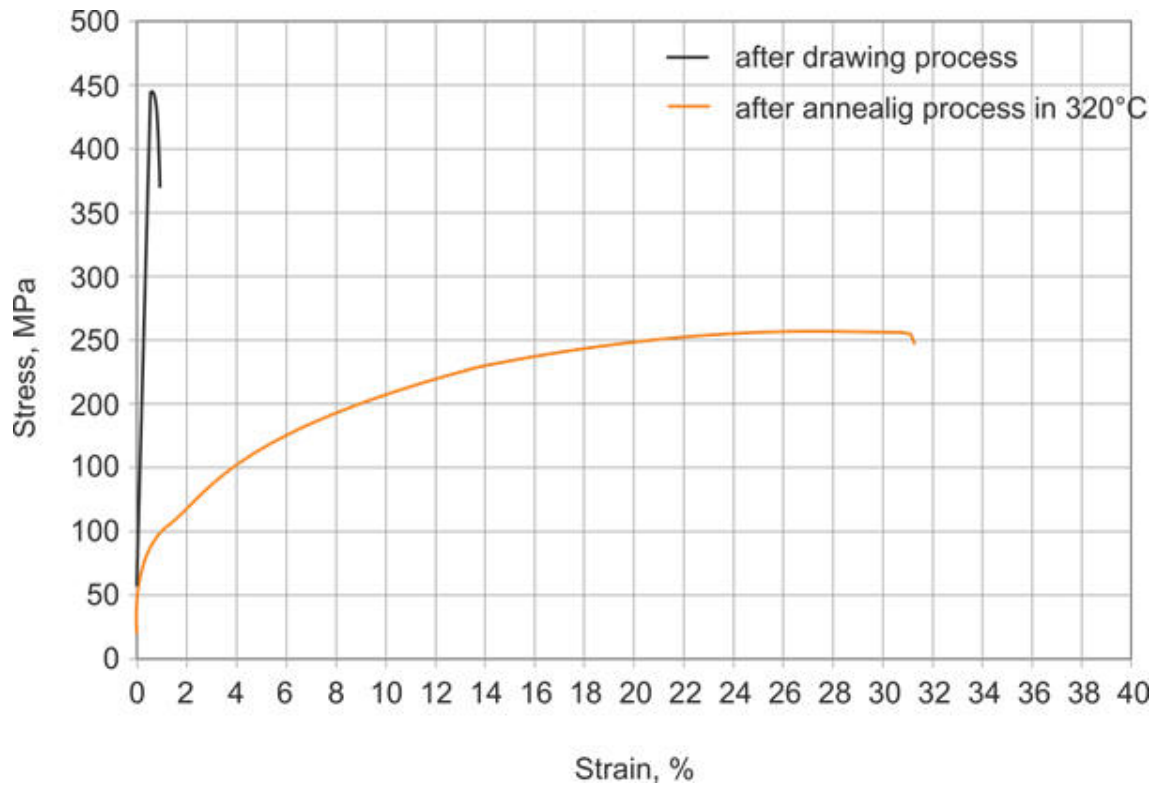
| Mechanical properties | Value | Comments | Literature |
|---------------------------|---------|----------|------------|
| UTS [MPa] | 200-400 | | |
| YS [MPa] | 100-360 | | |
| Elongation [%] | 2-45 | | |
| Hardness | 40-110 | | |
| Young's modulus [GPa] | 119 | | |
| Kirchhoff's modulus [GPa] | 45 | | |
| Poisson ratio | 0,33 | | |

Mechanical properties of CuPHC according KME [Ref: 309]

| Cu - PHC | Tensile strength, MPa | Yield strength, MPa | Elongation, % | Hardness, HV | Literature |
|----------|-----------------------|---------------------|---------------|--------------|------------|
| R200 | 200-250 | ≤100 | - | 40-65 | [Ref: 309] |
| R220 | 220-260 | <140 | 33 | 40-65 | |
| R240 | 240-300 | ≥180 | 8 | 65-95 | |
| R290 | 290-360 | ≥250 | 4 | 90-110 | |
| R360 | ≥360 | ≥320 | 2 | ≥110 | |

Mechanical properties of CuPHC [Ref: 310]

| Form | Section, mm | Tensile strength, MPa | Yield strength, MPa | Elongation | Literature |
|--------|-------------|-----------------------|---------------------|------------|------------|
| flat | 1 | 224 | 70 | 45 | [Ref: 310] |
| | | 238 | 77 | 45 | |
| | | 252 | 196 | 30 | |
| | | 266 | 210 | 25 | |
| | | 294 | 252 | 14 | |
| | 350 | 315 | 6 | | |
| | 6,25 | 224 | 70 | 50 | |
| | | 252 | 196 | 40 | |
| | | 350 | 315 | 12 | |
| | | 224 | 70 | 50 | |
| 25 | 315 | 280 | 20 | | |
| rod | 6,25 | 385 | 350 | 20 | |
| | | 336 | 308 | 16 | |
| | | 315 | 280 | 20 | |
| | | 224 | 70 | 45 | |
| | | 238 | 77 | 45 | |
| | | 280 | 224 | 25 | |
| pipe | | 385 | 350 | 8 | |
| | | 350 | 315 | 10 | |
| shapes | 12,5 | 224 | 70 | 50 | |
| | | 280 | 224 | 30 | |

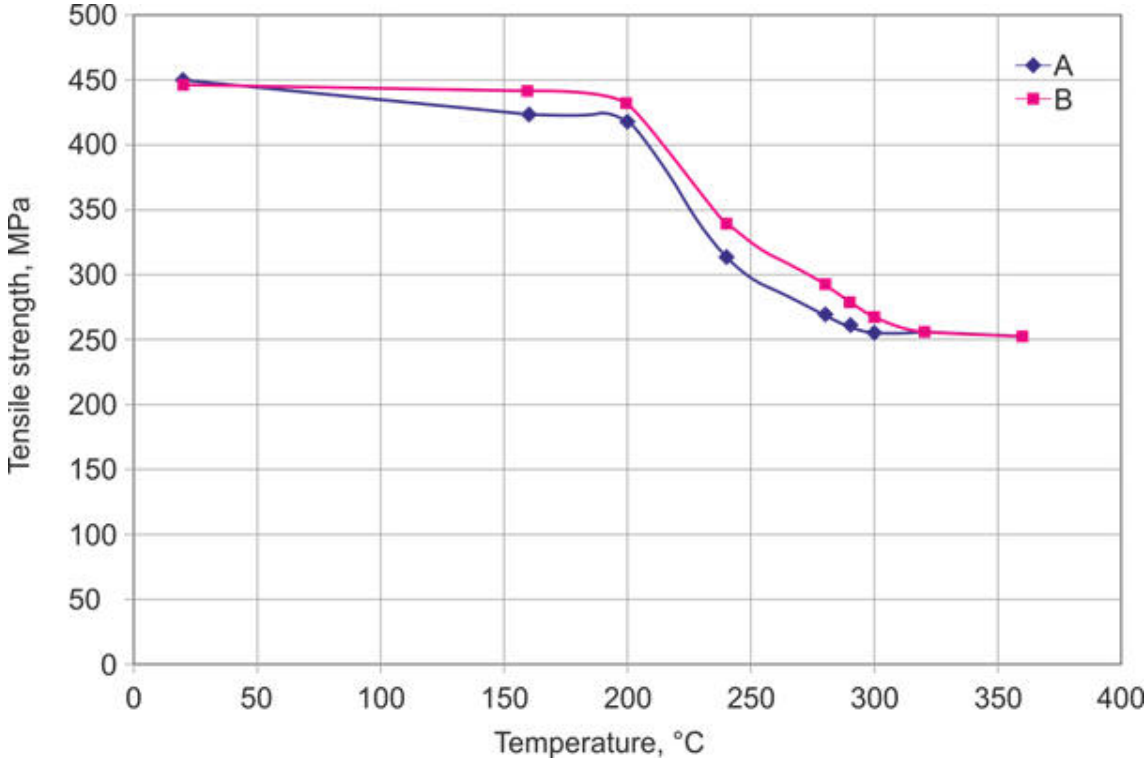


Stress strain characteristic of Cu-PHC wires (diameter 2 mm) after drawing process and after annealing process in 320°C temperature [Ref: 567]

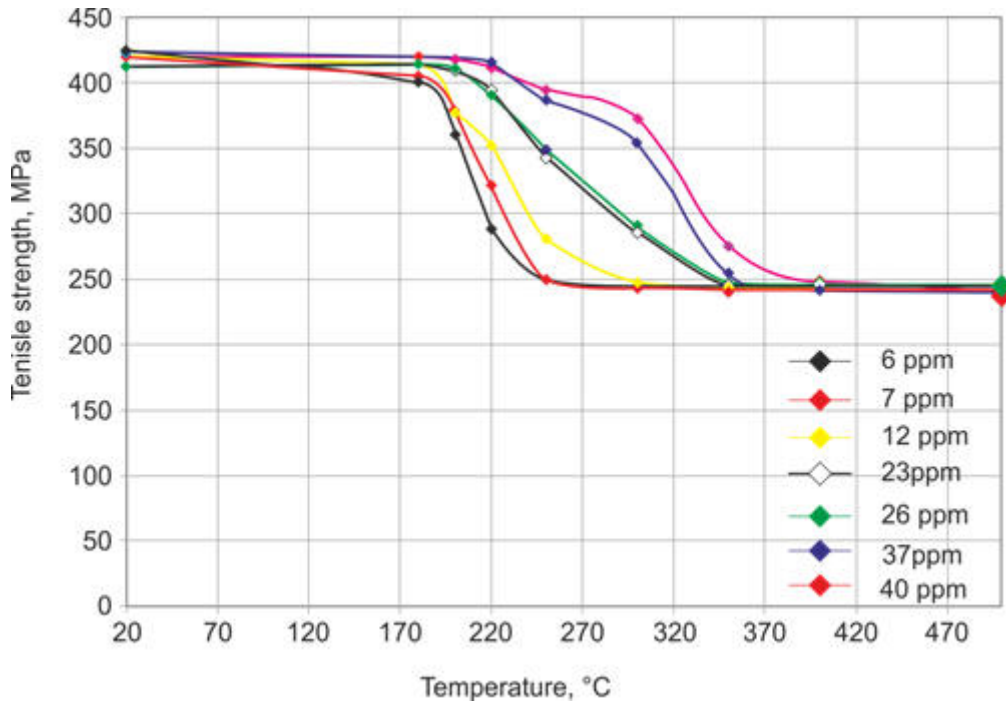
Exploitation properties

Heat resistance

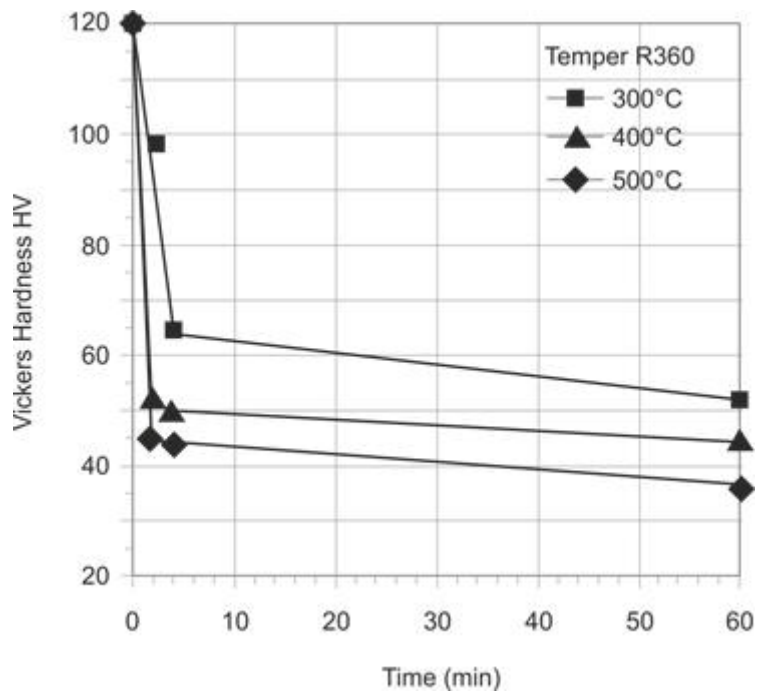
Mechanical and electrical properties vs temperatures



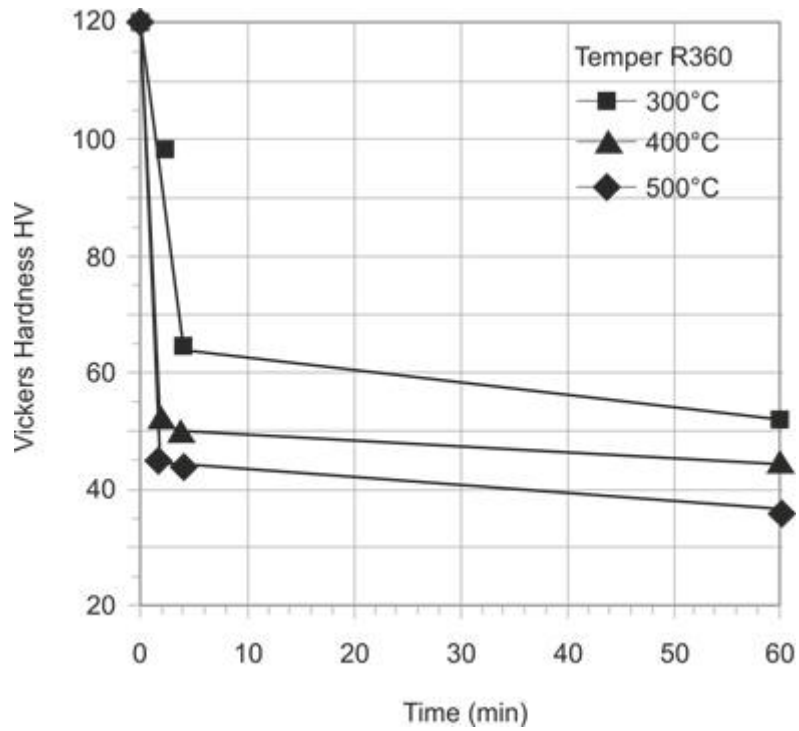
Softening curves of CuPHC Cu-PHC wire (diameter 2.00 mm, P-24 pm, oxygen -20ppm) [Ref: 567]



Softening curves of CuPHC Cu-PHC wire (diameter 2.00 mm) vs various P content [Ref: 567]



Softening resistance of Cu-PHC [Ref: 306]

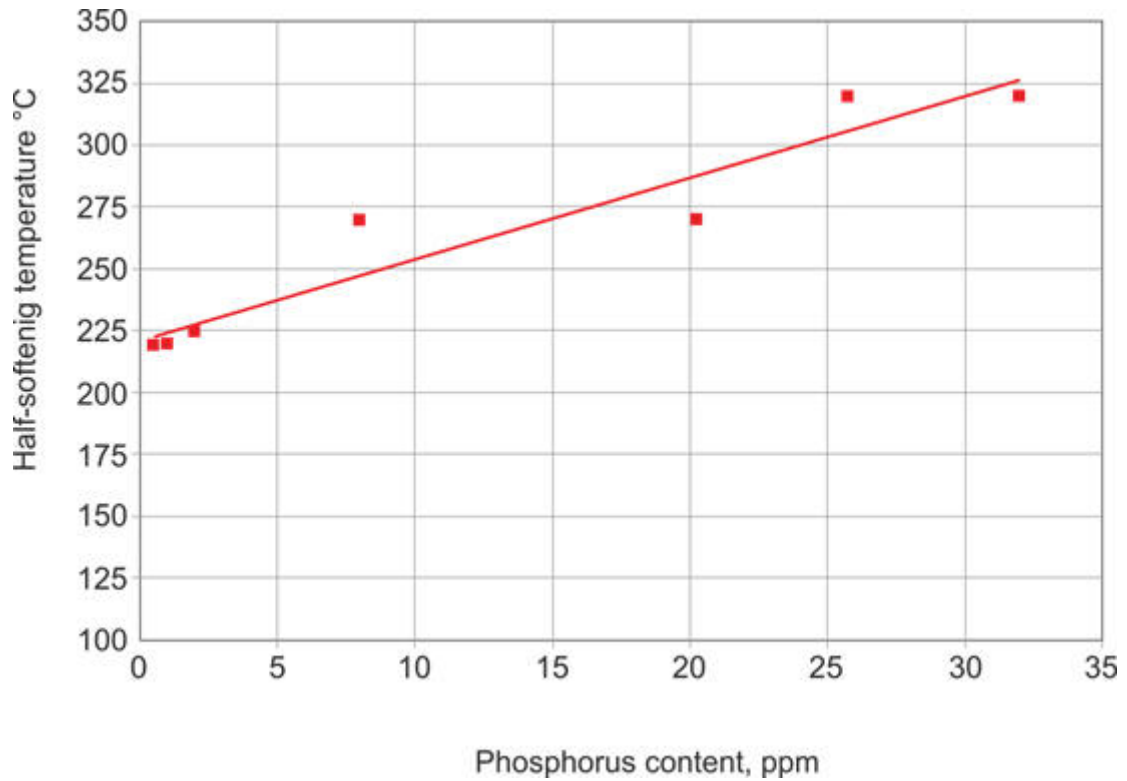


Softening resistance of Cu-HCP [Ref: 305]

Long-term heat resistance, e.g. Arrhenius curve

NO DATA AVAILABLE

Half- softening temperature



Half-softening temperature of Cu-PHC wire (diameter 2.00 mm) vs various P content, [Ref: 567]

Corrosion resistance

Hydrogen embrittlement resistance

Good hydrogen embrittlement resistance [Ref: 254, 310]

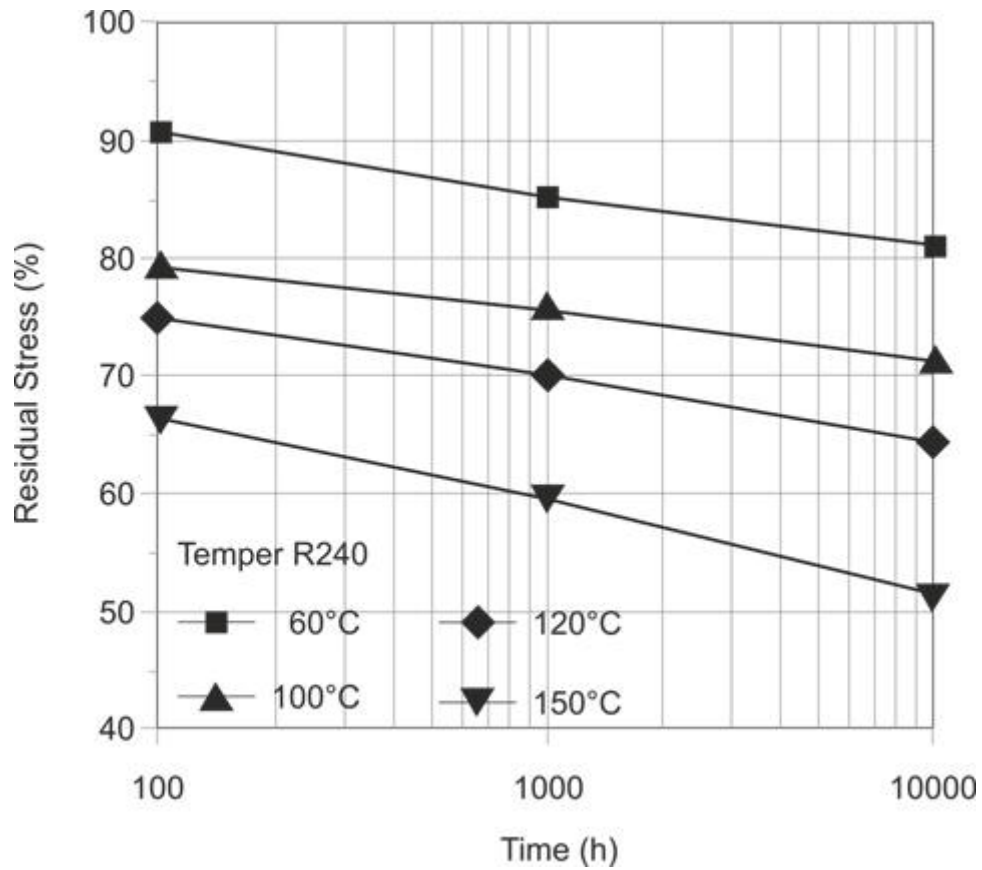
Other kind of corrosion elements

Cu-PHC and Cu-HCP are resistant to industrial atmosphere, industrial and drinking water (max. flow rate approx. 1,5-2 m/s), pure water vapor, nooxidizing acids, alkalis. Cu-PHC is not resistant to oxidizing acids, hydrous ammonia and halogenated gases, hydrogen sulfide, seawater

| Type of corrosion | Suitability | Literature |
|------------------------|-------------|-----------------|
| Atmospheric | Good | [Ref: 254, 310] |
| Marine environment | No data | - |
| Stress crack | No data | - |
| Hydrogen embrittlement | Good | [Ref: 254, 310] |
| Electrolytic | No data | - |

Rheological resistance

Stress relaxation



Stress relaxation resistance of Cu-HCP [Ref: 305]

Creep

NO DATA AVAILABLE

Wear resistance

Friction resistance

NO DATA AVAILABLE

Fatigue resistance

Fatigue cracking

| Temper | Fatigue strength (100×10^6) cycles, MPa | Literature |
|-----------------------|---|------------|
| 1mm thick strip 0S025 | 76 | [Ref: 254] |
| H02 i H04 | 90 | |

Impact strength

NO DATA AVAILABLE

Fabrication properties

| Fabrication properties | Value | Comments |
|--------------------------------|-----------------|----------|
| Soldering | Excellent | |
| Brazing | Excellent | |
| Hot dip tinning | Excellent | |
| Laser welding | Fair | |
| Oxyacetylene Welding | Fair | |
| Gas Shielded Arc Welding | Excellent | |
| Coated Metal Arc Welding | Not recommended | |
| Resistance welding | Fair | |
| Spot Weld | Not recommended | |
| Seam Weld | Not recommended | |
| Butt Weld | Good | |
| Capacity for Being Cold Worked | Excellent | |
| Capacity for Being Hot Formed | Excellent | |
| Forgeability Rating | 65 | |
| Machinability Rating | 20 | |
| [Ref: 310, 252, 254] | | |

Technological properties

| Technological properties | Value | Comments |
|-----------------------------------|-----------|----------|
| Melting temperature [°C] | 1083 | |
| Casting temperature [°C] | 1140-1200 | |
| Annealing temperature [°C] | 225-650 | |
| Stress relieving temperature [°C] | 175-225 | |
| Hot working temperature [°C] | 750-950 | |
| [Ref: 310, 252, 254] | | |

References:

- 252. **Electronic Materials Handbook, vol.1 Packaging** - ASM International
- 254. **Copper and copper alloys** - J.Davis, ASM International, 2001
- 255. **Electrical and magnetic properties of metals** - Ch.Moosrigger, ASM International, 2000
- 256. **Thermal properties of metals** - F.Cverna, ASM International ASM, 2002
- 257. **Concise Metals** - Engineering Data Book, ASM International, 2004
- 267. **MatWeb - Data Base** - www.matweb.com
- 268. **Copper Development Association Inc.** - www.copper.org
- 305. **Data sheet - K12** - Wieland
- 306. **Data sheet - K14** - Wieland
- 307. **Data sheet - Cu-PHC** - Kemper
- 308. **Data sheet - Cu-HCP** - Fornitrade LCC
- 309. **Data sheet - KME 159** - KME
- 310. **Data sheet - 10300** - Alloy Digest, June 2002
- 567. **AGH-UST - own research** - contact person: tknych@agh.edu.pl