



**AGH**



## **CuNi3Si**

**UNS:C70250, C70320**  
**EN:CW112C**

### **Manufactures list:**

KM Europa Metal AG (<http://www.kme.com/>) - CuNi3Si(CuNi3Si)

CuNi3Si is an age-hardening copper alloy. It has high mechanical properties, high electrical and thermal conductivity, good corrosion resistance, good fatigue strength and thermal resistance, good spring properties.

## Basic properties

Basic properties	Value	Comments
Density [g/cm <sup>3</sup> ]	8,8	
Specific heat capacity [J/(kg*K)]	377	
Temperature coefficient of electrical resistance (0...100°C) [10 <sup>-3</sup> /K]	No data	
Electrical conductivity [T=20°C, (% IACS)]	35-45	
Thermal conductivity [W/(m*K)]	190	
Thermal expansion coefficient 20...300°C [10 <sup>-6</sup> /K]	17,6	
[Ref: 235, 236, 243]		

## **Applications**

### **Main applications**

Connectors, leadframe, electrical equipment. CuNi3Si alloy can also be used for current-carrying formed parts and contact springs. Literature: [Ref: 235]

### **Kinds of semi-finished products/final products**

Electrical industry components, stamped parts, connectors, relay springs, semiconductor components.

## Chemical composition

Chemical composition	Value	Comments
Cu [wt.%]	93,38-96,1	Calculated
Fe [wt.%]	0-0,2	
Mn [wt.%]	0-0,1	
Ni [wt.%]	2,6-4,5	
Pb [wt.%]	0-0,02	
Si [wt.%]	0,8-1,3	
Others [wt.%]	0,5	

[Ref: 570]

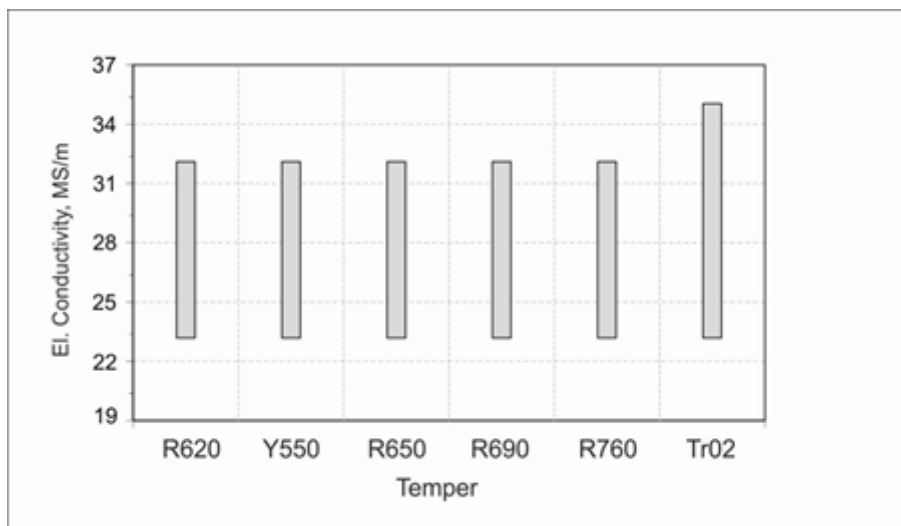
## Mechanical properties

Mechanical properties	Value	Comments	Literature
UTS [MPa]	590-830		
YS [MPa]	440-780		
Elongation [%]	5-12		
Hardness	180-220	HB, heat treated	
Young's modulus [GPa]	135		
Kirchhoff's modulus [GPa]	50,4		
Poisson ratio	0,34		

*Material's mechanical and electrical properties in different tempers*

Temper	Tensile strength, MPa	Yield strength (min), MPa	Elongation (min) A5 (%)	Hardness	Electrical conductivity % IACS	Literature
Bars, squares hexagonals, solution heat treated, artificially aged	690	540	8	200 HB		DIN 17672-1 (1969)
Bars, squares hexagonals; solution heat treated, strain-hardened	610	550	8	180 HB		
Bars, squares hexagonals; solution heat treated, strain-hardened, artificially aged;	830	780	10	220 HB		
Flats; solution heat treated, artificially aged	690	540	8	200		
R620	620-760	500	10 (A <sub>50</sub> )	180-240 HV	40	
R690	690-860	655	5 (A <sub>50</sub> )	220-260 HV	40	[Ref: 236]

R610 (H180)	610-720	570	>8 (A <sub>50</sub> )	180-230 HV	45	[Ref: 235]
R650 (H190)	650-740	550	>12 (A <sub>50</sub> )	190-230 HV	40	
R690 (H210)	690-800	660	>5 (A <sub>50</sub> )	200-240 HV	40	
R720 (H220)	720-810	690	>7 (A <sub>50</sub> )	210-250 HV	45	
R740 (H225)	740-850	690	>5(A <sub>50</sub> )	225-250 HV	35	
Rod 10-30mm	650	590	10	195 HB		[Ref: 625]
Rod 30-50mm	650	500	10	195 HB		
Rod >50	590	440	10	190 HB		

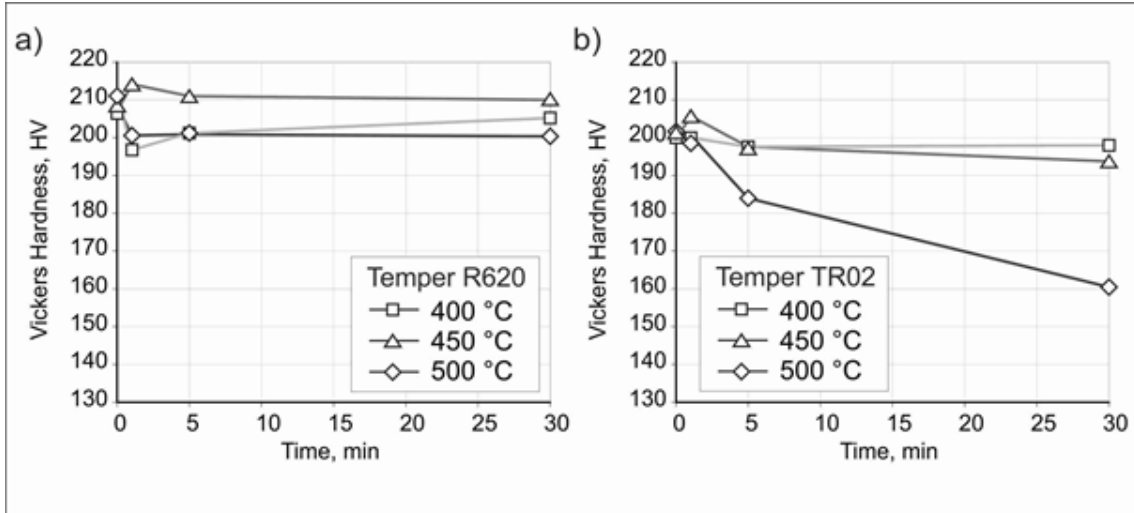


Electrical conductivity vs. temper [Ref: 569]

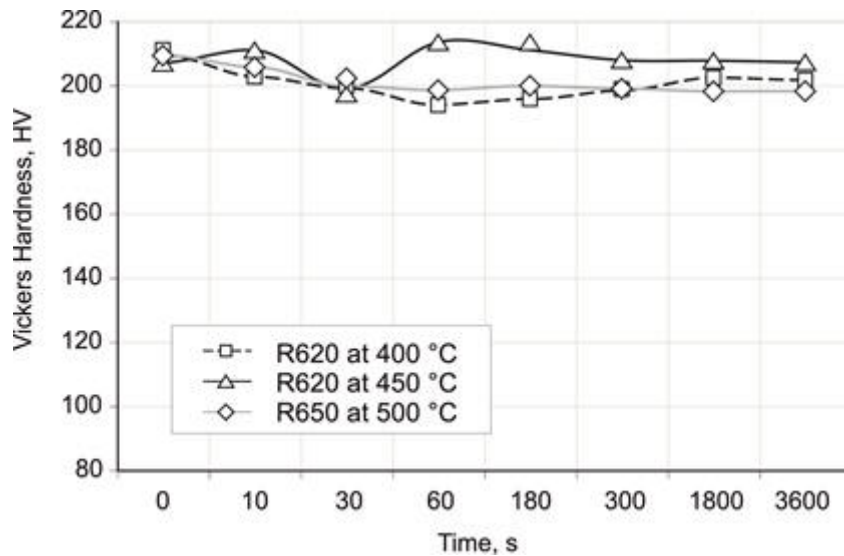
# Exploitation properties

## Heat resistance

### Mechanical and electrical properties vs temperatures



Resistance to softening of CuNi3Si [Ref: 569]



Softening resistance of CuNi3Si for different temper [Ref: 243]

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

NO DATA AVAILABLE

### Half- softening temperature

NO DATA AVAILABLE

### Corrosion resistance

## Hydrogen embrittlement resistance

NO DATA AVAILABLE

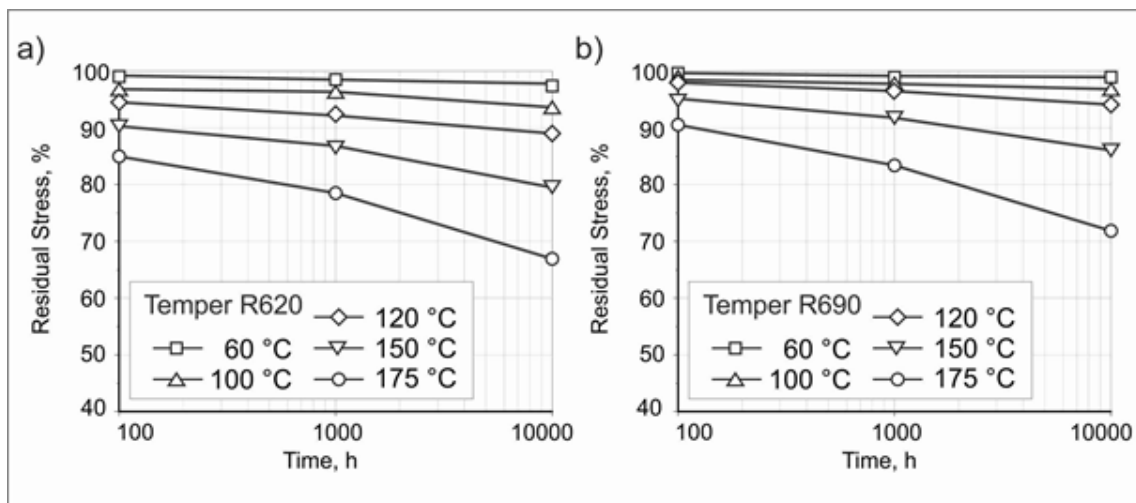
## Other kind of corrosion elements

Type of corrosion	Suitability	Literature
Atmospheric	Good	[Ref: 569, 243]
Marine environment	No data	-
Stress crack	Resistant	[Ref: 569, 243]
Hydrogen embrittlement	No data	-
Electrolytic	No data	-
Other	No data	-

## Rheological resistance

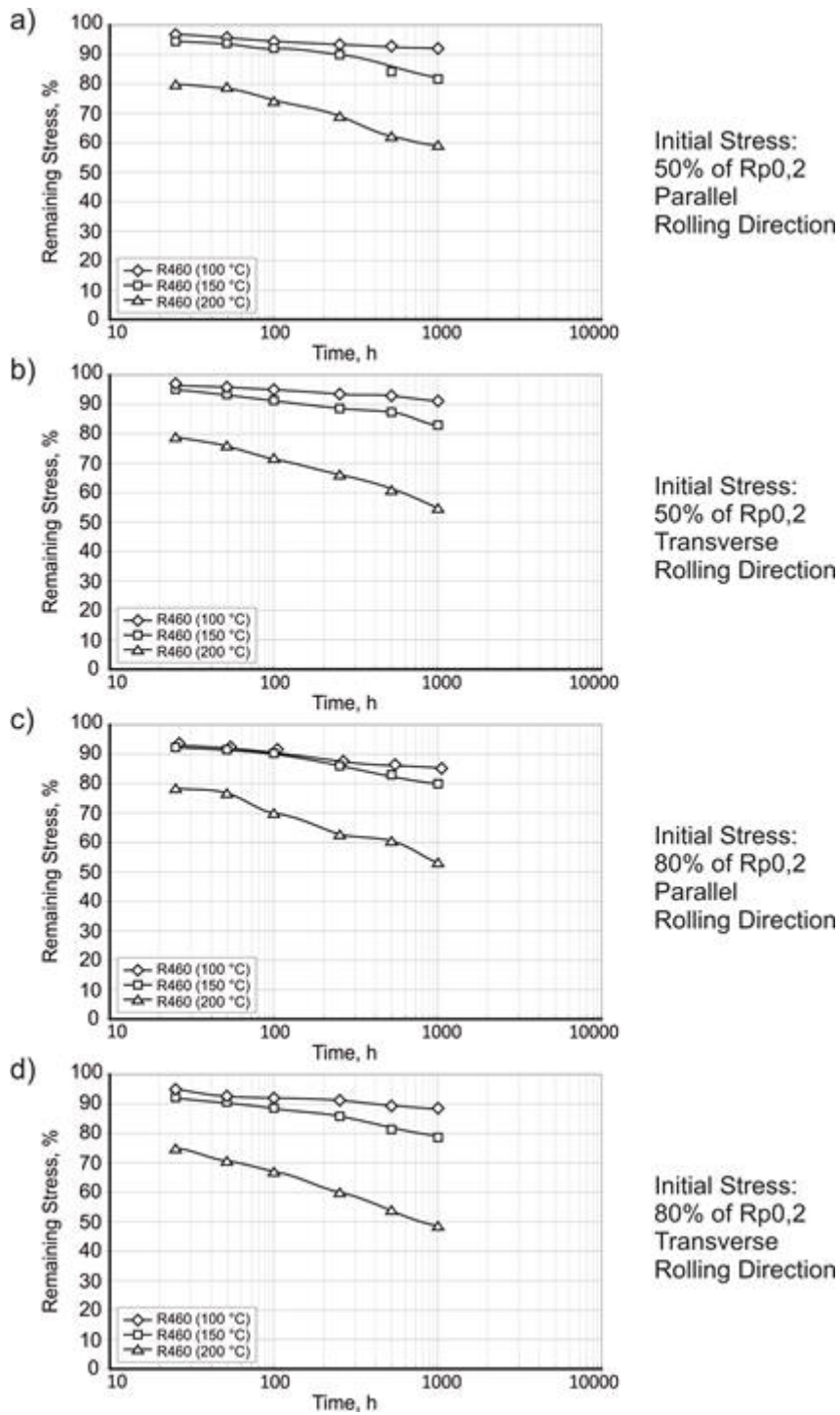
### Stress relaxation

*H temper condition up to 175°C - fair* [Ref: 235]



Stress relaxation of CuNi3Si [Ref: 569]





Stress relaxation of CuNi3Si at different temperature and temper [Ref: 243]

**Creep**

NO DATA AVAILABLE

**Wear resistance**

**Friction resistance**

NO DATA AVAILABLE

**Fatigue resistance**

### **Fatigue cracking**

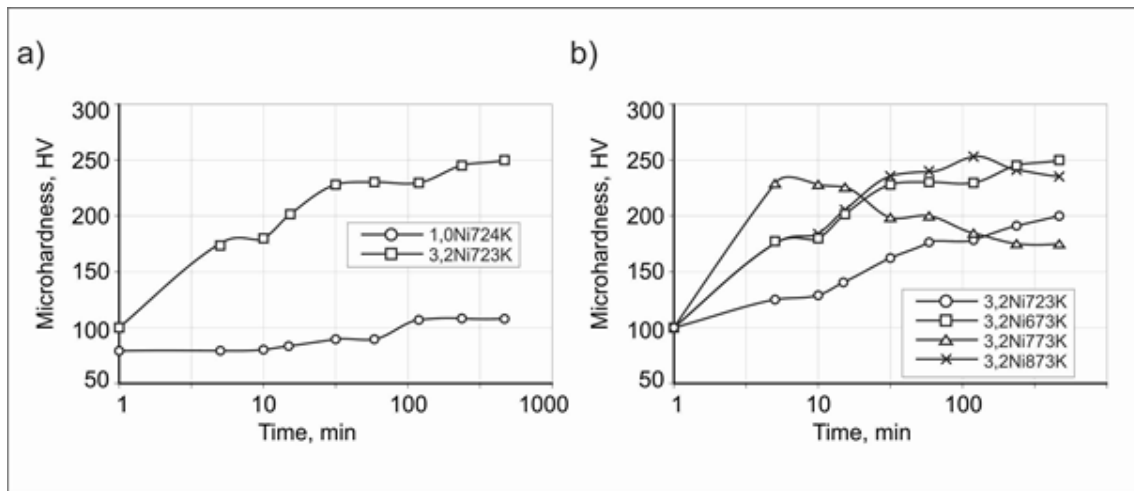
The fatigue strength is defined as the maximum bending stress amplitude with a material withstands for 10<sup>7</sup> load cycles under symmetrical alternate load without breaking. It is dependent on the temper tested and is about 1/3 of the tensile strength [Ref: 569].

### **Impact strength**

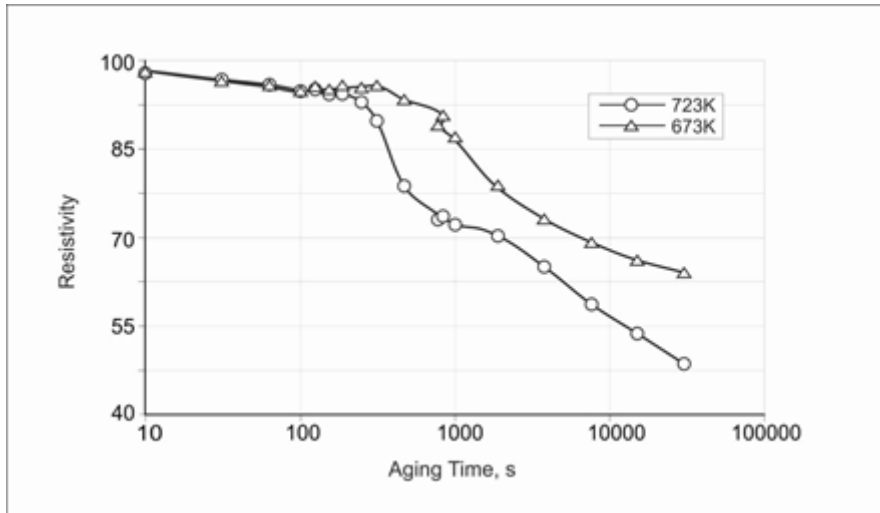
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## Fabrication properties

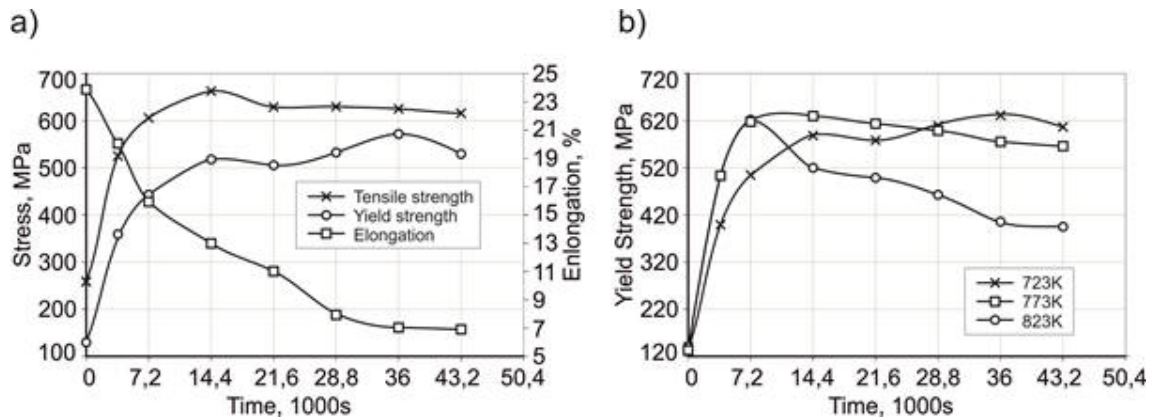
Fabrication properties	Value	Comments	Literature
Soldering	good		[Ref: 569]
Brazing	good		[Ref: 243]
Hot dip tinning	good		[Ref: 569]
Electrolytic tinning	good		[Ref: 569]
Electrolytic silvering	good		[Ref: 569]
Electrolytic nickel coating	good		[Ref: 569]
Laser welding	not recommended		[Ref: 569]
Oxyacetylene Welding	good		[Ref: 268]
Gas Shielded Arc Welding	good		[Ref: 569]
Coated Metal Arc Welding	fair		[Ref: 268]
Resistance welding	fair		[Ref: 243]
Capacity for Being Cold Worked	good		[Ref: 569]
Capacity for Being Hot Formed	excellent		[Ref: 268]
Forgeability Rating	40		[Ref: 268]
Machinability Rating	30		[Ref: 268]



The dependence of the microhardness on the aging time of CuNi3Si and CuNi1Si. (Note: Samples (strip) was solution heat-treated for 1h at 1173 K in an argon atmosphere and water quenched) [Ref: 229]



Variation of the electrical resistivity with time at 673 and 723 K for the CuNi<sub>3</sub>Si alloy, showing the onset of spinodal decomposition. (Note: Samples (strip) was solution heat-treated for 1 h at 1173 K in an argon atmosphere and water quenched) [Ref: 229]



(a) Yield strength, tensile strength and elongation of CuNi<sub>3</sub>Si as a function of aging time at 723 K; (b) yield strength of CuNi<sub>3</sub>Si as a function of aging time from 723 to 823 K. (Note: The strip was solution heat treated for 1 h at 1173K in an argon atmosphere and water quenched) [Ref: 242]

## Technological properties

Technological properties	Value	Comments	Literature
Melting temperature [°C]	1040-1075		[Ref: 268, 625 ]
Annealing temperature [°C]	250-650	1-3h	[Ref: 243]
Homogenization temperature [°C]	900		[Ref: 229]
Quenching temperature [°C]	900	1h	[Ref: 229]
Ageing temperature [°C]	450-500		[Ref: 229]
Stress relieving temperature [°C]	150-200	1-3h	[Ref: 243]

## References:

229. **Aging behavior of Cu–Ni–Si alloy** - Dongmei Zhao, Q.M. Dong, P. Liu, B.X. Kang, J.L. Huang, Z.H. Jin, Materials Science and Engineering A361 (2003) 93–99
235. **Copper-Nickel-Silicon (CuNi3Si)** - Diehl Metall
236. **Data sheet - CuNi3Si** - KME
242. **Structure and strength of the age hardened Cu–Ni–Si alloy** - D.M. Zhao, Q.M. Dong, P. Liu, B.X. Kang, J.L. Huang, Z.H. Jin, Materials Chemistry and Physics 79 (2003) 81–86
243. **Data sheet - CuNi3Si1Mg** - KME
268. **Copper Development Association Inc.** - [www.copper.org](http://www.copper.org)
569. **Data sheet - CuNi3Si1Mg** - Wieland-K55
570. **EN 12163 (2011) Copper and copper alloys. Rod for general purposes.** -
625. **Data sheet – CuNi3Si** - Busby Metals