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http://conductivity-app.org

CuNi1Si

UNS:C19010, C19015
EN:CW109C

Manufactures list:
Aurubis (http://www.aurubis.com/en/) - CuNi1Si(LNSP)
KM Europa Metal AG (http://www.kme.com/) - CuNi1Si(STOL76)

A copper alloys containing nickiel and silicon are heat treated. CuNi1Si has excellent cold and hot forming, good resistance to atmospheric corrosion, high mechanical and electrical properties, high wear resistance and fatigue strength.

Basic properties

Basic properties	Value	Comments
Density [g/cm^3]	8,9	
Specific heat capacity [J/(kg*K)]	377	
Temperature coefficient of electrical resistance (0...100°C) [10^{-3}/K]	2	
Electrical conductivity [T=20°C, (% IACS)]	29-60	(17-35 MS/m)
Thermal conductivity [W/(m*K)]	85-260	
Thermal expansion coefficient 20...300°C [10^{-6}/K]	16,8	
[Ref: 232, 239, 237]		

Applications

Main applications

Connectors, slide bearings, leadframe, electrical contact elements, clips for electrical contact lines, power supply and grounding, high corrosion resistance mechanical equipment, fittings. *Literature:* [Ref: 232, 240]

Kinds of semi-finished products/final products

Slide bearings technology, electrical technology, railway engineering, general mechanical engineering, die casting practice.

Chemical composition

Chemical composition	Value	Comments
Cu [wt.%]	97,08-98,3	Calculated
Fe [wt.%]	0-0,2	
Mn [wt.%]	0-0,1	
Ni [wt.%]	1,0-1,6	
Pb [wt.%]	0-0,02	
Si [wt.%]	0,4-0,7	
Others [wt.%]	0,3	
[Ref: 570]		

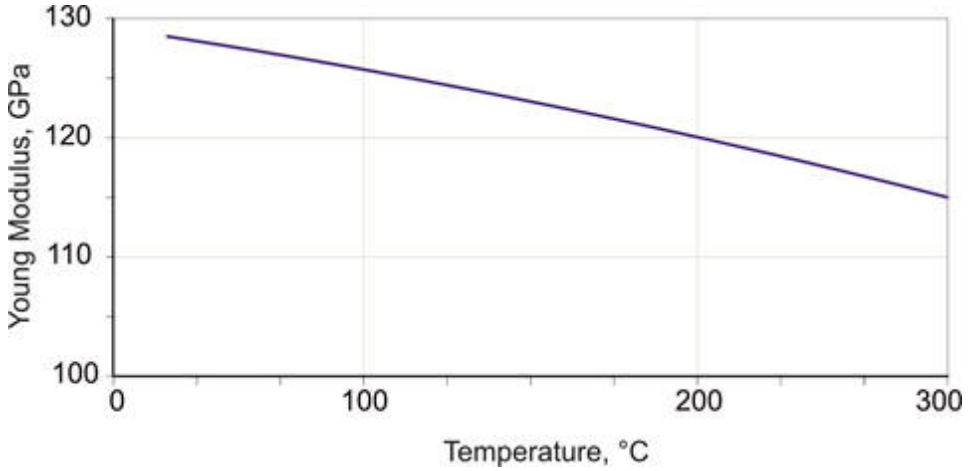
Mechanical properties

Mechanical properties	Value	Comments	Literature
UTS [MPa]	240-650		
YS [MPa]	90-620		
Elongation [%]	5-25		
Hardness	100-205	[HV]	
Young's modulus [GPa]	128		
Kirchhoff's modulus [GPa]	No data		
Poisson ratio	No data		

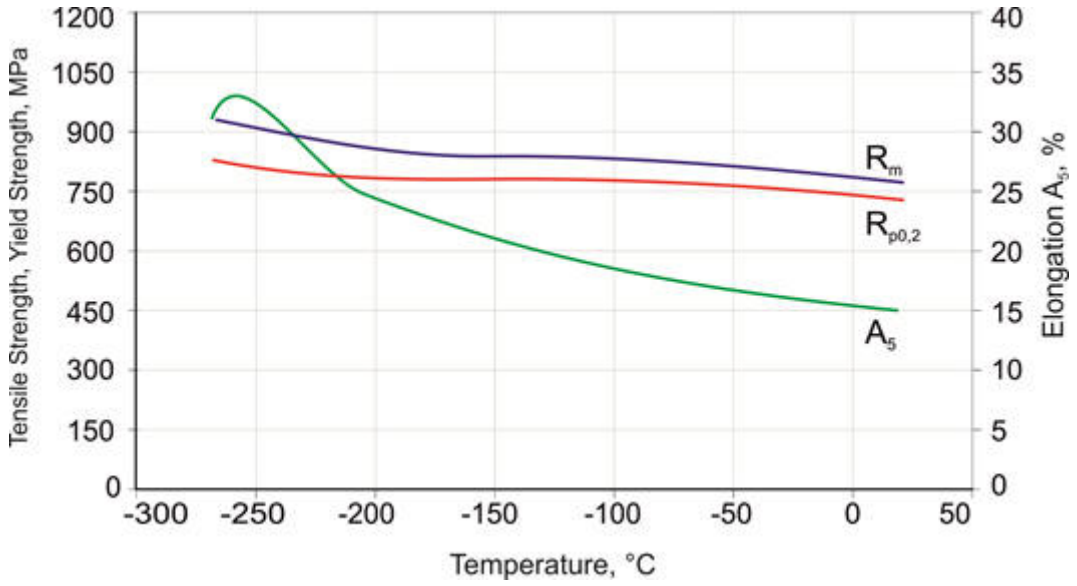
Material's mechanical and electrical properties in different tempers

Temper	Tensile strength, MPa	Yield strength (min), MPa	Elongation (min)A50mm, %	Hardness	Literature
R360/H100	360-430	250	12	100-130 HV	[Ref: 239]
R410/H130	410-480	360	10	130-150 HV	
R460/H140	460-530	430	8	140-160 HV	
R520/H150	520-570	490	5	150-170 HV	
R580/H175	580-650	540	6	175-205 HV	
R440, Rod	440	300	16 ($Lo=5,65*(So)^{0,5}$)		EN 12163 (2011)
R540, Rod	540	470	10 ($Lo=5,65*(So)^{0,5}$)		
R590, Rod	590	540	12 ($Lo=5,65*(So)^{0,5}$)		
R440, Wire	440	300	16 ($Lo=5,65*(So)^{0,5}$)		EN 12167 (2011)
R540, Wire, rod, sheet, strip, tube.	540	470	12 ($Lo=5,65*(So)^{0,5}$)		
R590, Wire, rod, sheet, strip, tube.	590	540	10 ($Lo=5,65*(So)^{0,5}$)		

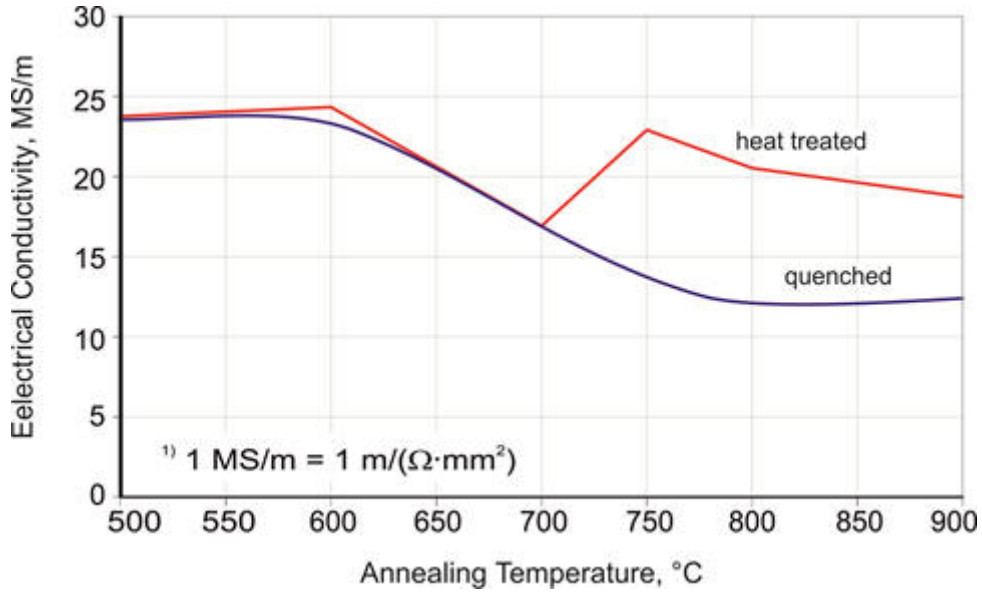
R240, Rod	min. 240	90	25 (A_{100})		[Ref: 232]
R300, Rod	min. 300	210	16 (A)		
R350, Rod	min. 350	280	12 (A)		
R410, Rod	min. 410	320	5 (A_{100})		
R440, Rod	min. 440	320	12 (A_{100})		
R500, Rod	min. 500	420	10 (A)		
R540, Rod	min. 540	450	10 (A)		
R590, Rod	min. 590	570	8 (A_{100})		
R250, Profile	min. 250	100	35 (A)		
R380, Profile	min. 380	250	8 (A)		
R420, Profile	min. 420	260	15 (A)		
R560, Profile	min. 560	520	10 (A)		
R410, Wire	min. 410	400	6 ($A_{11,3}$)		
R450, Wire	min. 450	440	5 (A_{100})		
R590, Wire	min. 590	580	7 (A_{100})		
R650, Wire	min. 650	620	7 (A100)		



Modulus of elasticity vs. temperature of CuNi1Si [Ref: 232]



Mechanical properties vs. temperature below 0°C of CuNi1Si (age hardened at 450°C for 2 hour) [Ref: 232]

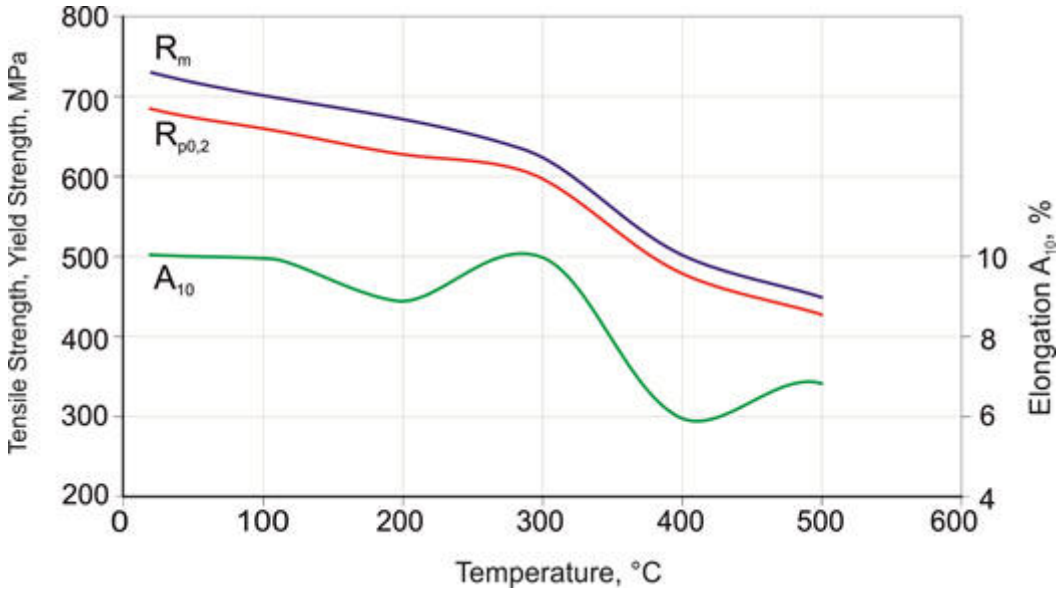


Electrical conductivity vs. annealing temperature of CuNi2Si [Ref: 232]

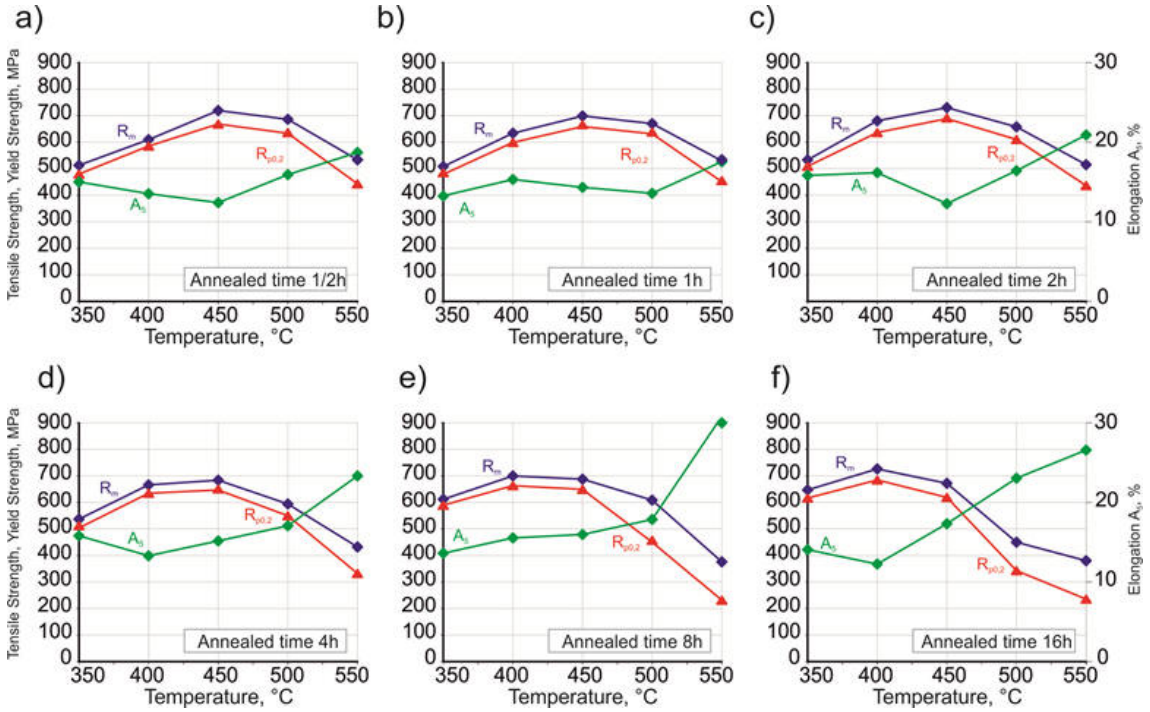
Exploitation properties

Heat resistance

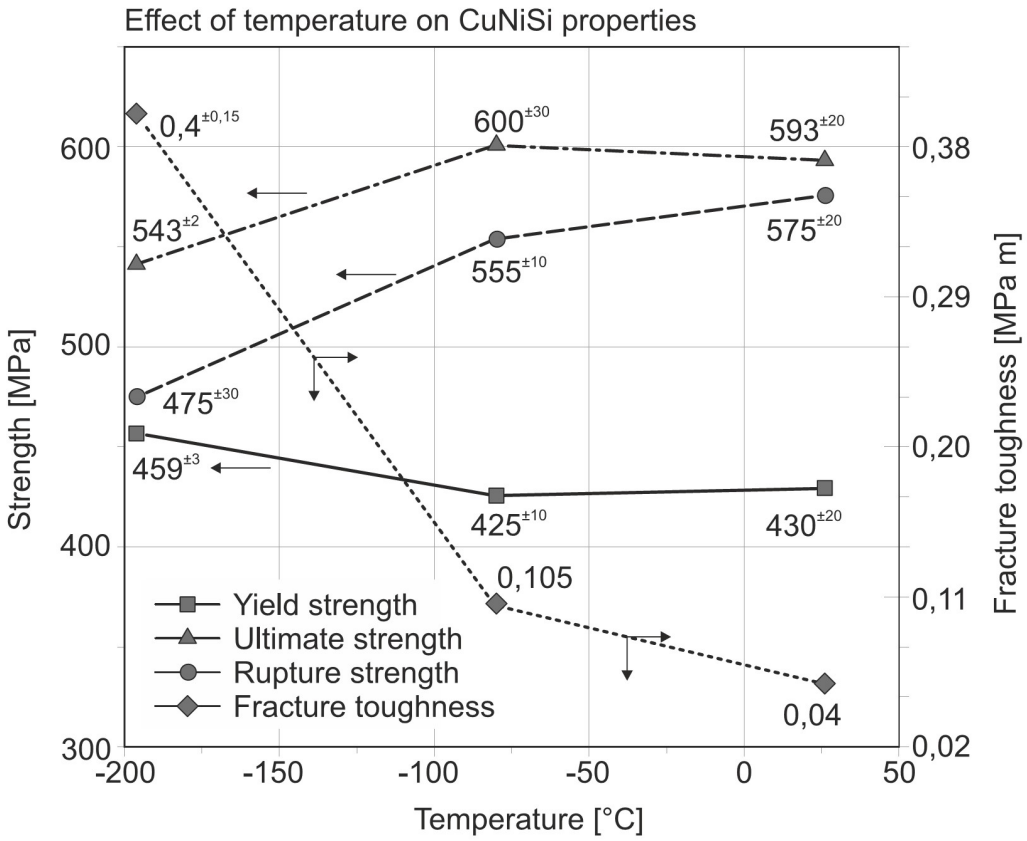
Mechanical and electrical properties vs temperatures



Heat resistance of CuNi1Si [Ref: 232]



Influence of annealing temperature and time on CuNi1Si mechanical properties after cold deformation of 80% [Ref: 232]



Effect of Temperature on the strength and fracture toughness of precipitation hardened CuNiSi [Ref: 237]

Long-therm 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

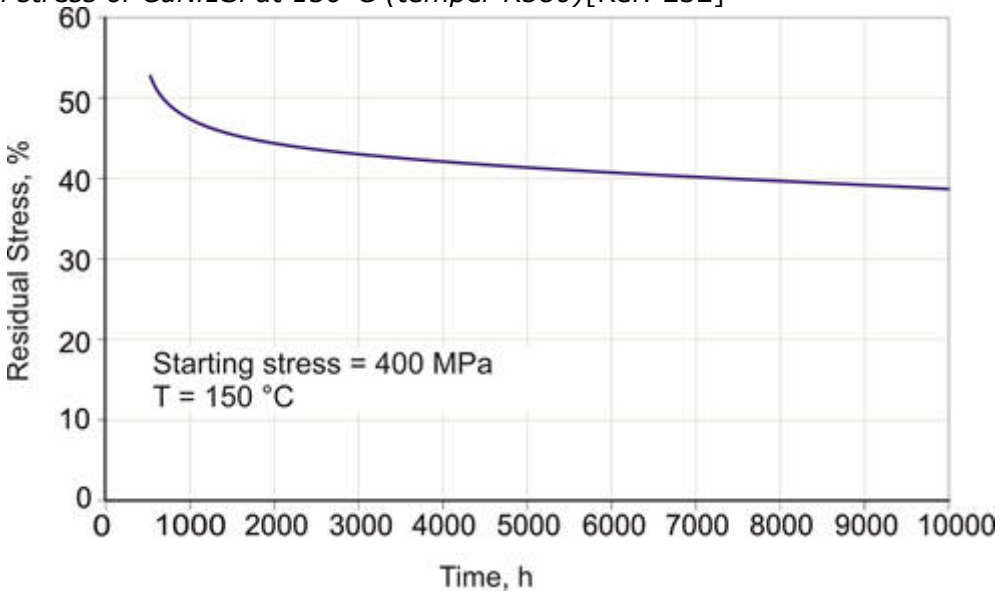
Type of corrosion	Suitability	Literature
Atmospheric	Good	[Ref: 232]
Marine environment	Good	[Ref: 232]

Stress crack	Not resistant	[Ref: 239]
Hydrogen embrittlement	No data	-
Electrolytic	No data	-
Other	No data	-

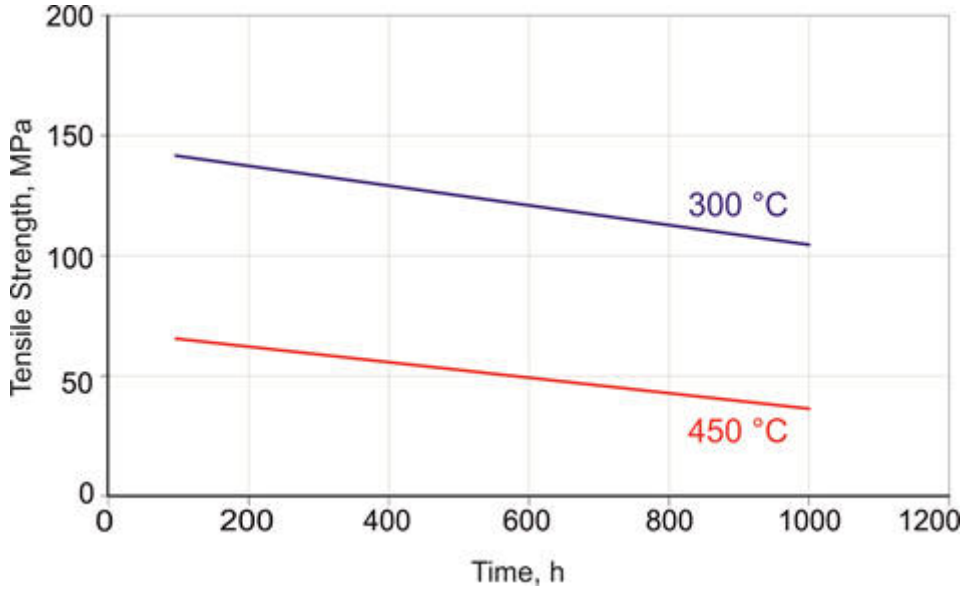
Rheological resistance

Stress relaxation

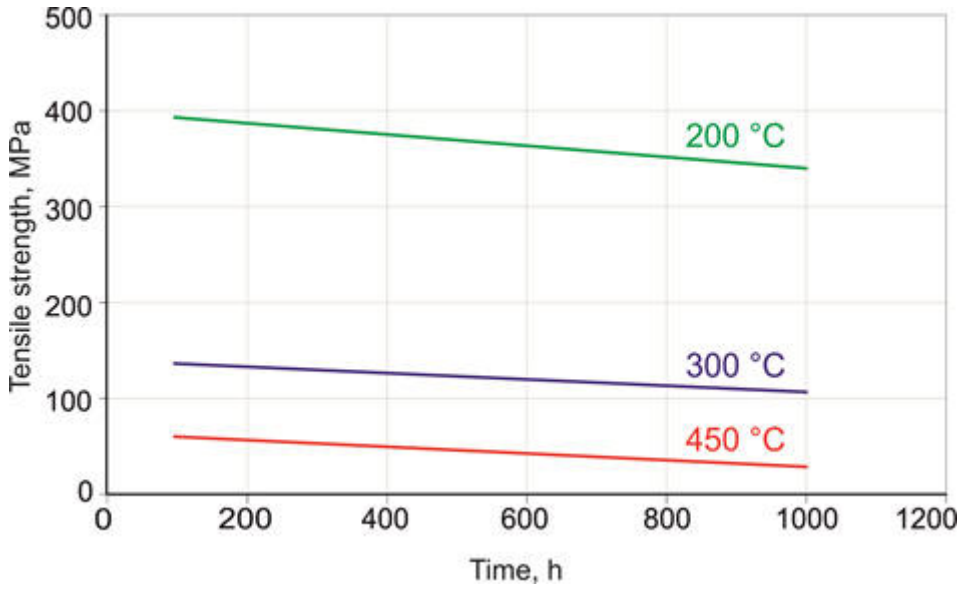
Residual stress of CuNi1Si at 150°C (temper R580)[Ref: 232]



Creep



Creep strength of CuNi1Si supersaturated hardened [Ref: 232]



Creep strength of CuNi1Si thermally hardened [Ref: 232]

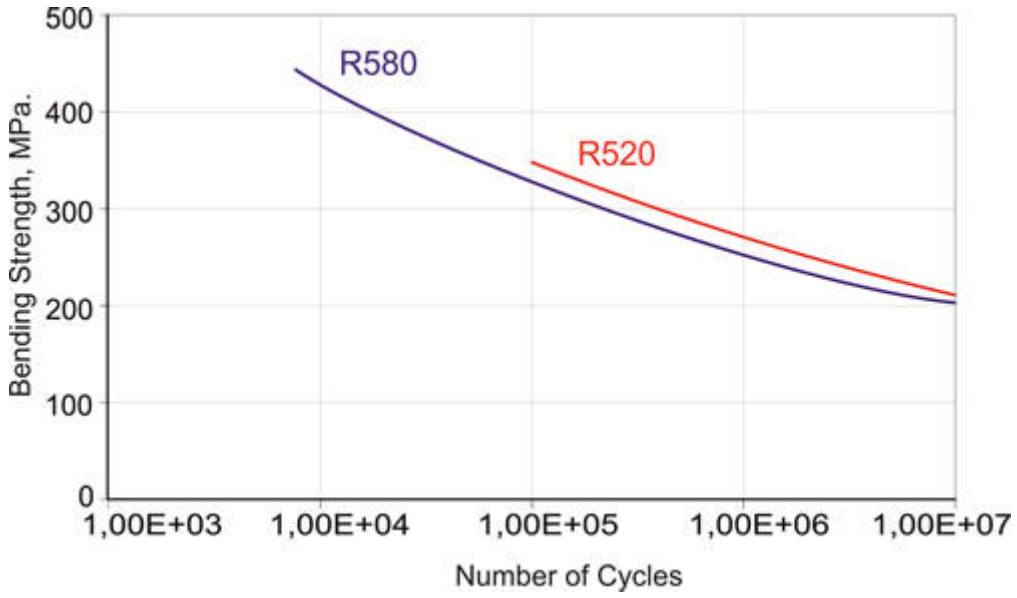
Wear resistance

Friction resistance

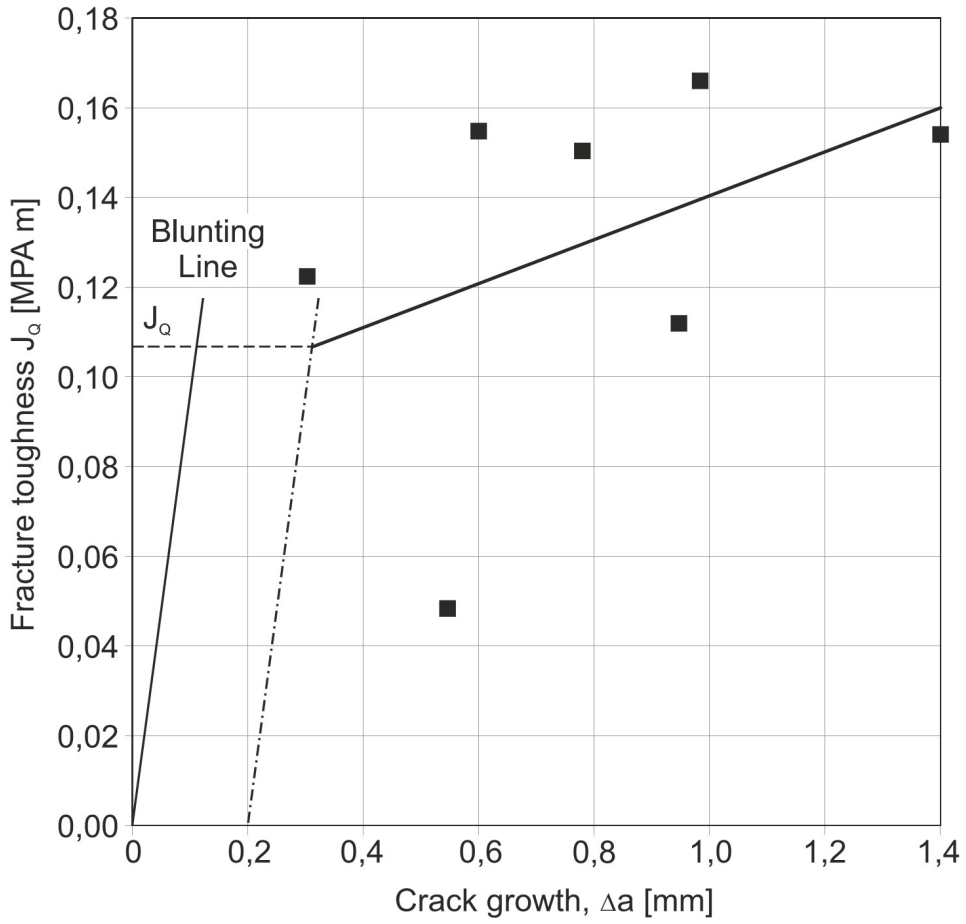
NO DATA AVAILABLE

Fatigue resistance

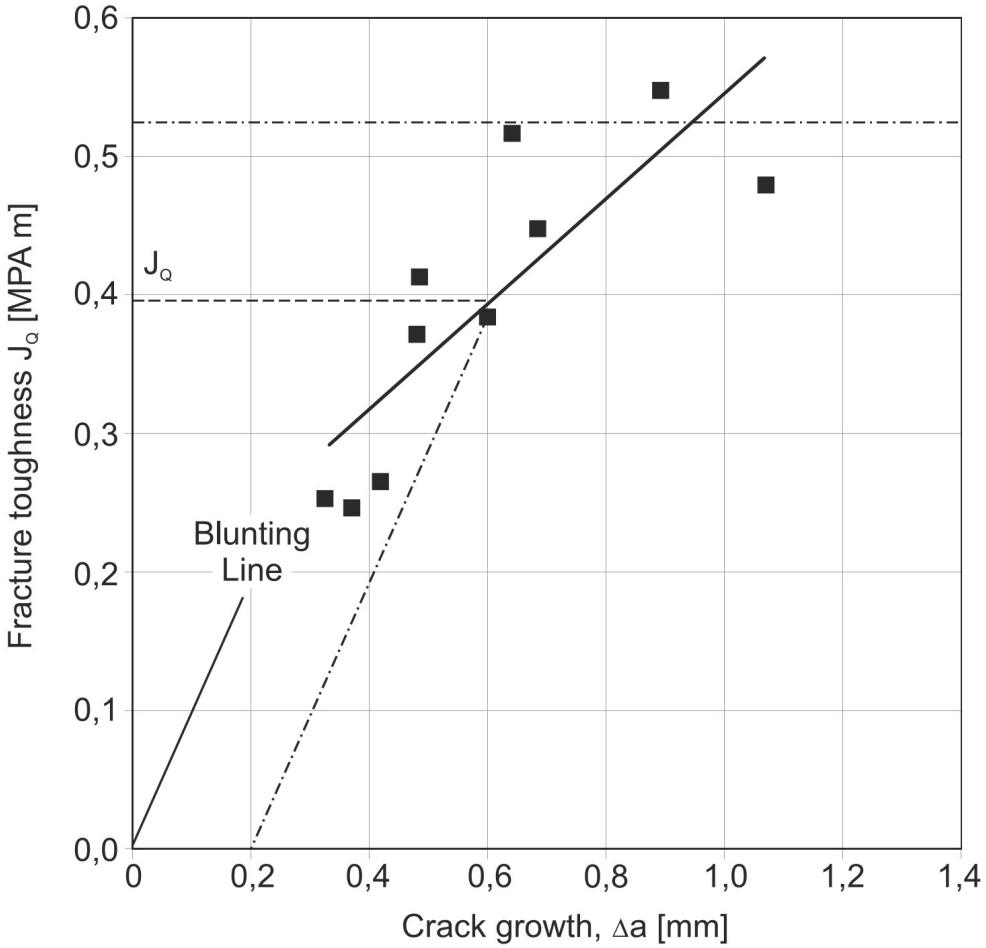
Fatigue cracking



Fatigue strength on bending vs number of cycles of CuNi1Si [Ref: 232]



Measured J *versus crack extension, Δa, from a series of fracture toughness tests at -80o C with CT precipitation hardened CuNiSi specimens. Δa assumed as half the height of the triangular fractured surface* [Ref: 237].



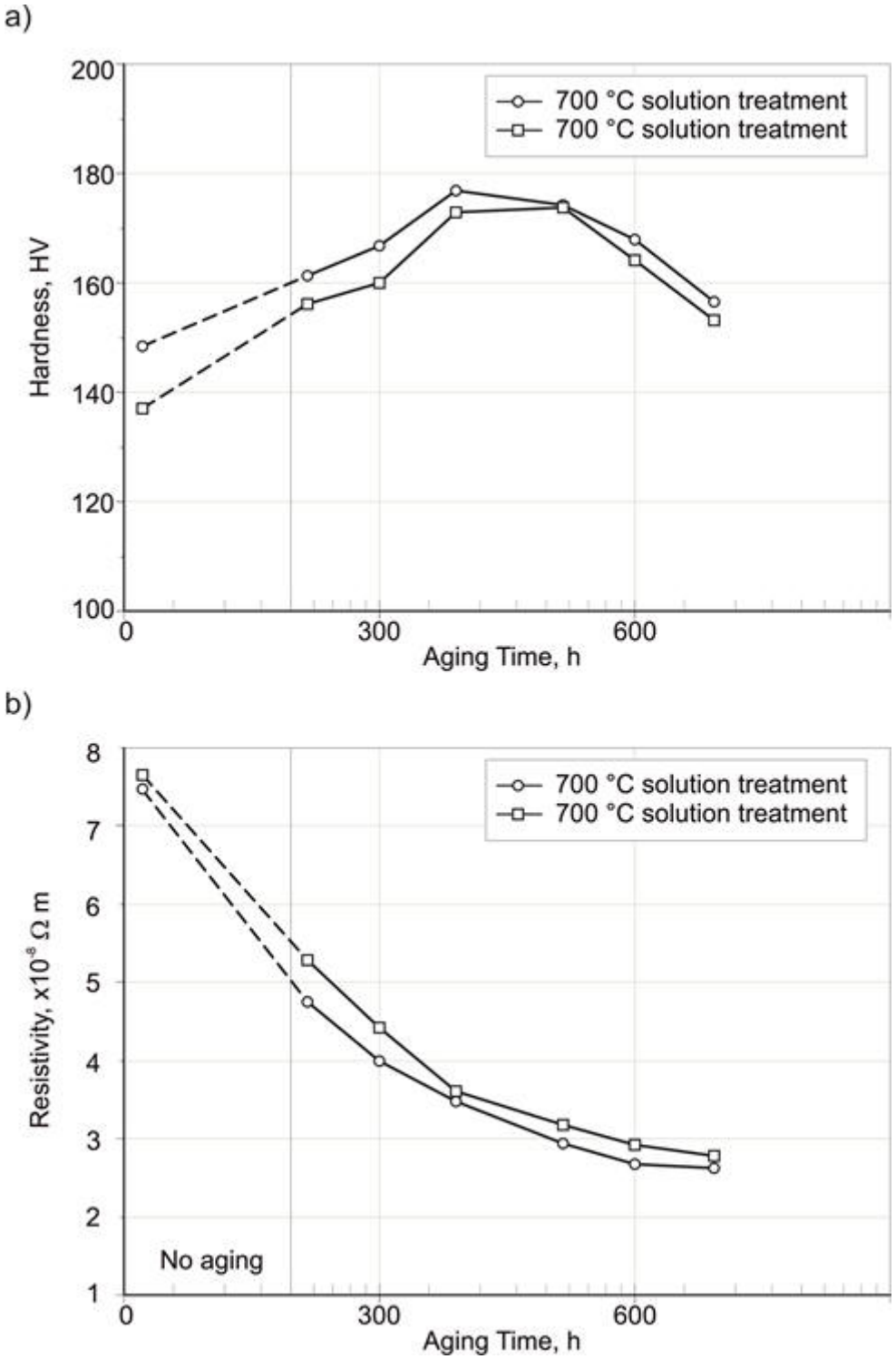
Measured J versus crack extension, Δa, from a series of fracture toughness tests at -196 oC with CT precipitation hardened CuNiSi specimens. Δa assumed as half the height of the triangular fractured surface [Ref: 237]

Impact strength

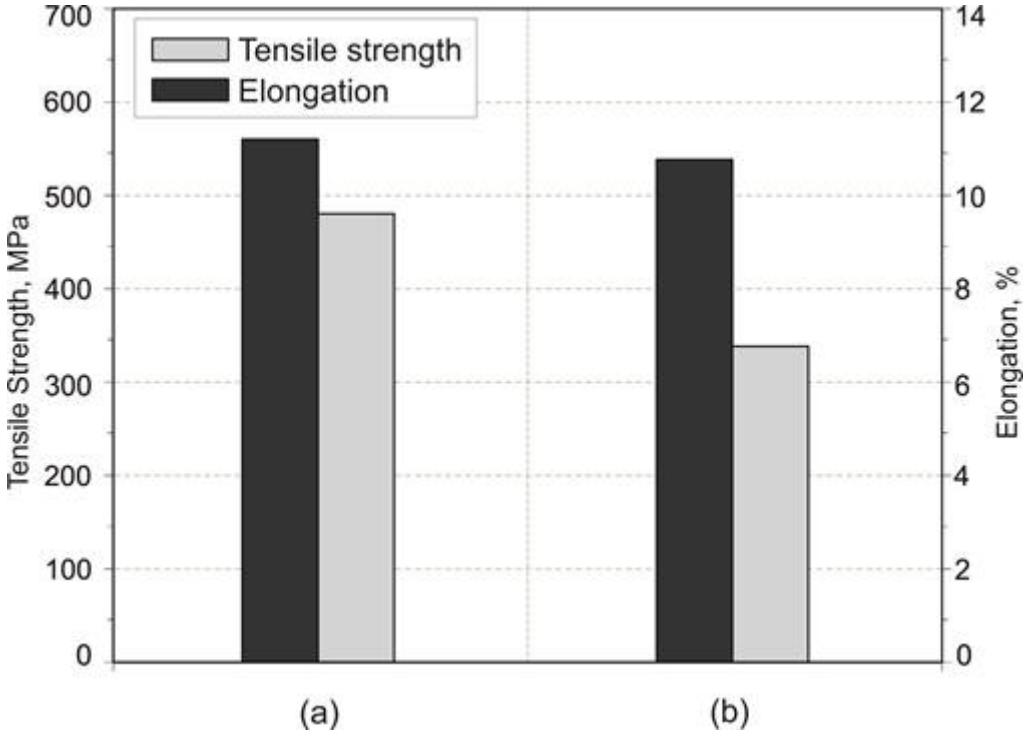
NO DATA AVAILABLE

Fabrication properties

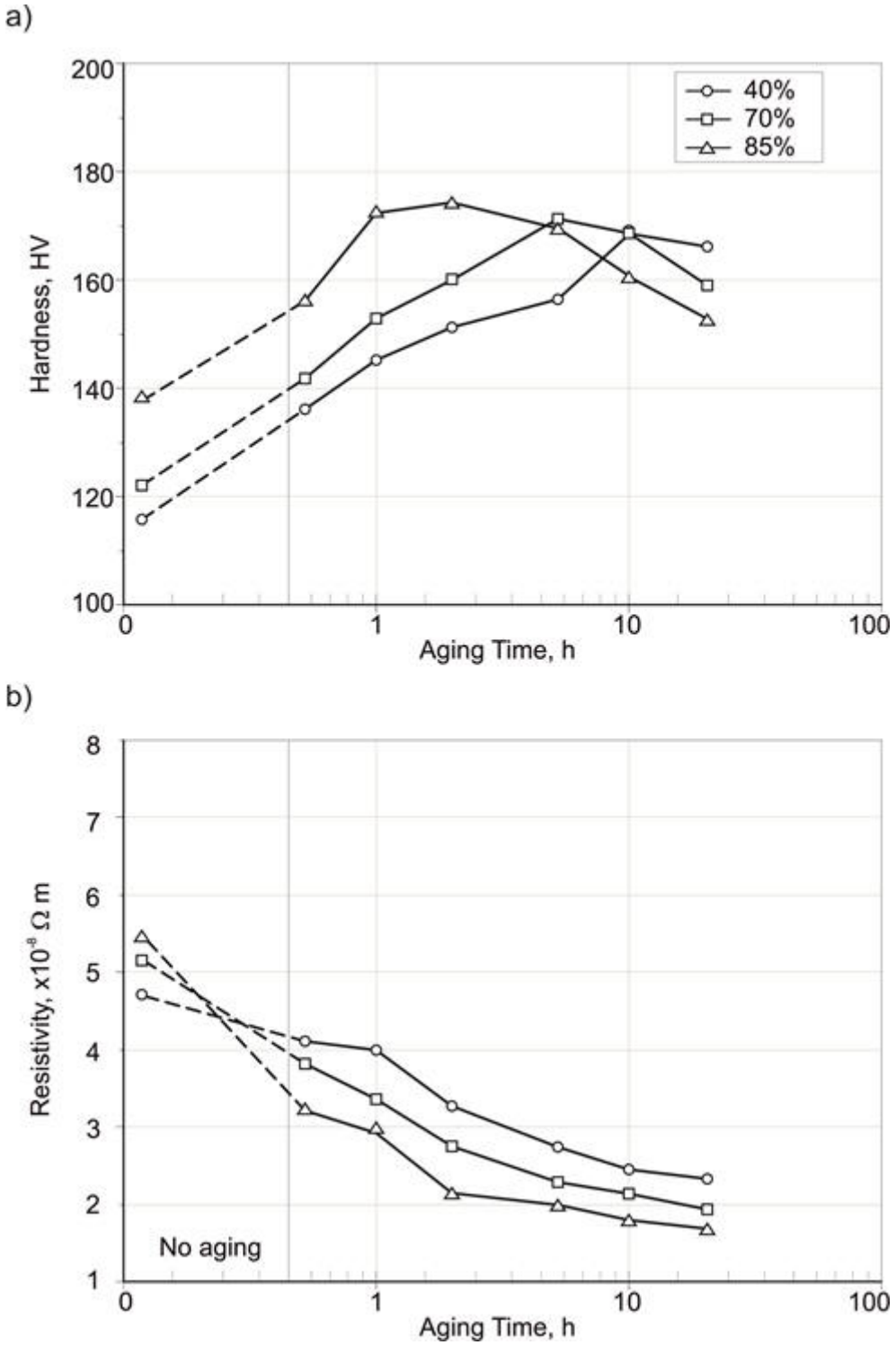
Fabrication properties	Value	Comments
Soldering	good	
Brazing	fair	
Hot dip tinning	good	
Electrolytic tinning	good	
Electrolytic silvering	good	
Electrolytic nickel coating	good	
Laser welding	fair	
Oxyacetylene Welding	not recommended	
Gas Shielded Arc Welding	fair	
Spot Weld	good	
Seam Weld	good	
Butt Weld	good	
Capacity for Being Cold Worked	good	
Capacity for Being Hot Formed	good	
Machinability Rating	30	
[Ref: 232]		



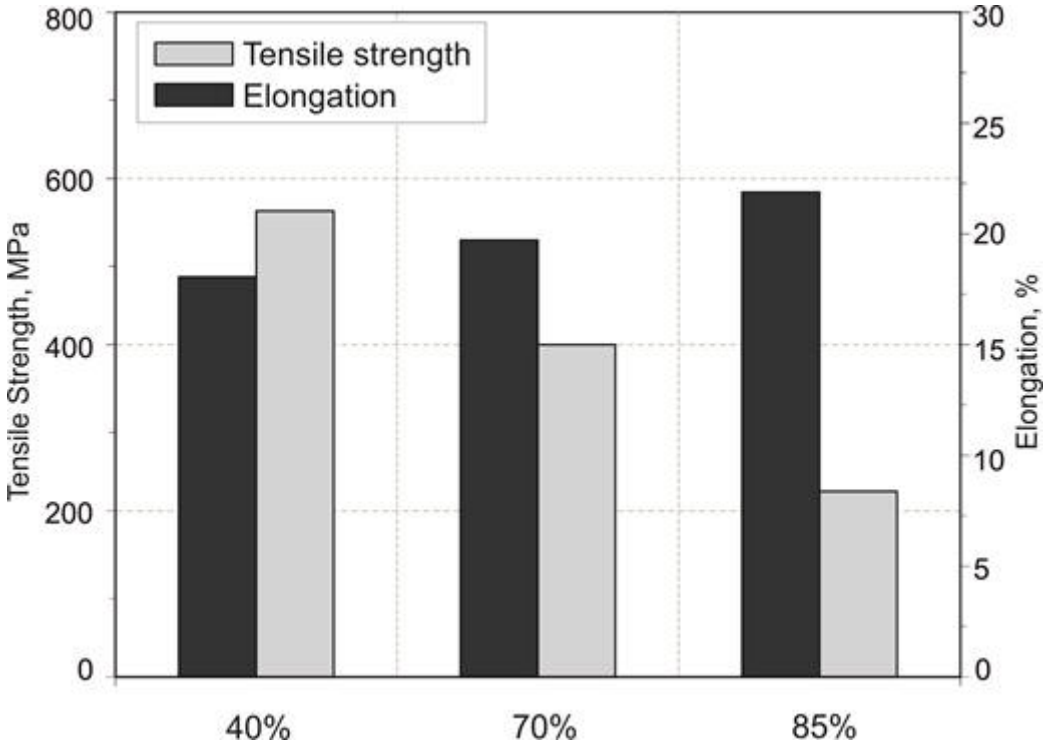
The variations of hardness and electrical resistivity of Cu1.5 Ni-0.3Si-0.03P-0.05Mg leadframe alloy with varying aging time at 450°C. Cu-1.5Ni-0.3Si-0.03P-0.05Mg is cold rolled 80% and aged at 450°C after solution treatment; (a) hardness, (b) electrical resistivity [Ref: 230].



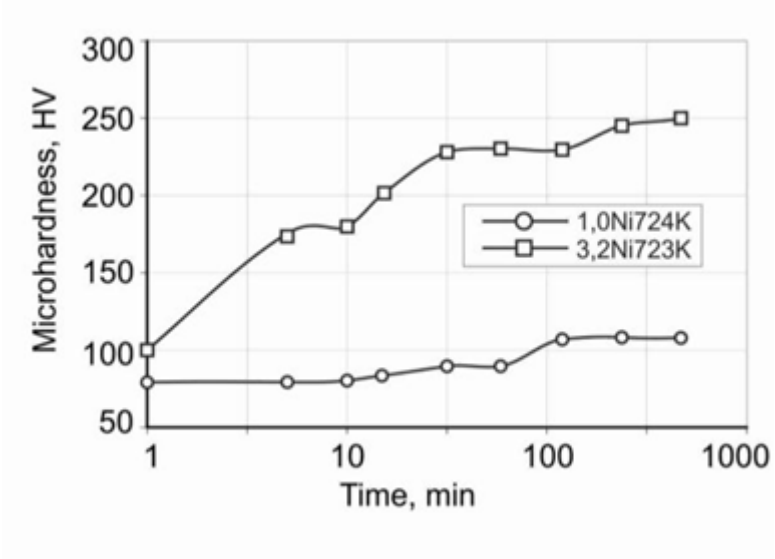
The comparison of tensile strength and elongation of Cu-1.5Ni-0.3Si-0.03P-0.05Mg leadframe alloy with different initial grain size; (a) initial grain size of 10 μm after solution treatment at 700°C, (b) initial grains size of 15 μm after solution treatment at 800°C [Ref: 230].



The variation of (a) hardness and (b) electrical resistivity of Cu-1.5Ni-0.3Si-0.03P-0.05Mg leadframe alloy cold rolled to 40, 70, 85% with increasing aging time at 450°C [Ref: 230].



The variation of tensile properties of Cu-1.5Ni-0.3Si-0.03P- 0.05Mg leadframe alloy with varying cold rolling ratio from 40 to 85% at peak aged condition at 450°C [Ref: 230].



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

Technological properties

Technological properties	Value	Comments
Melting temperature [°C]	1050-1070	
Annealling temperature [°C]	650-750	
Homogenization temperature [°C]	750-850	
Ageing temperature [°C]	425-490	
Hot working temperature [°C]	800-900	
[Ref: 232]		

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

230. **Effect of thermomechanical treatments on microstructure and properties of Cu-base leadframe alloy** - HO J. RYU, HYUNG K. BAIK, SOON H. HONG, JOURNAL OF MATERIALS SCIENCE 35 (2000) 3641 – 3646

232. **CuNi1Si** - Deutsches Kupferinstitut

237. **Tensile and Fracture Toughness Tests of CuNiSi at Room and Cryogenic Temperatures** - P A Ageladarakis, N P O'Dowd, G A Webster, JET–R(99)01

239. **Data sheet - CuNiSi** - Kemper

240. **Material data sheet CARODUR® A special alloy on CuNiSi-base** - Austria Buntmetall

570. **EN 12163 (2011) Copper and copper alloys. Rod for general purposes.** -