CuFe1P

UNS:C19200, C19210
EN:-

Manufactures list:
Aurubis (http://www.aurubis.com/en/) - CuFe1P
Wieland-Werke AG (http://www.wieland.de/) - K80

CuFe1P has a nominal copper content of 99.9%, CuFe1P has small amount of iron and phosphorus in chemical compositions, and is hardened by Fe2P precipitates in copper matrix. It is heat-treat hardenable copper alloys. High performance copper alloy with relatively high strength and electrical conductivity Its electrical conductivity is 80% IACS 20°C and it has good heat resistant characteristics. It has good hot forgeability and good capacity for being cold work. Its workability characteristics are good and it can be fabricated by a wide range of processes. It can be machined successfully and joined by a number of methods. This alloy has good resistance to softening and to stress corrosion cracking. In many environments its corrosion resistance is similar to that of copper.
CuFe1P has higher stengths than many alloys found on the market today. CuFe1P retains much of the formability and conductivity that is often lost on the other copper alloys. This enables purchase a material that is superior in strength; allowing higher contact forces.

Basic properties

Basic properties	Value	Comments
Density [g/cm^3]	8,86-8,92	
Specific heat capacity [J/(kg*K)]	385	
Temperature coefficient of electrical resistance (0...100°C) [10^{-3}/K]	3,2	
Electrical conductivity [T=20°C, (% IACS)]	91	
Thermal conductivity [W/(m*K)]	350	
Thermal expansion coefficient 20...300°C [10^{-6}/K]	17	20-100°C
[Ref: 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257]		

Electrical conductivity requirements according to standard ASTM B465

Temper	Electrical conductivty MS/m	Electrical conductivity % IACS	Source
O50	min. 35	min. 60	[Ref: 260]
O60	min. 35	min. 60	
O61	min. 35	min. 60	
O62	min. 35	min. 60	
H01	min. 35	min. 60	
H02	min. 35	min. 60	
H03	min. 35	min. 60	
H04	min. 35	min. 60	
HO6	min. 35	min. 60	
HO8	min. 35	min. 60	
H10	min. 35	min. 60	
H14	min. 35	min. 60	

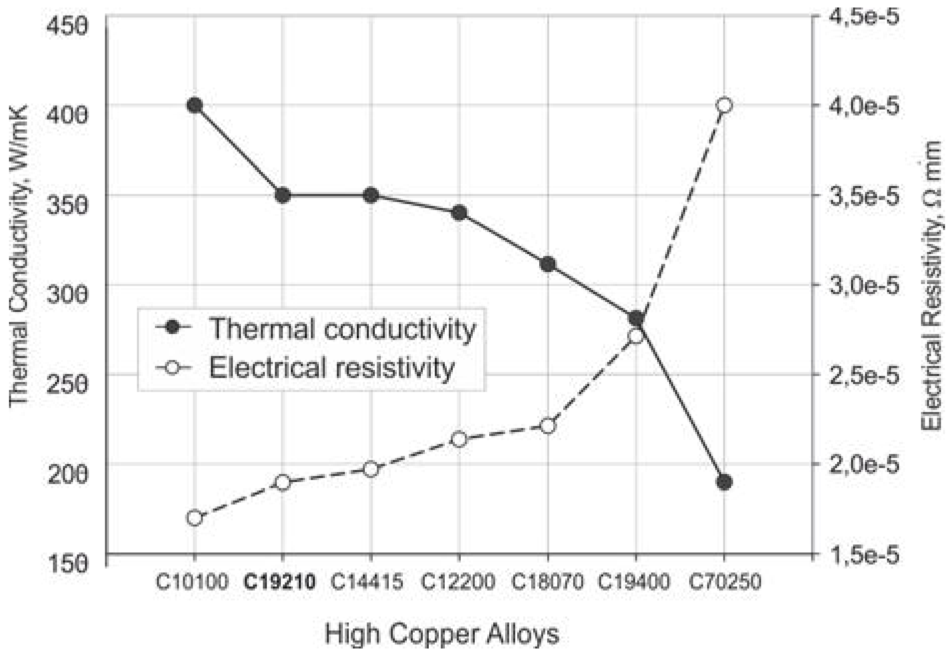
Electrical requirements of CuFe1P of lead frames

Name of alloy	Electrical conductivty MS/m	Electrical conductivity % IACS	Literature
Lead frame alloy	Min38	Min 60	[Ref: 252]

Electrical properties for different tempers of CuFe1P

Temper	Electrical conductivty MS/m	Electrical conductivity % IACS	Literature

R290	46.4	80	[Ref: 245]
R320	46.4	80	
R355	46.4	80	
R370	464	80	
R410	46.4	80	
R440	46.4	80	
R455	46.4	80	



Thermal conductivity and electrical conductivity for CuFe1P (C19210) and different copper alloys [Ref: 261]

Applications

Main applications

Typical uses for CuFe1P comprise air conditioning and heat exchanger tubing. applications requiring resistance to softening and stress corrosion. automotive hydraulic brake lines. cable wrap. circuit breaker components. contact springs. electrical connectors and terminals. eyelets. flexible hose. fuse clips. gaskets. gift hollow ware and lead frames for QFP, QFN package and LED. Literature: [Ref: 245, 246, 247, 252, 254, 265, 266]

Kinds of semi-finished products/final products

The common fabrication processes for copper alloy 19200 include blanking. coining. drawing. etching. forming and bending. heading. upsetting. hot forging and pressing. shearing. spinning. squeezing and stamping.

Product	Specification
Bar. Rolled	ASTM B465
Plate	ASTM B465
Sheet	ASTM B465
Strip	ASTM B465
Tube	SAE J463. J461
Tube. Condenser	ASME SB111
	ASTM B111
Tube. Finned	ASME SB359
	ASTM B359
Tube. Seamless	ASTM B469
Tube. U-Bend	ASME SB395
	ASTM B395

Chemical composition

Chemical composition	Value	Comments
Cu [wt.%]	98,76-99,19	Calculated
Fe [wt.%]	0,8-1,2	
P [wt.%]	0,01-0,04	
[Ref: 254, 265]		

Chemical composition of C19210 [Ref: 245, 254, 266]

Chemical composition, weight percentage,												
Ag	Mg	Sn	Ni	Si	Cr	Zr	Fe	P	Pb	Zn	other	Cu
-	-	-	-	-	-	-	0.05-0.15	0.025 -0.04	-	-	-	99.9

Mechanical properties

Mechanical properties	Value	Comments	Literature
UTS [MPa]	275-570		
YS [MPa]	110-480		
Elongation [%]	2-30		
Hardness	80-170	[HV]	
Young's modulus [GPa]	130		
Kirchhoff's modulus [GPa]	44		
Poisson ratio	0,34		

Mechanical properties of CuFe1P according copper.org

Kind of semiproduct	Temper	Tensile strength MPa	Yield stregth MPa	Elongation 50. %	Rockwell Hrdenss. HRC
Flat Products	O60	310	138	25	38
Flat Products	H02	448	310	18	55
Flat Products	H06	483	455	3	75
Flat Products	H04	448	414	7	72
Flat Products	H08	510	490	2	76
Flat Products	H10	531	510	2	77
Flat Products	H01	345	255	25	45
Tube	O60	255	76	40	-
Tube	O50	290	152	30	-

Mechanical requirements according ASTM standards (different tempers)

Temper	Tensile strength. MPa	Yield strength 0.2% MPa	Elongation 50 %	Literature
O61	190-290	110	30	[Ref: 250]
H01	300-365	135	20	
H02	325-410	310	5	
H03	355-425	345	4	
HO4	385-455	355	3	
H06	410-480	400	2	

Mechanical properties of flat products. 1 mm thick

Temper	Tensile strength MPa	Yield strength. 0.2% MPa	Elongation 50 mm. %	Literature

O60	310	Min.140	Min.25	[Ref: 254, 258]
O82	395	305	20	
HO2	395	305	9	
HO4	450	415	7	
HO6	485	460	3	
HO8	510	490	Min.2	
H10	530	510	Min. 2	

TUBING. 48mm outside diameter x 3 mm wall thickness

Temper	Tensile strength MPa	Yield strength. 0.2% MPa	Elongation 50 mm. %	Hardness HRB	Literature
O50	290	150	30	38	[Ref: 254]
O60	255	76	40	-	
H80(40%)	385	360	7	-	

Mechanical properties of CuFe1P according Wieland

Temper	Tensile strength MPa	Yield strength MPa	Elongation A10 %	Hardness HV	Literature
R300	300-380	<=300	>=10	80-110	[Ref: 247]
R360	360-440	>=260	>=3	100-130	
R420	420-500	>=350	>=2	120-150	

Mechanical properties of CuFe1P

Temper	Tensile strength MPa	Yield strength MPa	Elongation A10 %	Literature
R290	290-370	135-240	20	[Ref: 245]
R320	320-425	310-410	5	
R355	355-425	345-425	4	
R370	370-460	355-460	3	
R410	410-480	400-480	2	
R440	Min440	Min.425	1	
R455	Min 455	Min.440	1	

Mechanical properties of CuFe1P according SofiaMed

Temper	Tensile strength MPa	Yield strength MPa	Hardness Vickers HV	Elongation A10 %	Literature

0/R300/HV80	300-380	<300	80-110	>15	[Ref: 648]
H02/R360/HV100	360-440	280	110-130	>6	
H04/R390/HV110	390-450	330	110-140	>3	
H06/R415/HV130	415-480	380	120-145	>3	
H08/R450/HV140	450-520	430	130-160	<2	

Exploitation properties

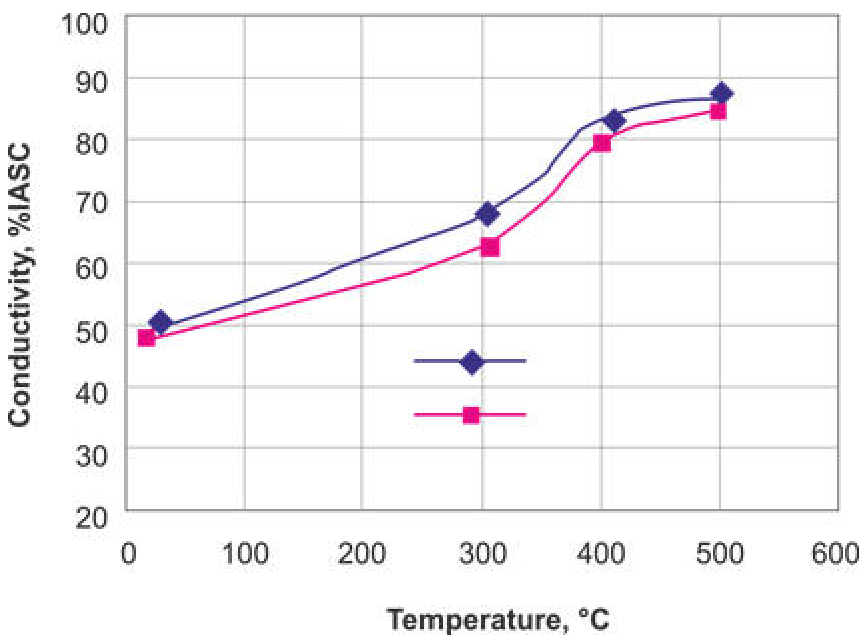
Heat resistance

Mechanical and electrical properties vs temperatures

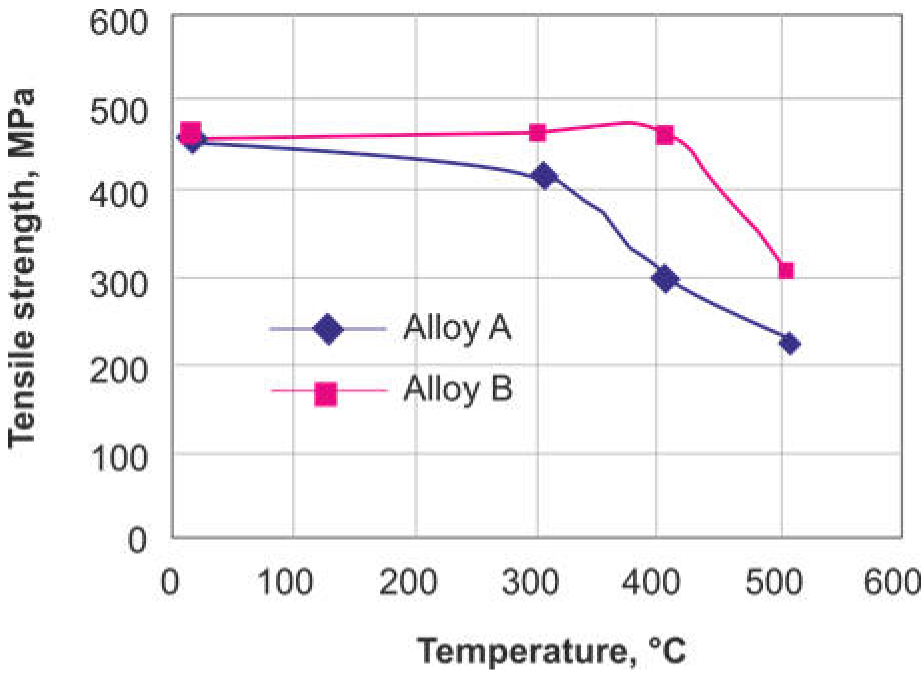
The cast CuFe1P were hot rolled into bars of 22mm diameter and solution treated for 70min at 900 ?C in a furnace full of nitrogen atmosphere. followed by water quenching. These solution treated bars were cold rolled by about 50% into rods. Then the rods were machined into tensile samples of 10mm diameter and cut into conductivity test samples 2 mm in diameter and 200mm in length [Ref: 267]

Chemical composition of CuFe alloys A and B [Ref: 267]

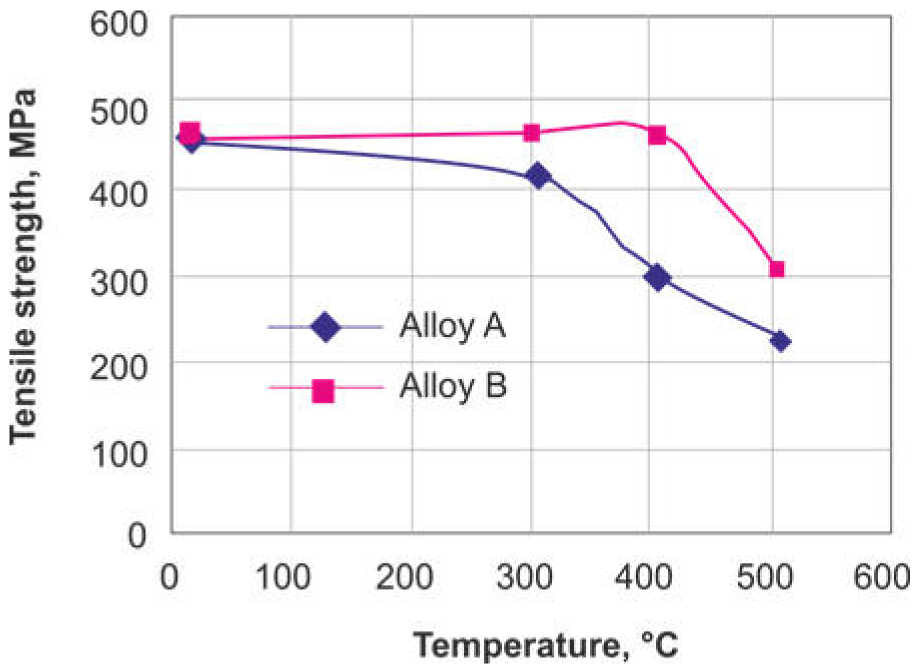
Alloy	Chemical composition, wt%				
	Fe	P	B	Ce	Cu
Alloy A	0.22	0.06	-	-	Rest
Alloy B	0.22	0.06	0.02	0.05	Rest



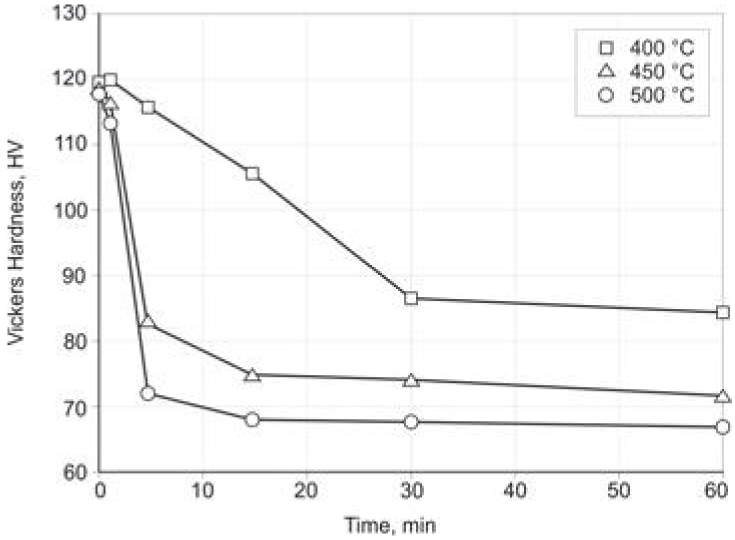
Electrical conductivity vs annealing temperature of CuFe1P [Ref: 267]



Tensile strength vs annealing temperature of CuFe1P [Ref: 267]

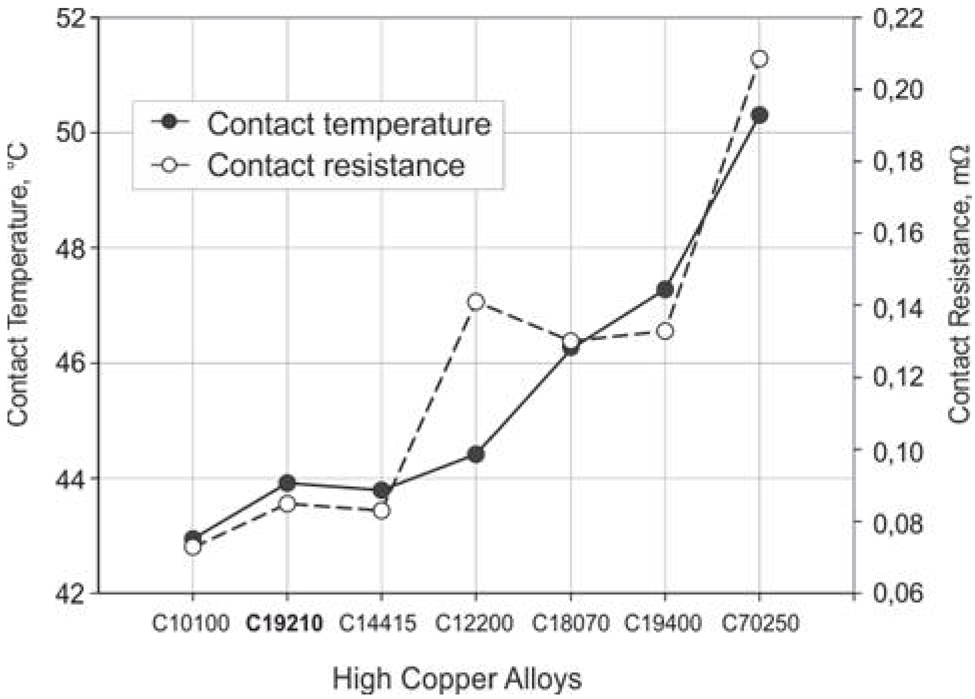


Yield strength vs annealing temperature of CuFe1P [Ref: 267]

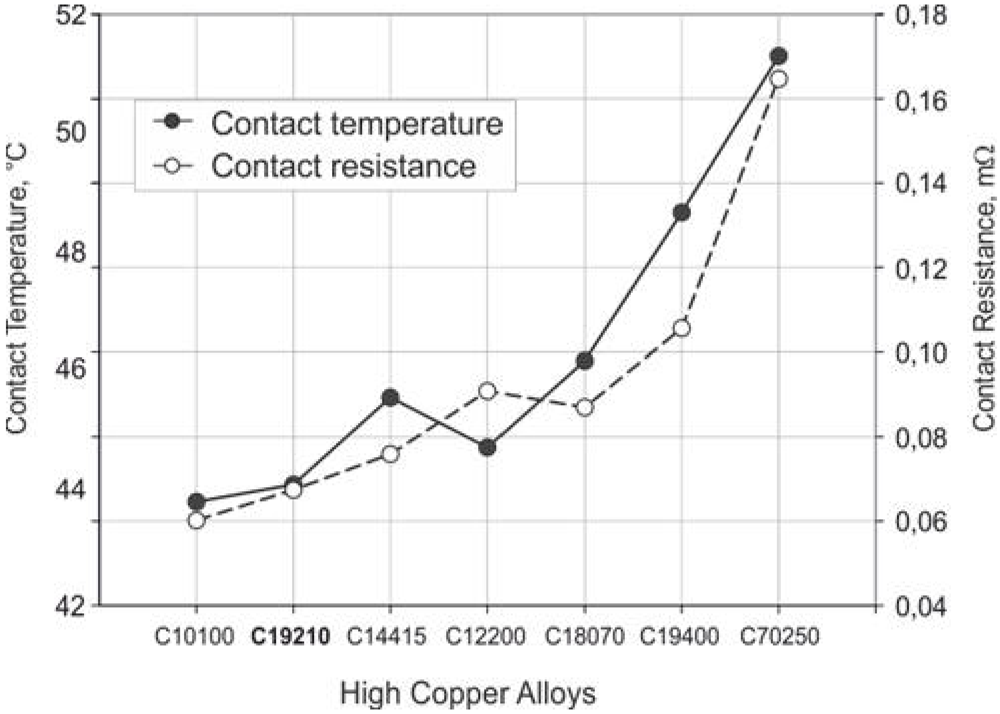


C19210 Vickers hardness vs annealing time in 400,500 and 500°C [Ref: 259]

One of the major difficulties of the use of power automotive connectors is the increase of their electrical contact resistance in the running time.



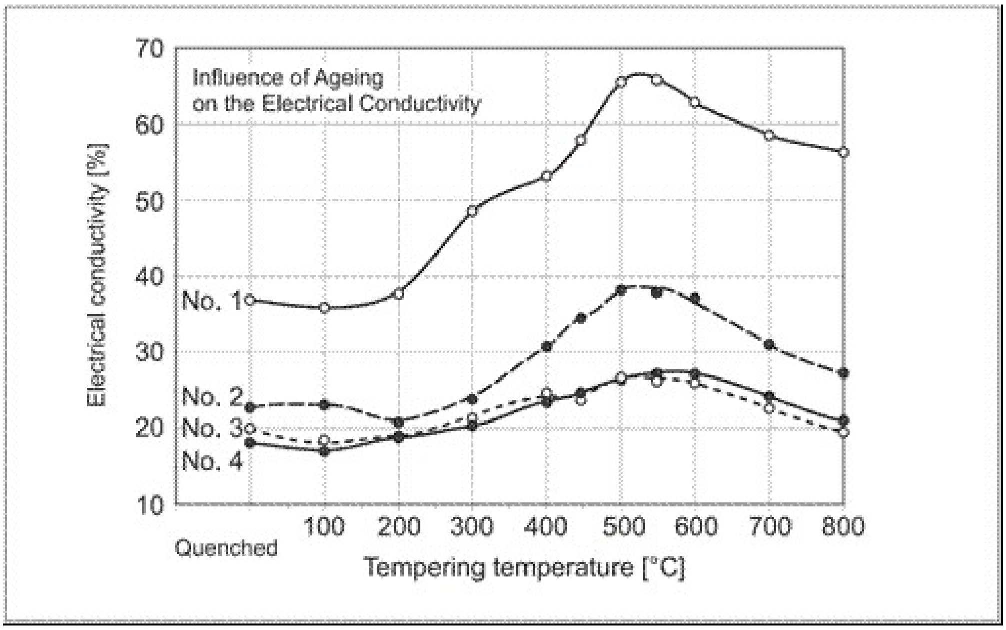
Contact temperature and contact resistance for all the tested material at 1500 seconds Fc=50 N, I=100 A [Ref: 261]



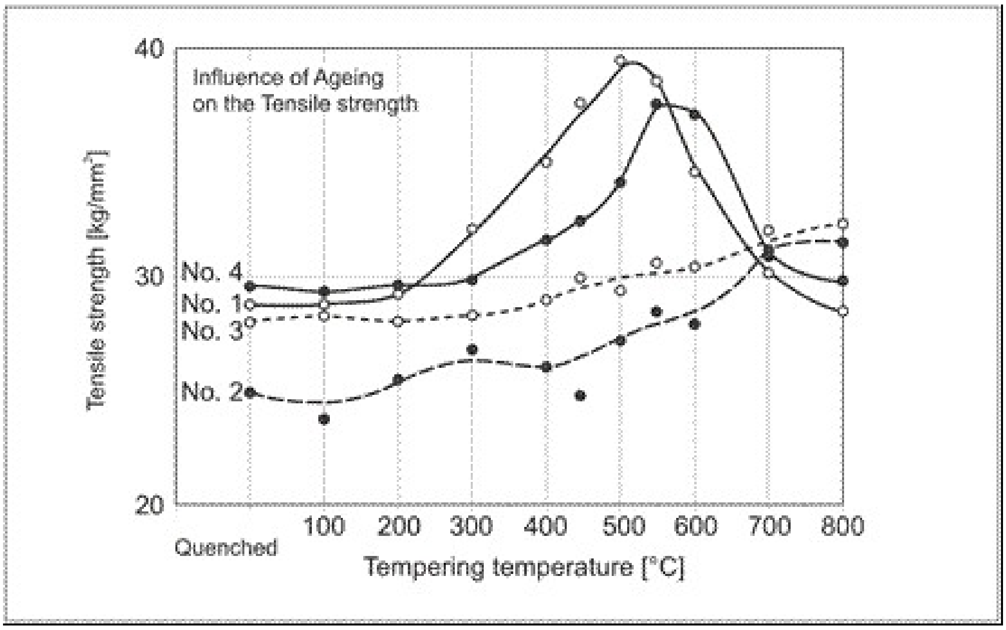
Contact temperature and contact resistance for all the tested material at 1500 seconds Fc=100 N, I=100 [Ref: 261]

Table Composition of specimens [Ref: 649]

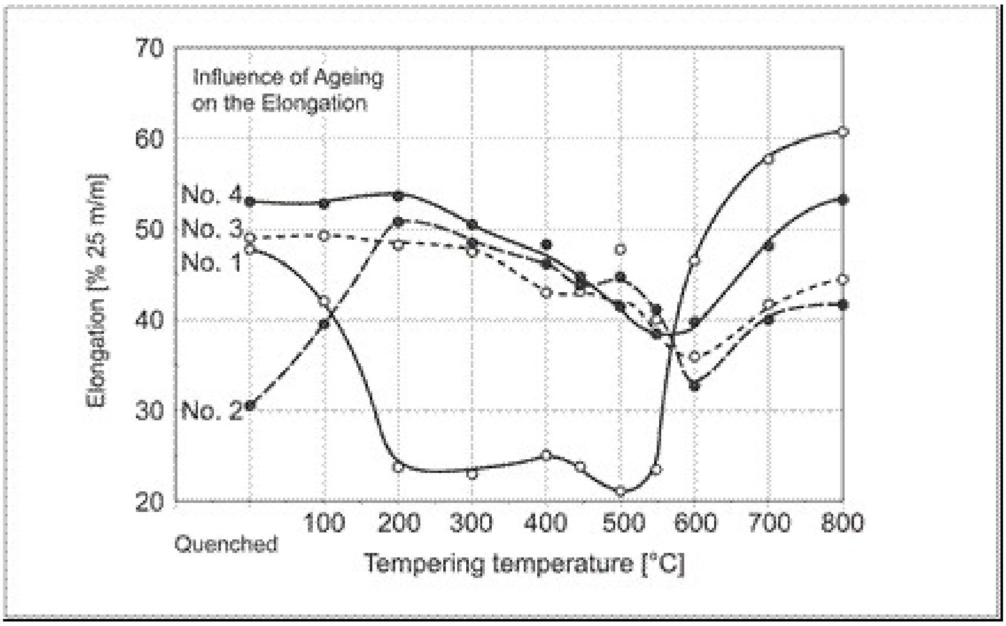
Specimens No.	Compuund	Fe	P	As	Sb	Si	Cu
	% wt.						
1	Fe2P -2%	1,58	0,42				bal.
2	Fe2As - 2%	1,2		0,8			bal.
3	FeSb - 2%	0,64			1,36		bal.
4	FeSi - 2%	1,32				0,68	bal.



Influence of ageing on the electrical conductivity of specimens no 1,2,3 and 4 [Ref: 649]



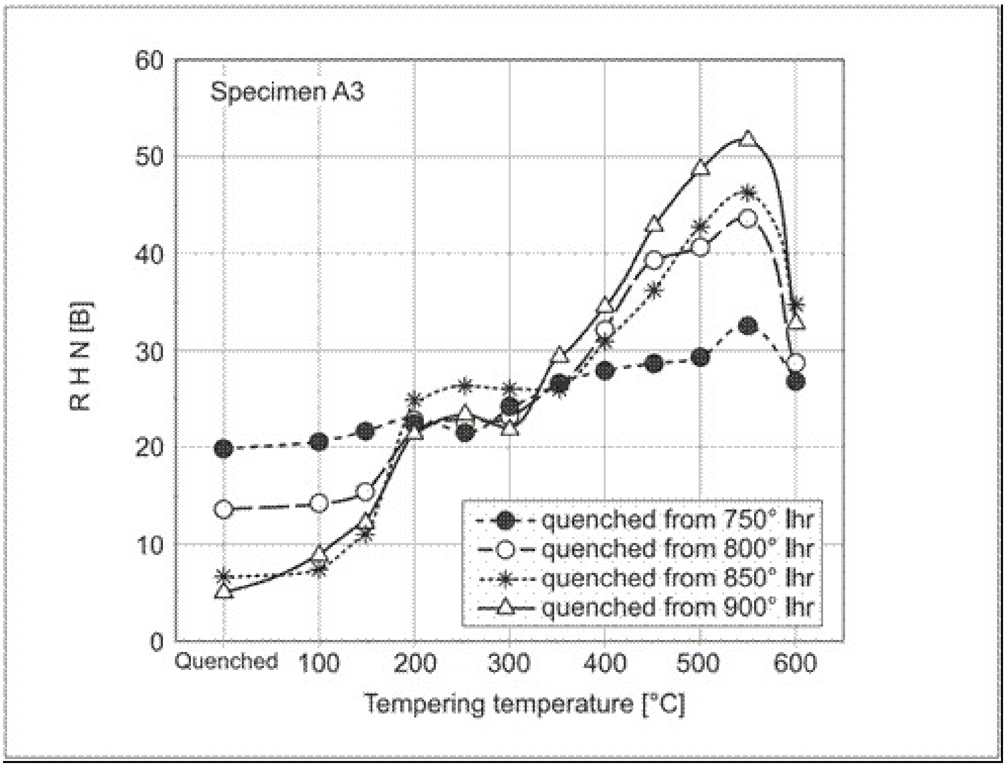
Influence of ageing on the tensile strength of specimens no 1,2,3 and 4 [Ref: 649]



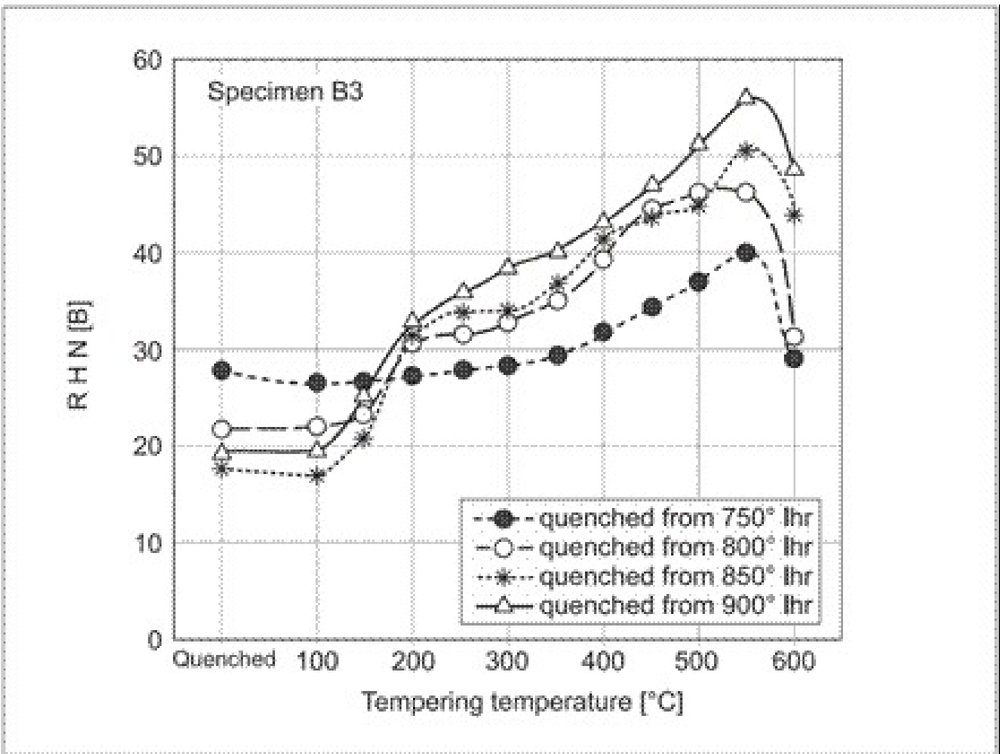
Influence of ageing on the elongation of specimens no 1,2,3 and 4 [Ref: 649]

Composition of CuFe1P spcimens [Ref: 649]

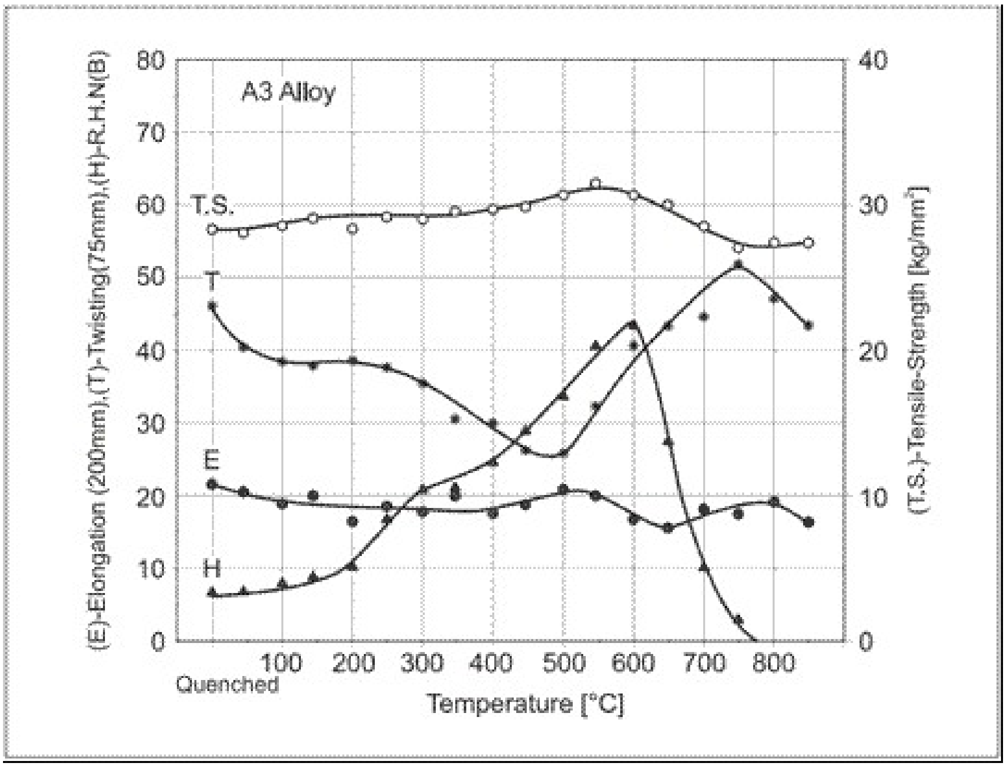
Specimens No	Fe	P	Fe+P	Cu
	%.wt			
A1	1.02	-	1.02	bal.
A2	0.86	0.17	1.03	bal.
A3	0.78	0.21	0.99	bal.
A4	0.51	0.48	0.99	bal.
A5	-	0.98	6.98	bal.
B1	2.03	-	2.03	bal.
B2	1.65	0.29	1.94	bal.
B3	1.56	0.49	2.02	bal.
B4	1.01	0.98	1.99	bal.
B5	0.51	1.47	1.98	bal.
B6	-	1.97	1.97	bal.



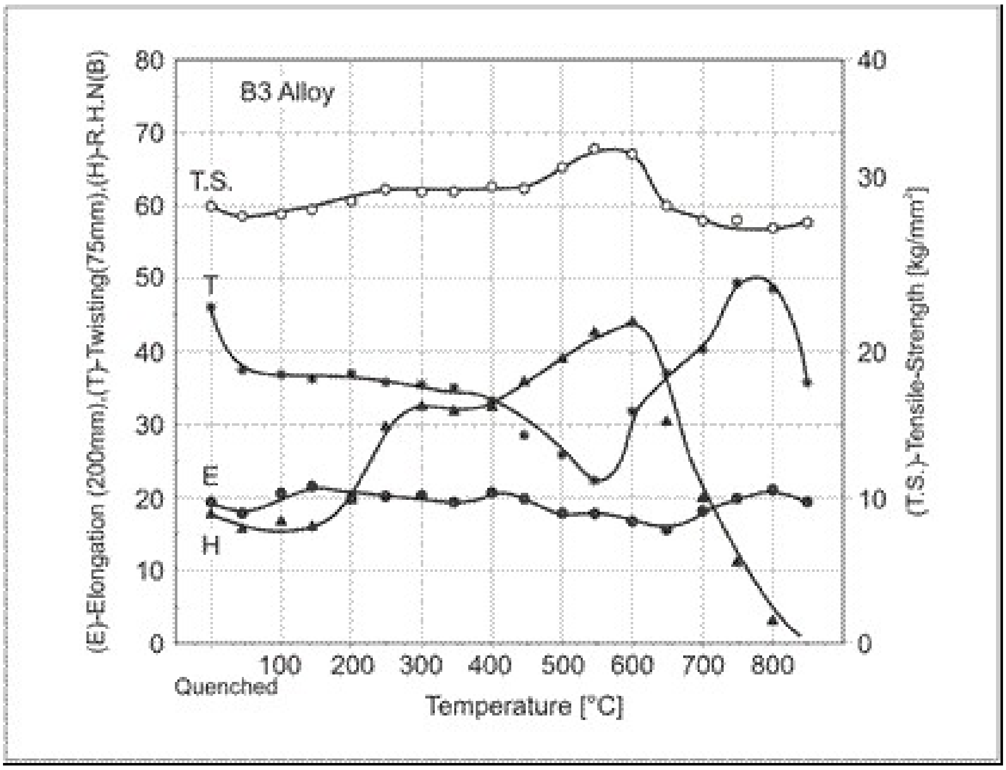
Age-hardening of several Cu-F2P alloys (specimen no A3) [Ref: 649]



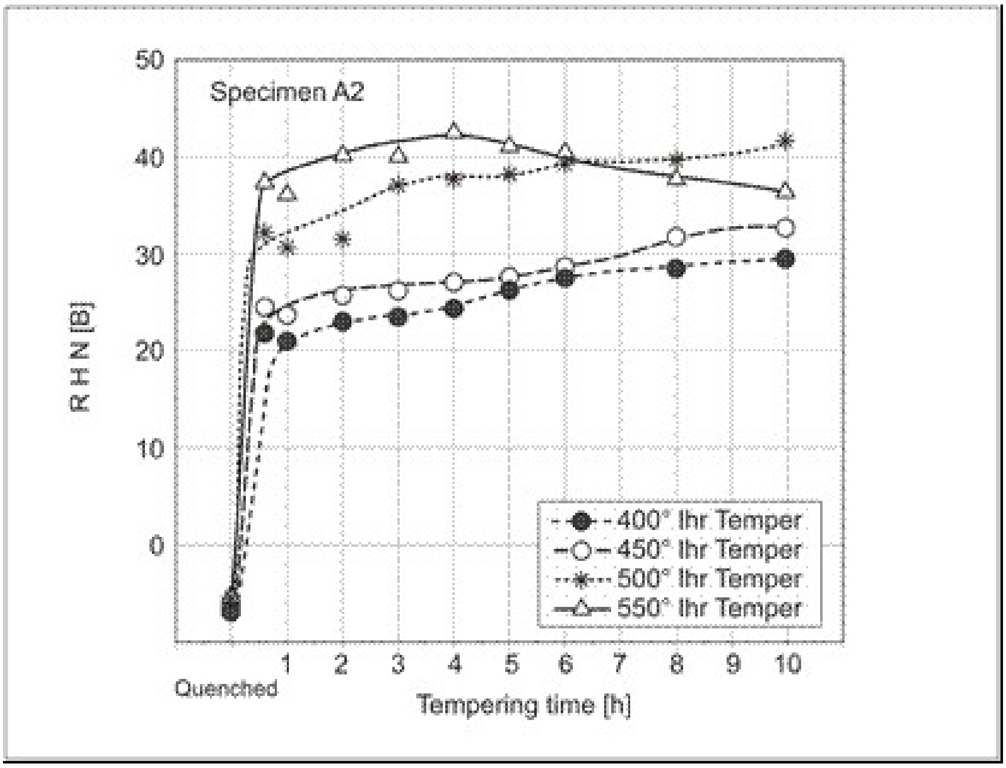
Age-hardening of several Cu-F2P alloys (specimen B3) [Ref: 649]



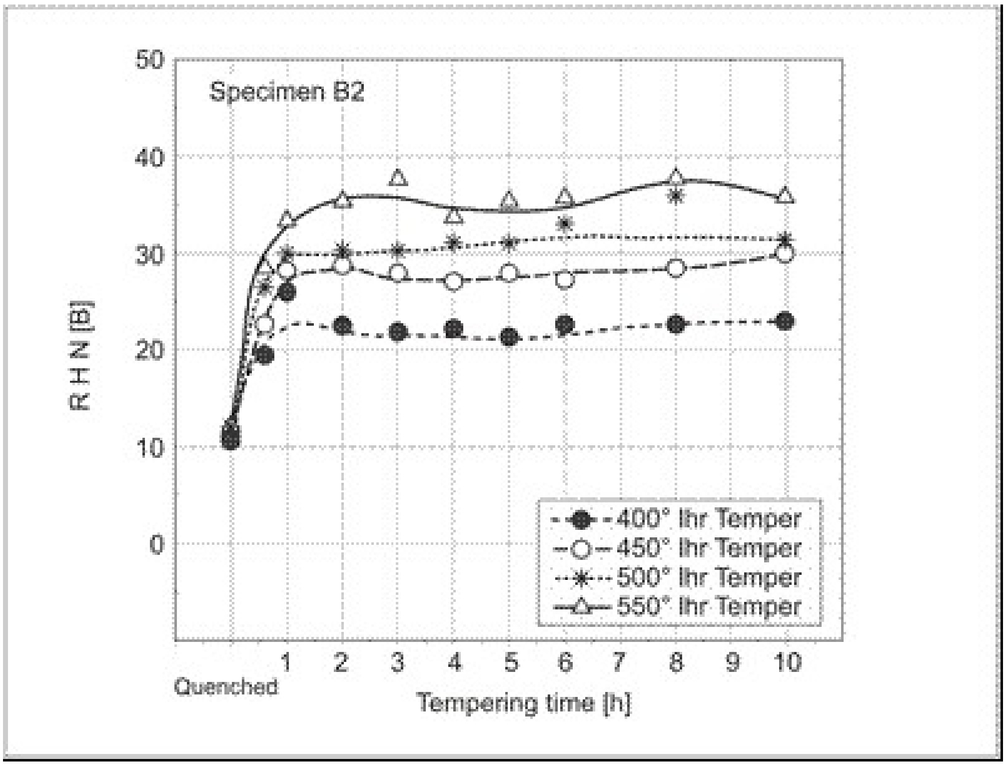
Change of mechanical properties of A3 alloy [Ref: 649]



Change of mechanical properties of B3 alloy [Ref: 649]



Influence of tempering time on the age -hardening of several Cu-Fe3P alloyd quenched from 900°C (Specimen no A2) [Ref: 649]



Influence of tempering time on the age -hardening of several Cu-Fe3P alloyd quenched from 900°C (Specimen no B2) [Ref: 649]

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

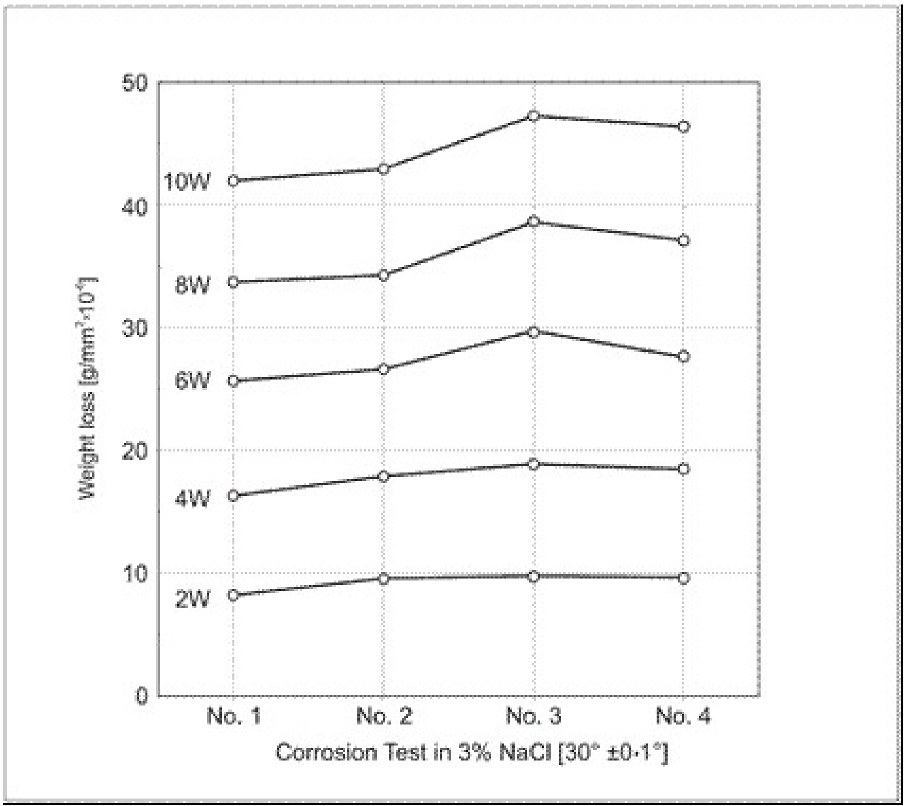
Other kind of corrosion elements

The corrosion resistance - closely copper in many environments. Good resistance to stress corrosion cracking. Alloy 19200 should not be used where there is prolonged contact with mercury compounds. oxidizing acids. cyanides. mois ammonia and strong bases.

N*umbers and compositions of CuFe1P alloys* [Ref: 649]

Specimens No	Compound	Fe	P	As	Sb	Cu
No 1	Fe2P -2%	1.58	0,42	-	-	-
No 2	Fe2As-2%	1.22	-	0,8	-	-
No 3	FeSb-2%	0.64	-	-	1,36	-
No 4	FeSi -2%	1.32	-	-	-	0,68

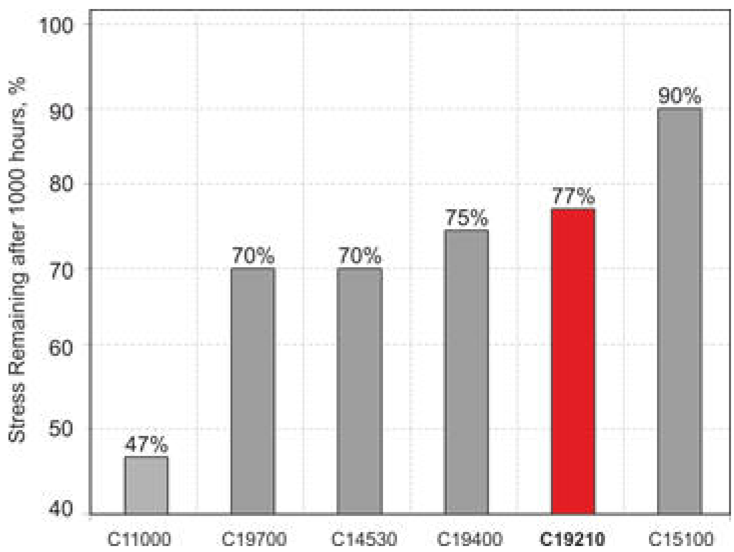
Results of corrsion test of CuFe2P alloys (test in 3% NaCl - 30°C) [Ref: 649]



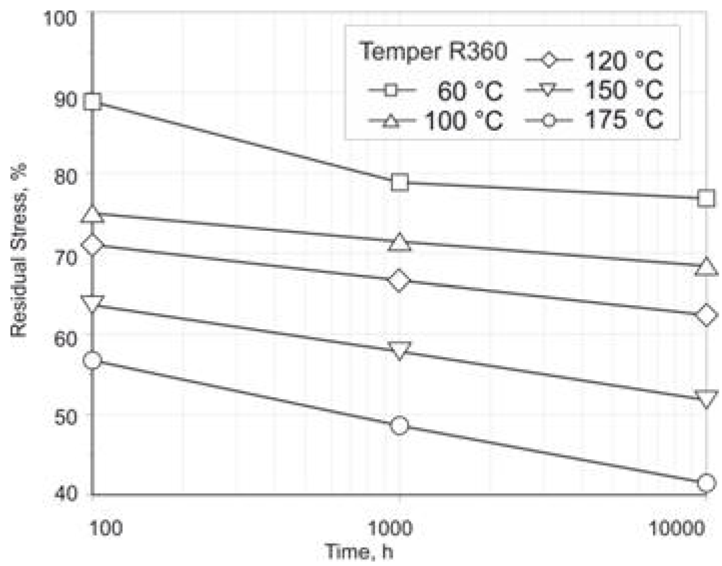
Type of corrosion	Suitability	Literature
Atmospheric	Good	[Ref: 254]
Marine environment	Good	
Stress crack	Excellent (insensitive)	
Hydrogen embrittlement	Not resistant	
Electrolytic	Fair	

Rheological resistance

Stress relaxation



Stress relaxation resistance at 105°C of different copper alloys for lead frames [Ref: 253]



Stress relaxation characteristics CuFe1P (temper R360) [Ref: 247]

Creep

NO DATA AVAILABLE

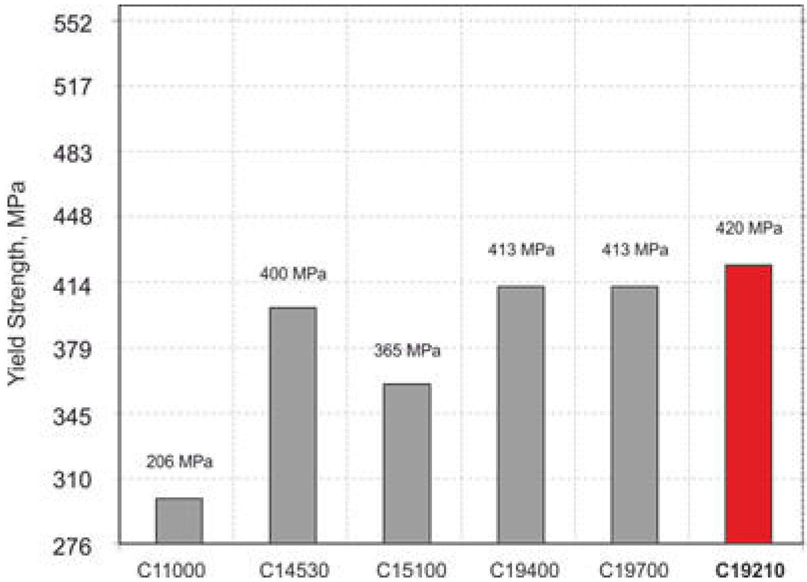
Wear resistance

Friction resistance

NO DATA AVAILABLE

Fatigue resistance

Fatigue cracking



Typical Yield strength available at 90 degree goodway bend (samples 15.5 mm) in width [Ref: 253]

Bend properites (sample 15.5 mm in width) [Ref: 253]

	H01	H02	H03	H04	H06	H08
Goodway - (min R/T)	0.0	0.0	0.0	0.5	1.0	1.5
Badway - (min R/T)	0.0	0.0	0.0	1.0	1.5	2.0

Impact strength

NO DATA AVAILABLE

Fabrication properties

Fabrication properties	Value	Comments
Soldering	Excellent	
Brazing	Excellent	
Hot dip tinning	Excellent	
Electrolytic tinning	Excellent	
Electrolytic silvering	fair	
Laser welding	good	
Oxyacetylene Welding	good	
Gas Shielded Arc Welding	Not recomended	
Coated Metal Arc Welding	Not recomended	
Resistance welding	fair	
Spot Weld	Not recomended	
Seam Weld	Not recomended	
Butt Weld	good	
Capacity for Being Cold Worked	Excellent	
Capacity for Being Hot Formed	Excellent	
Forgeability Rating	65	65% C37700 (forging brass)
Machinability Rating	20	20% OF C36000 (free-cutting brass)
[Ref: 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 265, 266]		

The common fabrication processes for CuFe1P include blanking. coining. drawing. etching. forming and bending. heading and upsetting. hot forging and pressing. piercing and punching. roll threading and knurling. shearing. spinning. squeezing and swaging. and stamping.

Technological properties

Technological properties	Value	Comments
Melting temperature [°C]	1080-1090	
Annealling temperature [°C]	450-550 700-800	C19210 C19200
Ageing temperature [°C]	500-700	
Stress relievieng temperature [°C]	300-400	
Hot working temperature [°C]	825-950	
[Ref: 254, 255, 266, 268]		

References:

245. **Data sheet - CuFe0.1P** - Wieland

246. **Data sheet** - PMX Industries

247. **Data sheet - K80** - Wieland

248. **Data sheet - SB01** - Rolled Diehl

249. **Data sheet** - Kobe Steel

250. **ASTM B465-04 Standard specification for Copper-Iron Alloy Plate, Sheet, Strip and Rolled Bar** -

251. **ASTM B888-06 Standard specification for Copper Alloy Strip for Use in Manufacture of Electrical Connectors and Contacts** -

252. **Electronic Materials Handbook, vol.1 Packaging** - ASM International

253. **Data sheet - C19210** - PMC Inndustries

254. **Copper and copper alloys** - J.Davis, ASM International, 2001

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256. **Thermal properties of metals** - F.Cverna, ASM International ASM, 2002

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258. **Data sheet - PNA 214** - Aurubis

259. **Data sheet - Sop & power sop** - Possehl Electronics

260. **Numercial and experimental optimization of mechanical stress, contact temperature and electrical contact resistance of power automotive connector** - A. Beloufa, International Journal of mechanics, Issue4, vol.4 2010

261. **Ageing characteristcis of copper-iron alloys** - S.Shigeoki, H. Shigeoki, G.Mima, TRANS JIM, vol. 14, 1973

265. **Data sheet - Copper alloy No C19210** - Alloy Digest, april 1992

266. **Study on high-strength and High conductivity Cu-Fe-P alloys** - L.De-Ping, J.Wung, ZWei-Jun, LYoung, L.Lei,B.Sun

267. **MatWeb - Data Base** - www.matweb.com

268. **Copper Development Association Inc.** - www.copper.org

648. **Data sheet – SM220** - Sofia Med

649. **Investigations of the Nickels, high conductivity, high strength copper alloys. Age-Hardening Cu-Fe-P system** - Y.Konishi, T.Kashibuchi, F.Sakakibbara, Journal of the Japan Institute of Metal, Vol. 7 (1943) No. 3 P 95-114