CuFePCoSn

UNS:C19500
EN:-

High strength modified copper alloy, best combinations of electrical conductivity, mechanical strength, forming properties and stress relaxation resistance. C19500 is a precipitation-hardenable copper alloy which has an electrical conductivity of 50%IACS in the aged condition. The alloy is highly resistant to stress relaxation when used a spring under constant stress and it is expected that its creep resistance at moderately elevated temperatures will also prove to be good, has good joinability and good corrosion resistance. This alloy also exhibits good corrosion resistance making it essentially immune to stress corrosion cracking.
CuFePCoSn fits applications requiring excellent hot and cold workability as well as high strength and conductivity. C19500 is high strength, high conductivity alloy developed for applications in current carrying parts. The high strength of CuFePCoSn coupled with moderate conductivity makes this alloy use ful in spring terminal applications. Resistance to stress relaxation over time improves the life expectancy of connectors.

Basic properties

Basic properties	Value	Comments
Density [g/cm^3]	8,90-8,94	
Specific heat capacity [J/(kg*K)]	370	
Temperature coefficient of electrical resistance (0...100°C) [10^{-3}/K]	0,00344	
Electrical conductivity [T=20°C, (% IACS)]	50	
Thermal conductivity [W/(m*K)]	199	
Thermal expansion coefficient 20...300°C [10^{-6}/K]	16,9	
[Ref: 296, 91, 250, 252, 267, 254, 255, 256]		

Applications

Main applications

Sheet, strip, rolled bar, flat wire, welded tube and fabricated parts. Electrical components such as springs, contacts, connectors, terminals, clips, jaws, clamps, sockets in electro-mechanical assemblies, electronics assemblies, and wiring harness for automobiles and appliances, edge connectors for printed circuit boards, switches, integrated circuit lead frames. *Literature:* [Ref: 295, 296, 252, 254, 257]

Kinds of semi-finished products/final products

NO DATA AVAILABLE

Chemical composition

Chemical composition	Value	Comments
Al [wt.%]	0,2	
Co [wt.%]	0,6-1,0	
Cu [wt.%]	96,24-97,42	Calculated
Fe [wt.%]	1,3-1,7	
P [wt.%]	0,08-0,12	
Pb [wt.%]	0-0,02	
Sn [wt.%]	0,4-0,7	
Zn [wt.%]	0-0,02	
[Ref: 91, 267]		

Chemical composition of CuFePCoSn (C19500) [Ref: 268]

Chemical composition of CuFePCoSn (C19500) [Ref: 296]

Chemical composition. wt%														
Ag	**Mg**	**Sn**	**Ni**	**Si**	**Cr**	**Zr**	**Fe**	**P**	**Pb**	**Zn**	**Co**	**Al**	**other**	**Cu**
-	-	0.1-1.0	-	-	-	-	1.0-2.0	0.015-0.15	0.02	0.20	0.3-1.3	0.2	-	min. 97.8
		0.6					1.5	0.18						

Chemical composition. wt.%														
Ag	**Mg**	**Sn**	**Ni**	**Si**	**Cr**	**Zr**	**Fe**	**P**	**Pb**	**Zn**	**Co**	**Al**	**other**	**Cu**
-	-	0.4-0.7	-	-	-	-	1.3-1.7	0.08-0.12	max 0.03	max 0.20	0.6-1.0	max 0.2	max.0.10	min. 97.8

Mechanical properties

Mechanical properties	Value	Comments	Literature
UTS [MPa]	350-700		
YS [MPa]	170-650		
Elongation [%]	2-25		
Hardness	81-90	[HRB]	
Young's modulus [GPa]	119		
Kirchhoff's modulus [GPa]	No data		
Poisson ratio	0,33		

Mechanical requirements of CuFePZnCoSn (C19500) according ASTM standards (different tempers) [Ref: 250]

Temper	Tensile strength, MPa	Yield strength 0.2%, MPa	Elongation 50, %	Hardness, HRB	Literature
O61	Min. 350	Min.170	Min.25	…	[Ref: 250, 254]
O50	520-590	395-530	11-17	81-89	
H02	565-620	505-605	3-13	85-88	
H08	605-670	585-650	2-5	87-90	
H10	Min. 670	Min.650	Max.2	Min.90	

Mechanical properties of CuFePZnCoSn Alloy [Ref: 296]

Temper	Tensile strength, MPa	Yield strength, MPa	Elongation, %	Literature
Soft annealed	360	172	25	[Ref: 296]
Precipitation hardened	550	450	15	
PHT. CR half hard	590	550	8	
PHT. CR spring	630	614	3	
PHT.CR super spring	670	650	2	
Note: PHT - precipitation heat treated, CR-cold rolling				

Mechanical properties of CuFe1.5P0.18Co0.8Sn0.6 (Olin 195) [Ref: 296]

Temper	Tensile strength, MPa	Elongation, %	Literature
Annealed	345-415	26	[Ref: 296]
1/4 hard	415-495	14	
1/2hard	470-540	6	
3/4hard	515-585	3	
Hard	565-620	2	
Sping	605-670	2	

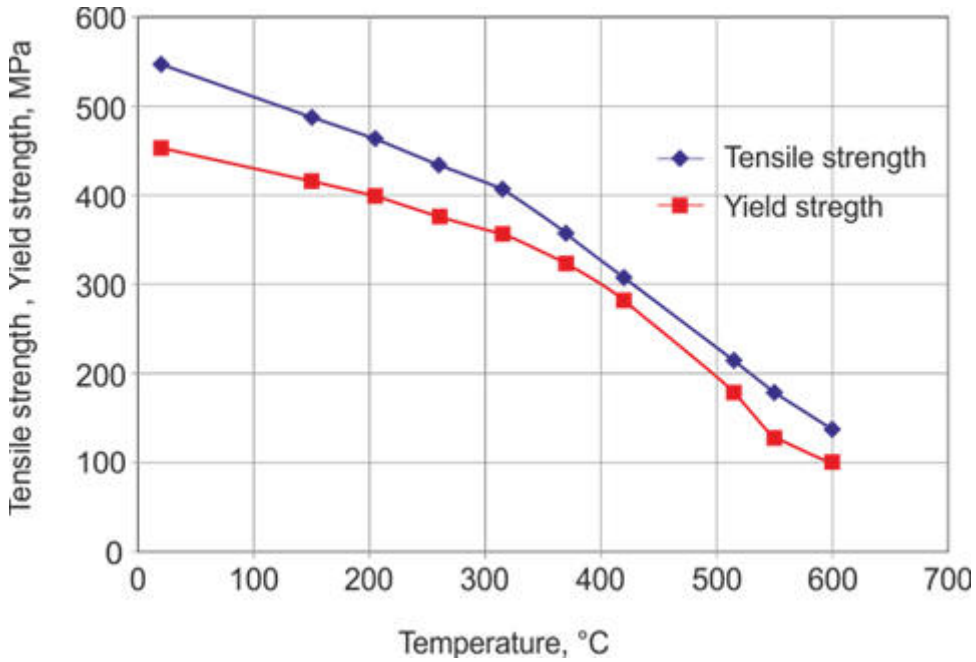
Exploitation properties

Heat resistance

Mechanical and electrical properties vs temperatures

Mechanical properties of CuFe1.5P0.18Co0.8Sn0.6 vs temperature annealing [Ref: 296]

Temperature, °C	Tensile strength, MPa	Yield strength, MPa	A50, %
20	550	453	14.9
150	487	416	12.4
205	463	399	12.9
260	434	376	13.7
315	407	356	11.3
370	357	323	16.2
425	308	282	19.8
390	214	179	18.7
550	179	128	16
600	137	101	17



C19500 alloy mechanical properties vs annealing temperature [Ref: 296]

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

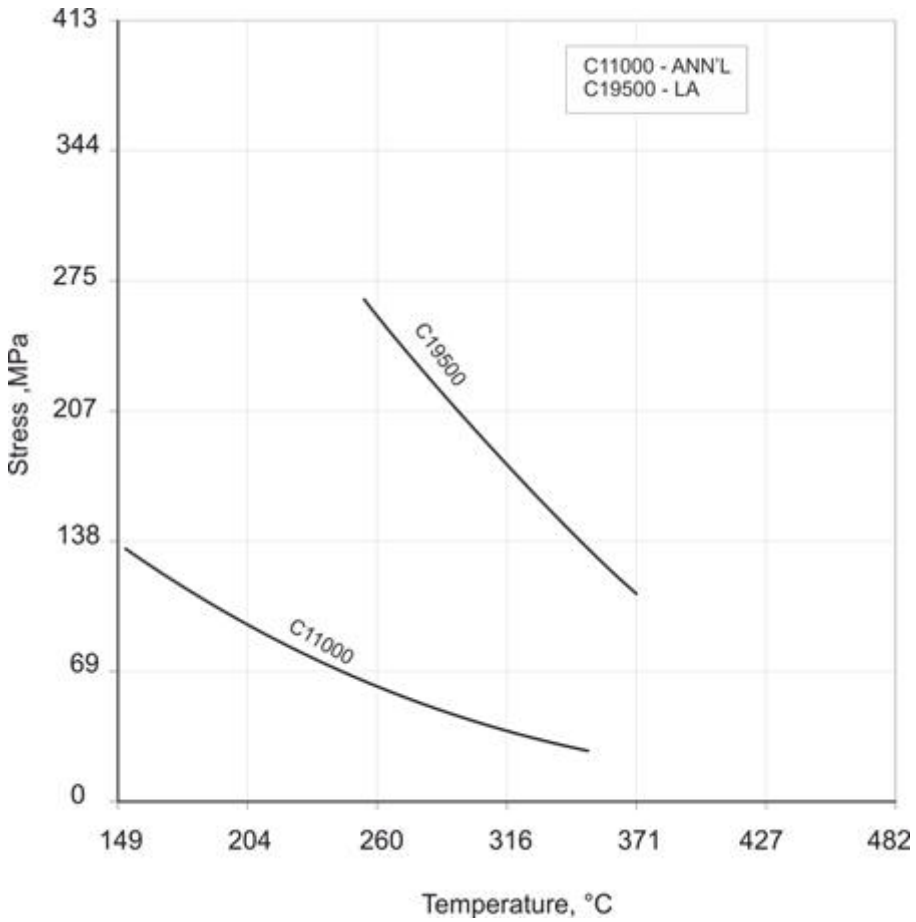
Other kind of corrosion elements

The alloy has corrosion resistance superior to that of copper when exposed to industrial. marine or industrial-marine atmospheres. It is essentially immune to stress corrosion cracking.

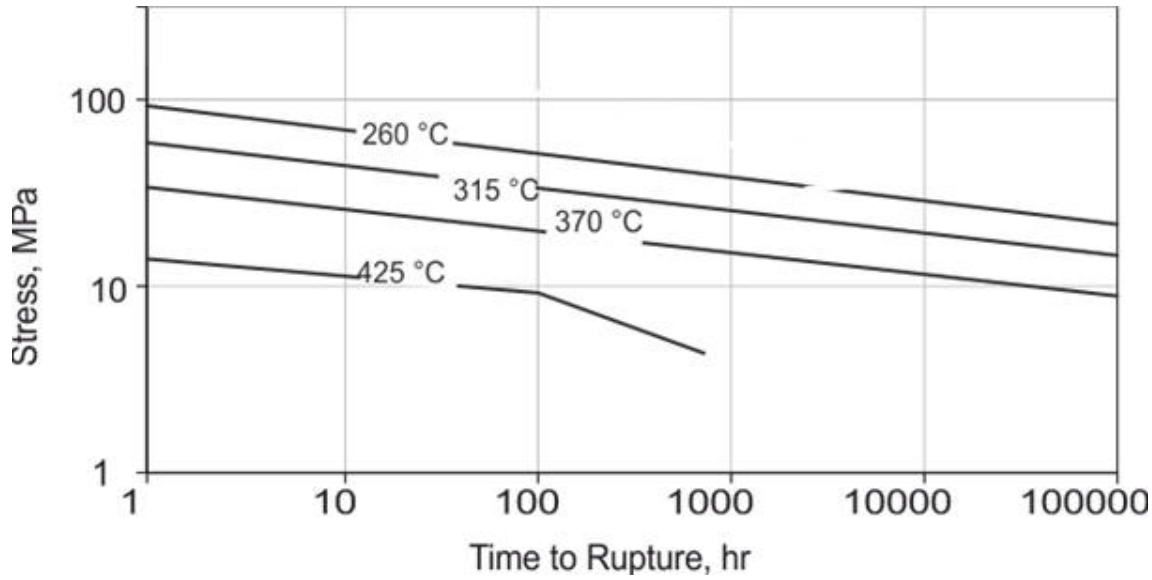
Type of corrosion	Suitability	Literature
Atmospheric	Good	[Ref: 254]
Marine environment	Good	
Stress crack	Good	
Hydrogen embrittlement	No	
Electrolytic	No data	

Rheological resistance

Stress relaxation

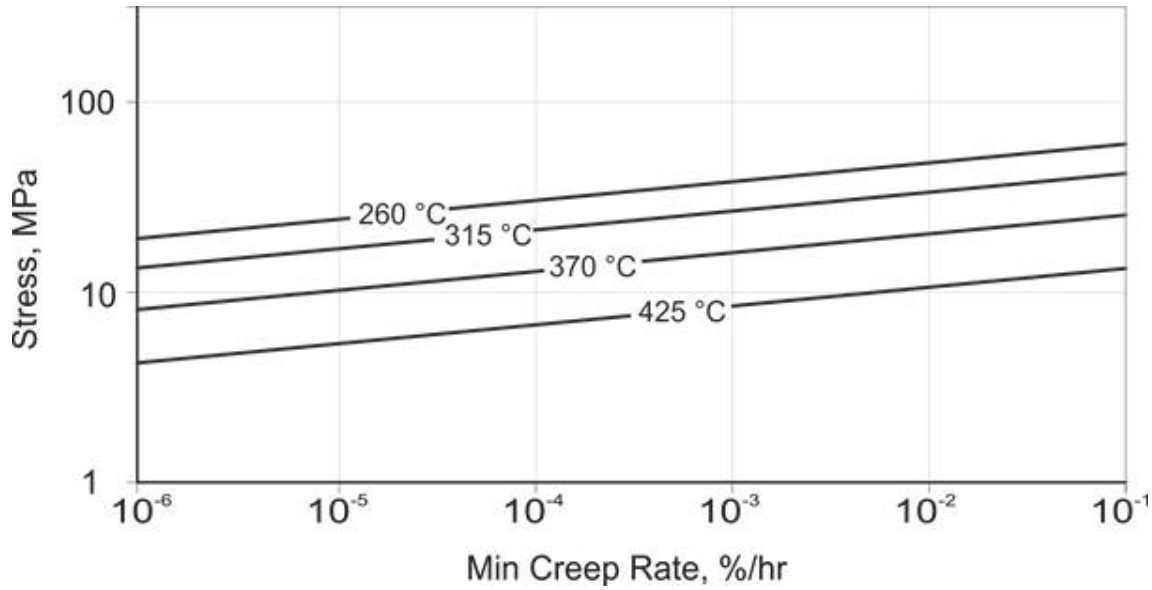


Rupture strengths of copper (C11000) and CuFePZnCoSn (19500) - 100000h rupture strength of strip [Ref: 281]



Stress rupture strength of CuFePCoSn (C19500) strip at 260. 315.370 and 425°C [Ref: 297]

Creep



Creep rate for CuFePCoSn strip [Ref: 297]

Wear resistance

Friction resistance

NO DATA AVAILABLE

Fatigue resistance

Fatigue cracking

Fatigue strength of CuFePCoSn copper alloy [Ref: 296]

Temper	Tensile strength, MPa	Fatigue strength, MPa	Literature
Precipitation hardened	552	180	[Ref: 296]
PHT. CR spring	634	200	

Impact strength

NO DATA AVAILABLE

Fabrication properties

Fabrication properties	Value	Comments
Soldering	excellent	
Brazing	excellent	
Hot dip tinning	excellent	
Electrolytic tinning	excellent	
Laser welding	good	
Oxyacetylene Welding	fair	
Gas Shielded Arc Welding	good	
Coated Metal Arc Welding	fair	
Spot Weld	fair	
Seam Weld	good	
Butt Weld	good	
Capacity for Being Cold Worked	excellent	
Capacity for Being Hot Formed	excellent	
Forgeability Rating	65	65% of C37700 (forging brass)
Machinability Rating	18	18% of C36000 (free-cutting brass)
[Ref: 296, 254]		

In the mill annealed condition. i.e. precipitation hardened to have a yield strength of 450 MPa. Alloy C19500 can be readily cold formed by bending. shallow stamping or deep drawing. However. only moderate stretching should be attempted. in the cold rolled tempers. a generous bending radius is desirable and parts should be designed to avoid bends parallel to the rolling direction when maximum strength is required. The alloy can be hot worked in the temperature range 650 to 980 °C.
The alloy can be joined by the inert-gas shielded metallic-arc process and by resistance welding using the seam or butt welding procedures. It has excellent solderability.

Alloy 195 has a machinability rating of 18 where free-cutting brass equals 100. In general. the most satisfactory machined surface on copper is obtained by means of high cutting speeds combined with light cuts. For turning and similar operations. speeds of about 40 to 60 m per minute may be adopted but these speeds must be reduced when employing heavy cuts. With tungsten carbide tools. considerably higher speeds can be used. Tools are commonly used with about 15 degree front clearance and 25 degree top rake. The included angle of the cutting tool must be increased for heavy work. The lubricant employed should be varied with the type of work. For heavy cuts at slow speeds. mineral oils or blended lard and mineral oils are preferable; for lighter cuts at higher speeds. emulsions are favored. Degreasing of soiled metal followed by cleaning in a dilute sulfuric acid solution will remove surface oxidation resulting from atmospheric exposure or controlled atmospheric annealing. Heavy oxide films or stains are removed by the same brightening solutions used for copper.

Technological properties

Technological properties	Value	Comments
Melting temperature [°C]	1080-1090	
Annealling temperature [°C]	500-600	After cold work, annealling time: 1h
Quenching temperature [°C]	900	water quench
Ageing temperature [°C]	450-600	Ageing time: 1h
Hot working temperature [°C]	650-980	
[Ref: 296, 254]		

References:

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