CuSn0,5

UNS:C18835
EN:CW129C

CuSn(CuSn0,2 - CuSn0,5) material with 0,2-0,55% is tin addition id single phase copper alloy with good mechanical and high electrical properties connected with high wearing resistance. Material has higher than pure copper softening temperature and good creep, stress relaxation fatigue resistance. The alloy permits good corrosion resistance and has no stress cracking corrosion.

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]	3,2-3,7	
Electrical conductivity [T=20°C, (% IACS)]	56-85	
Thermal conductivity [W/(m*K)]	277-290	
Thermal expansion coefficient 20...300°C [10^{-6}/K]	17	
[Ref: 147, 148, 149, 150, 90, 151, 152, 46, 153, 154, 155, 59, 156, 97]		

Applications

Main applications

Main applications are connected with electric current transfer in electro-industry. Possible applications: trolley wires, wiring harnesses, connectors and connector pins, sliding contacts, electric springs, automotive electric parts, electromechanical components, forged parts.
Literature: [Ref: 147, 148, 149, 150, 90, 151, 152, 46, 153, 154, 155, 59, 156, 97, 90]

Kinds of semi-finished products/final products

Rolled strips, rolled tinned strips, rolled profiles with different height, extruded round or polygonal rods, extruded sections, extruded tubes, drawn round or polygonal wires, drawn tubes.

Chemical composition

Chemical composition	Value	Comments
Cu [wt.%]	99,35-99,85	Calculated
Sn [wt.%]	0,15-0,55	
Others [wt.%]	0-0,10	
[Ref: 150]		

Chemical composition, wt%						
Sn	Fe	P	Pb	Zn	Others	Cu
0,15-0,55	max. 0,10	max. 0,01	max. 0,05	max. 0,3	max. 0,5	Cu+Fe+Pb+P+Zn min. 99,5
Literature: [Ref: 112]						

Mechanical properties

Mechanical properties	Value	Comments
UTS [MPa]	270-620	
YS [MPa]	No data	
Elongation [%]	3-30	
Hardness	No data	
Young’s modulus [GPa]	120-125	
Kirchhoff’s modulus [GPa]	No data	
Poisson ratio	No data	
[Ref: 146, 147, 148, 149, 150, 151, 152, 46, 153, 154, 155, 59, 156, 97]		

Material's mechanical and electrical properties in different tempers/ diameters -wires

Temper /diameter	Ultimate Tensile Strength UTS [MPa]	Electrical conductivity	Elongation at break during tensile test A50 [%]	Hardness [HV]	Literature:
annealed	max. 300	min. 68	-	-	[Ref: 151]
3,5	min. 485	min. 68	-	-	
3,0	min. 510	min. 68	-	-	
2,5	min. 540	min. 68	-	-	
2,0	min. 570	min. 68	-	-	
1,5	min. 610	min. 68	-	-	
1,3	min. 620	min. 68	-	-	

Material's mechanical and electrical properties in different cross sections - trolley wires

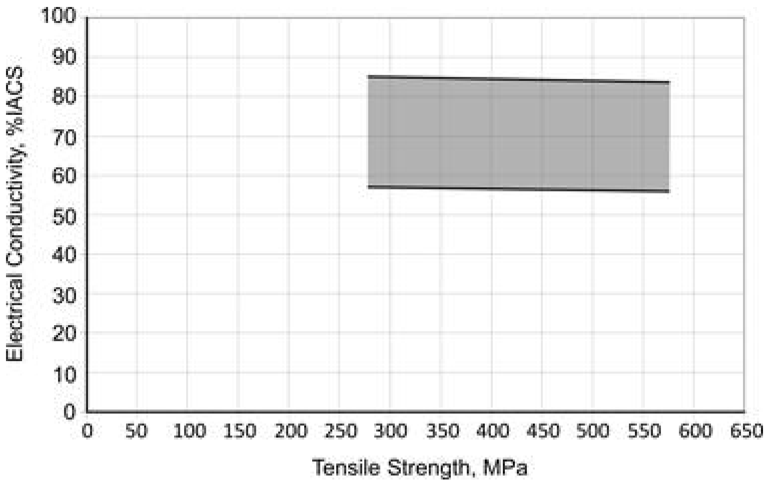
Cross section [mm]	Ultimate Tensile Strength UTS [MPa]	0,2%Yield strength YS [MPa]	Elongation at break during tensile test A50 [%]	Electrical conductivity [%IACS]	Literature
80	min. 460	min.370	3-8	min. 72	[Ref: 147, 152 , 153]
100	min. 450	min. 370	3-8	min. 72	
107	min. 430	min. 370	3-8	min. 72	
120	min. 420	min. 370	3-8	min. 72	
150	min. 420	min. 370	3-8	min. 72	

Material's mechanical and electrical properties in different tempers (non european standards)

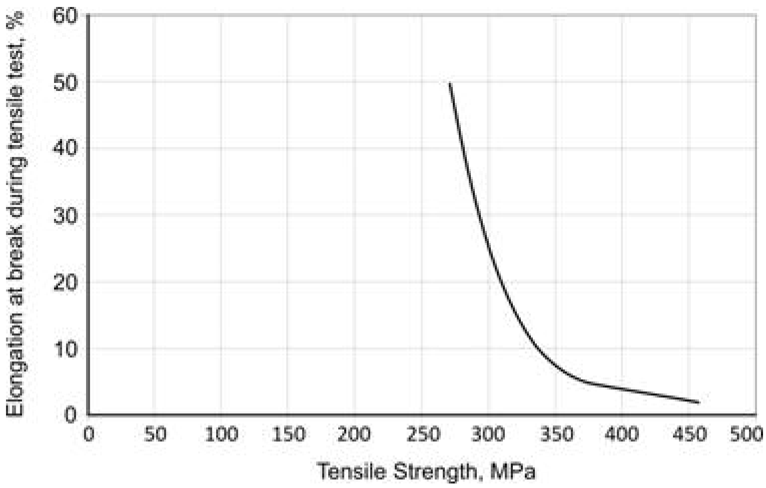
Temper	Ultimate Tensile Strength UTS [MPa]	Electrical conductivity [MS/m]	Elongation at break during tensile test A50 [%]	Hardness [HV]	Literature
Soft O 10	max 303	min. 70	-	-	[Ref: 150]
1/2H	typical 358	min. 70	-	-	
H	typical 434	min. 70	-	-	
Spring	typical 496	min. 70	-	-	
Extra spring	min. 531	min. 70	-	-	

Automotive cable electrical and mechanical properties

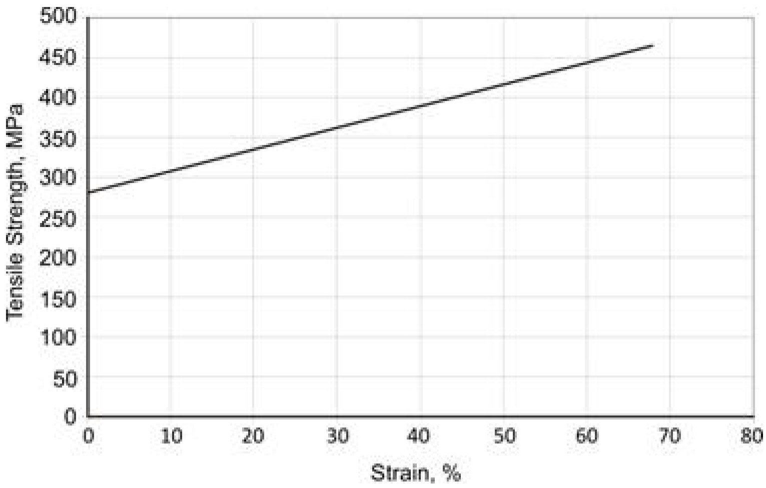
Alloying element concentration in copper	Ultimate Tensile Strength UTS [MPa]	Electrical conductivity [MS/m]	Elongation at break during tensile test A50 [%]	Hardness [HV]	Literature
0,25-0,35%Sn	min. 620	max. 43,5	min.1	-	[Ref: 650]



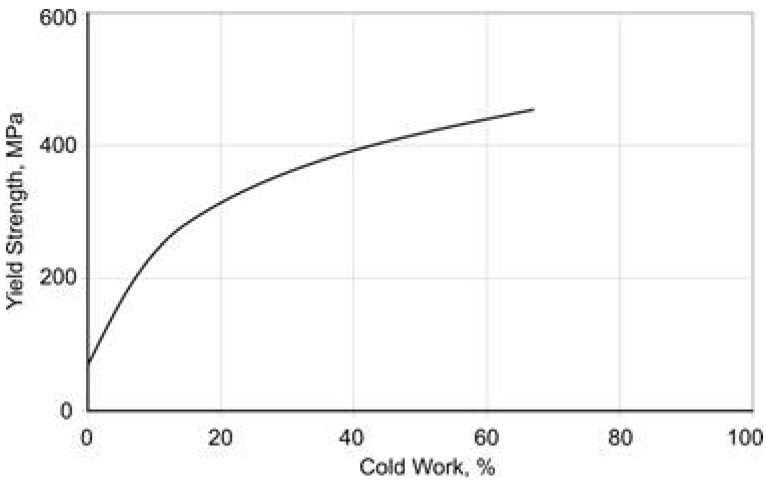
Levels of electrical and mechanical properties of material in different tempers [Ref: 2]



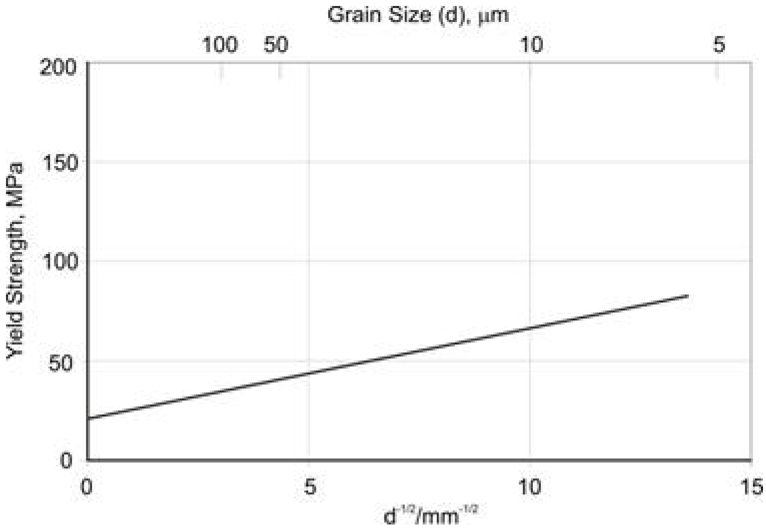
Elongation at break vs ultimate tensile strength at ambient temperature for material in different temper (0,42%Sn)* [Ref: 2]



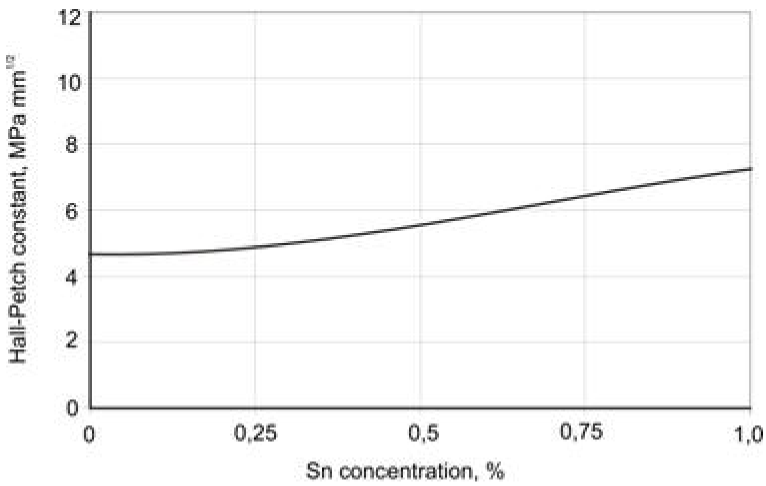
Ultimate tensile strength of material as a function of cold working strain measured ambient temperature, (0,42%Sn) [Ref: 2]



Yield Strength as a function of strain (cold rolling), temperature 22oC (0,5%Sn) [Ref: 146]



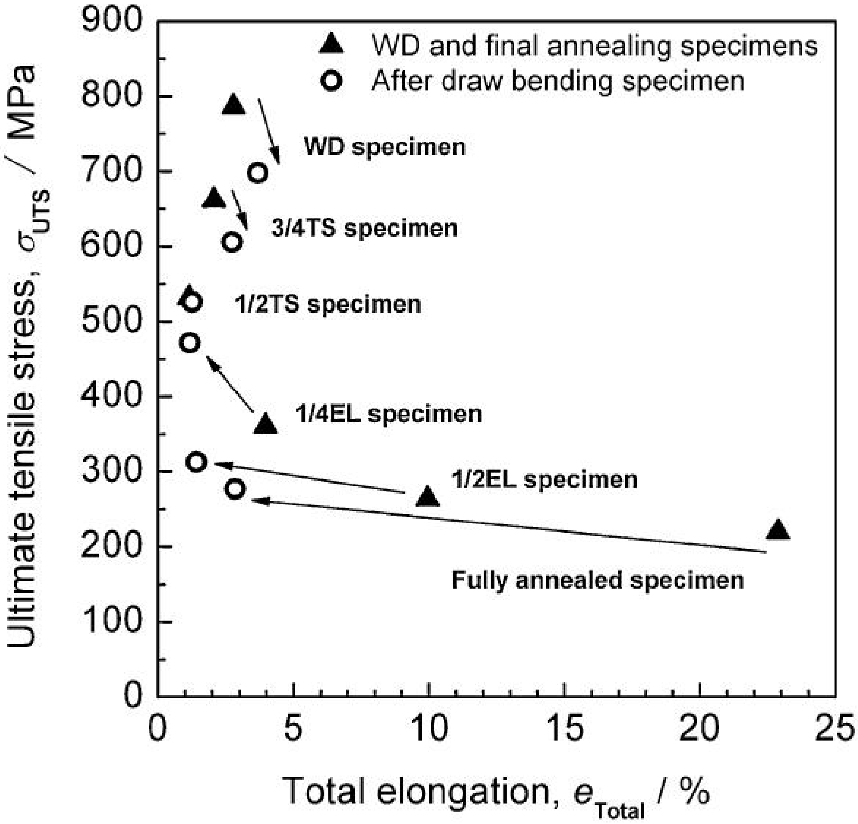
Relation between yield strength and material grain size (Hall-Petch relationship, 0,3%Sn) [Ref: 146]



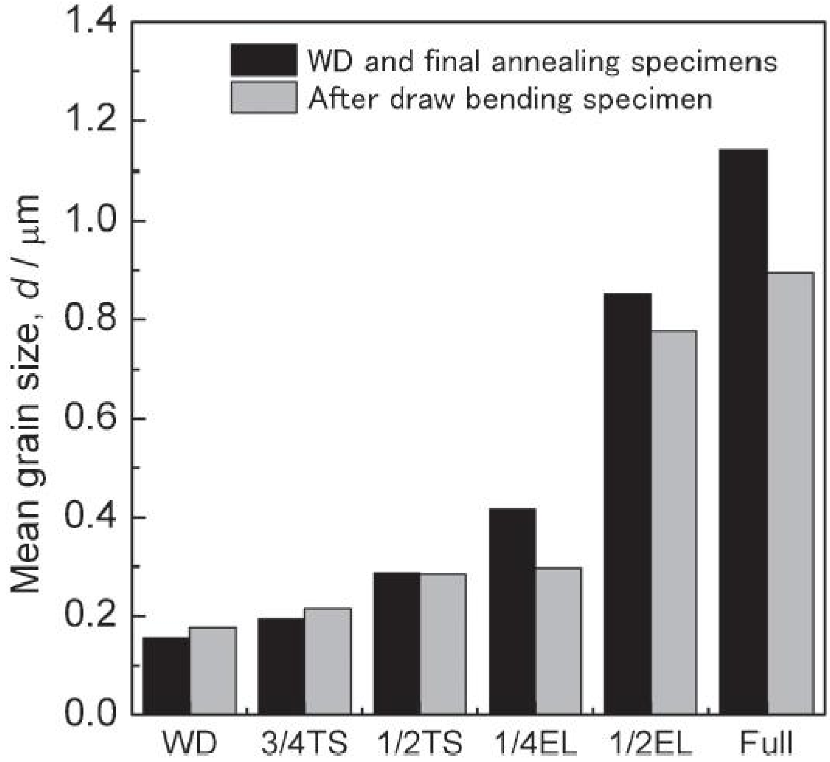
Relation between Hall-Petch relationship constant and tin content [Ref: 146]

Changes in mechanical behaviours of wire specimens processed and changes in grain size after final annealing and non-conventional processing by draw bending, material: Cu 0,27%Sn [Ref: 651]

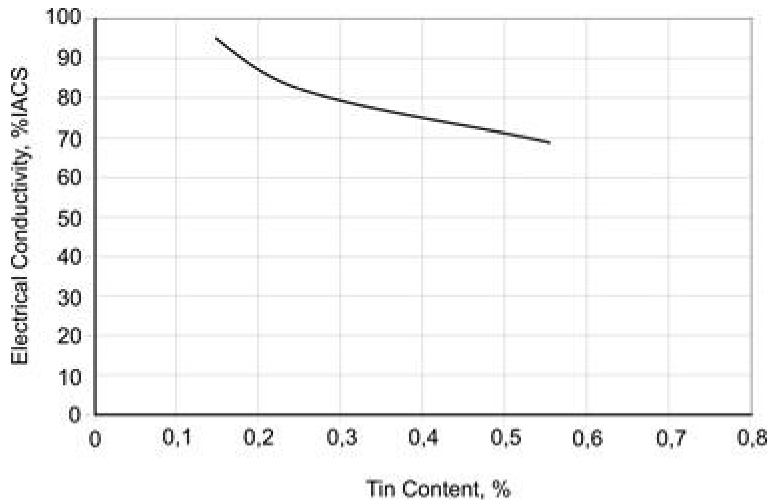
Sample name	**Final annealing condition**	
	Temperature	**Time**
Fully annealed specimen (ε^{WD}=0,0)	673 K	600s
1/2EL specimen	623 K	600s
1/4EL specimen	623 K	360s
1/2TS specimen	623 K	60s
3/4TS specimen	573 K	240s
WD specimen (ε^{WD}=7,2)	-	-



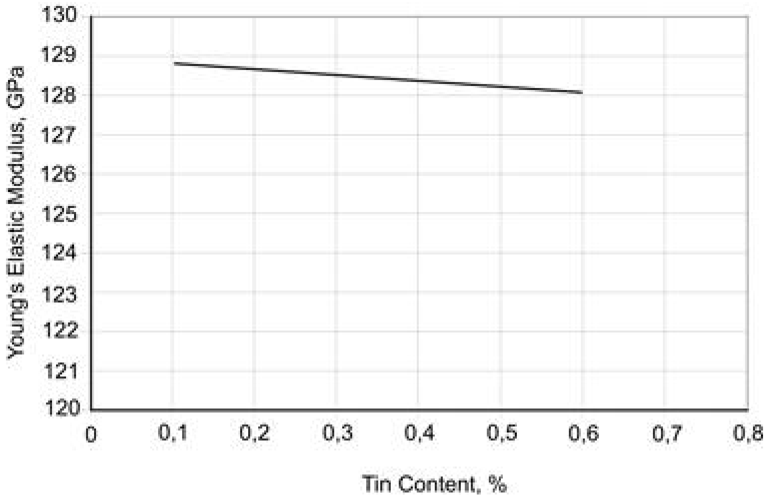
Ultimate tensile stress vs total elongation for specimens in table [Ref: 651]



Mean grain size for specimens in table [Ref: 651]



Tin content effect on electrical conductivity of copper at ambient temperature [Ref: 97]

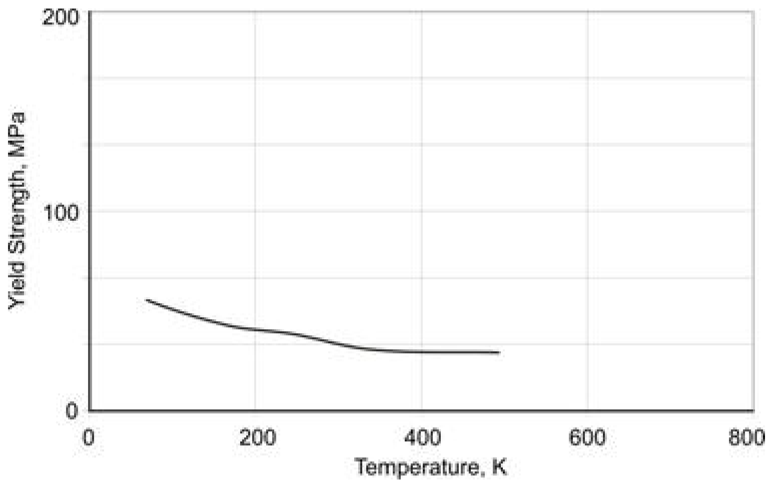


Tin content effect on Young's modulus of material at ambient temperature (values calculated from approximation of experimental data) [Ref: 130]

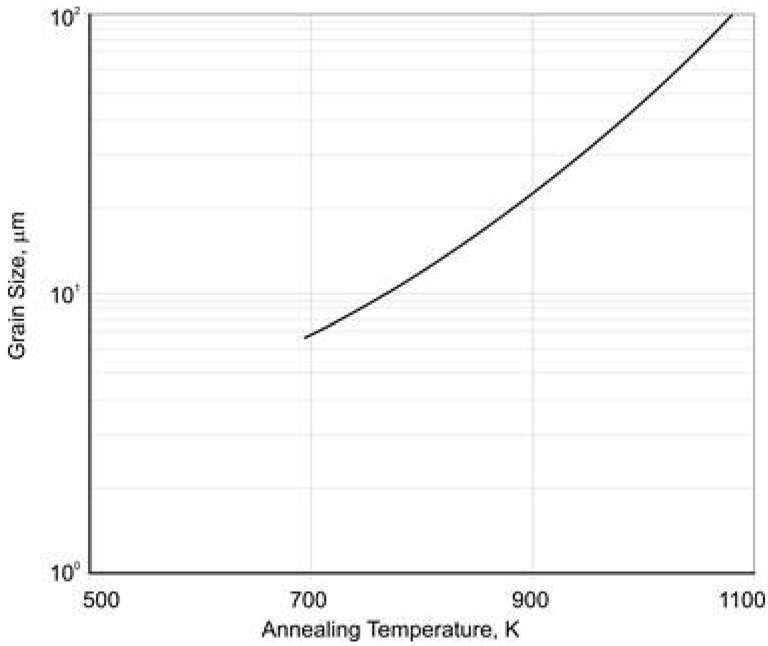
Exploitation properties

Heat resistance

Mechanical and electrical properties vs temperatures



Yield strength vs testing temperature relation for material in annealed temper (0,3%Sn) [Ref: 146]



Annealing temperatures for materials with different grain sizes, time of heating 0,5h (0,3%Sn) [Ref: 146]

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

NO DATA AVAILABLE

Half- softening temperature

Half softening temperature: 340-370 °C (0,4%Sn) [Ref: 59]

Corrosion resistance

Hydrogen embrittlement resistance

NO DATA AVAILABLE

Other kind of corrosion elements

Type of corrosion	Suitability	Literature
Atmospheric	no data	-
Marine environment	no data	-
Stress crack	no data	-
Hydrogen embrittlement	no data	-
Electrolytic	no data	-
Other - oxidising acids	no data	-

Rheological resistance

Stress relaxation

NO DATA AVAILABLE

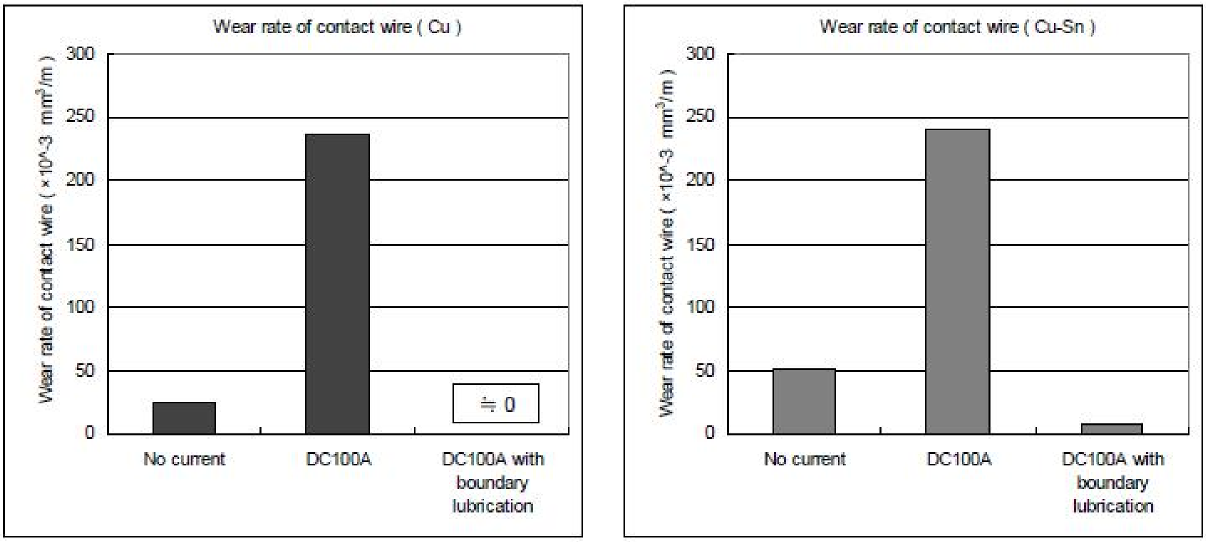
Creep

NO DATA AVAILABLE

Wear resistance

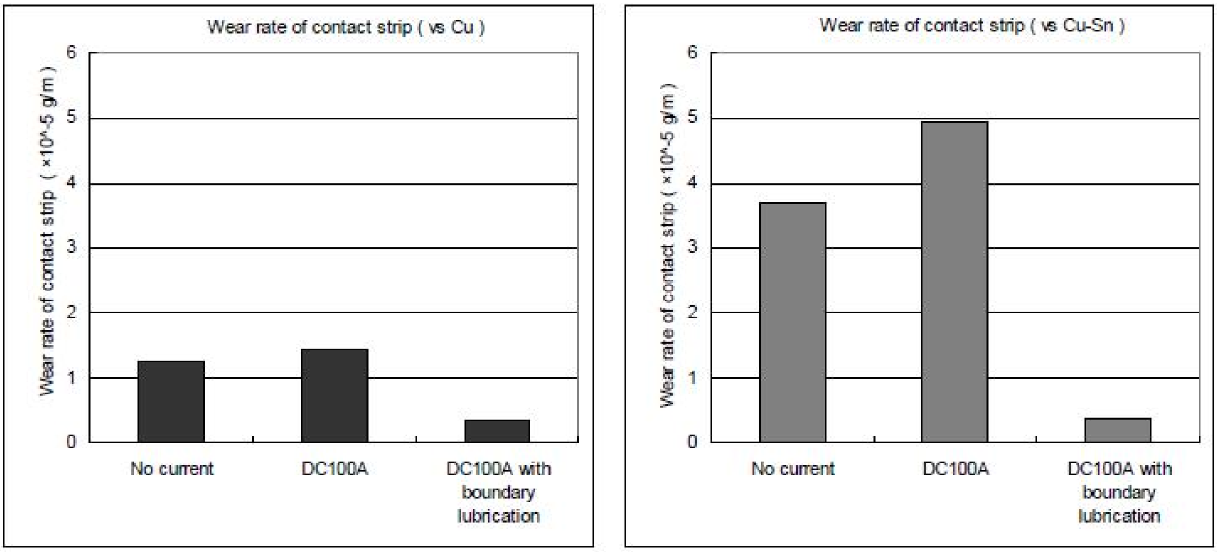
Friction resistance

Cooper -tin alloy CuSn0,4 shows 60% better wearing resistance due to pure ETP copper (materials in hard tempers)



(a) Cu

(b) Cu-Sn



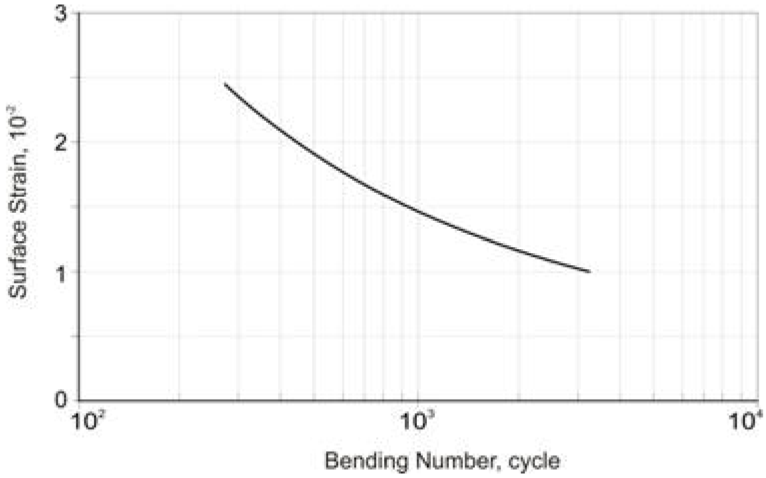
(a) Cu

(b) Cu-Sn

Wear rate data for trolley wire made from Cu (reference) and CuSn alloy and copper contact strip with and without electric current flow and with different friction conditions [Ref: 652]

Fatigue resistance

Fatigue cracking



Material bending fatigue life for different surface strains, material grain size 10µm (0,3%Sn) [Ref: 146]

Impact strength

NO DATA AVAILABLE

Fabrication properties

Fabrication properties	Value	Comments
Soldering	excellent	
Brazing	excellent	
Oxyacetylene Welding	fair	
Gas Shielded Arc Welding	fair	
Capacity for Being Cold Worked	excellent	
Capacity for Being Hot Formed	excellent	
Forgeability Rating	65	
[Ref: 150]		

Technological properties

NO DATA AVAILABLE

References:

2. **Properties of copper and copper alloys at cryogenic temperatures** - Simon N. J., Drexler E.S., Reed R. P., NIST Monograph 177, National Institute of Standards and Technology, U.S. Department of Commerce, Washington, D.C., Feb 1992

46. **Data sheet - Grooved contact wire** - LaFarga

59. **Optimization and development of contact wire for high speed lines** - F. Pupke, NKT Cables GmbH.

90. **Data sheet - High-performance copper-alloy wire** - Wieland

97. **Data sheet - CONTACT WIRE AND STRANDED CONDUCTORS FOR OVERHEAD CATENARY SYSTEMS** - LILJEDAHL BARE WIRE

112. **Application datasheet – C10100-C12099** -

130. **RELATIONS BETWEEN THE MODULUS OF ELASTICITY OF BINARY ALLOYS AND THEIR STRUCTURE** - Werner K&ter and Walter Rauscher, NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS TECHNICAL MEMORANDUM 1321

146. **Effects of Grain Size and Sn Concentration on Bending Fatigue Life of Cu-Sn Alloy** - , Seigi Aoyama and Ryouichi Urao, J. Japan Inst. Metals, Vol. 74, No. 1 (2010), pp. 49-54

147. **Copper and copper alloys-wire for electrical purposes** - AS/NZS 1574:1996

148. **Data sheet - Railway products** - LaFarga

149. **Contact wire - Engineering Specification Electrical EP 08000024 SP** -

150. **C18835** - www.copper.org

151. **Phospor Bronze (Copper Tin) BF03** - Diehl Metall

152. **Data sheet - Fahrdrahte aus CuSn0,2 nach EN 50149** - NKT Cables

153. **Zastosowania kolejowe - Urządzenia stacjonarne - Trakcja elektryczna – Profilowane druty jezdne z miedzi i jej stopów PN-EN 50149:2002/AC** - (Polish Railway Standard)

154. **Data sheet - HILO DE CONTACTO RANURADO DE ALTA RESISTENCIA AL DESGASTE** - LaFarga

155. **Data sheet - Hard drawn round and grooved contact wire for overhead electrified transport systems** - Kembla

156. **Microstructure Evolution in Preparation of Cu-Sn Contact Wire for High-speed Railway** - Yan Ming, Wu Yucai, Chen Jingchao, Zhou Xiaolong, Advanced Materials Research Vols. 415-417 (2012) pp 446-451

650. **Single-core automotive cables** - Leoni Report

651. **Changes in Mechanical Characteristics of Pre-Annealed Wires of CuSn Alloy Manufactured by Continuous Draw Bending** - Junichiro Tokutomi, Kenichi Hanazaki, Nobuhiro Tsuji, Jun Yanagimoto, Materials Transactions, Vol. 53, No. 1 (2012) pp. 116 to 122

652. **A Study on Reducing Wear of Contact Wire at Stations of High Speed Line by Using Wear Map of Wire** - F. Okimoto, S. Kusumi, H. Nagasawa, 8th World Congress on Railway Research, Seoul, Korea, 18-22 May 2008