WROUGHT MATERIALS

COPPER-NICKEL-ZINC ALLOYS
Nickel Silvers

Cu Ni18 Zn27

Common names: 18% Nickel Silver
Nickel Silver 55–18

A copper-nickel-zinc alloy with an alpha phase structure. The material, which is silver-white in colour, has good corrosion resistance to many organic products, waters and corrosive atmospheres. It is essentially a spring alloy widely used in the telecommunications field. The most commonly used wrought forms are sheet and strip.

COMPOSITION (weight %)

Cu	53.0–56.0
Ni	17.0–19.0
Mn	0– 0.5
Zn	rem.

1 SOME TYPICAL USES

Electrical
Relay and contact springs, wiper blades, cross-bar switches, control parts and uniselector components in telecommunications equipment (for more arduous service conditions); contacts, connectors, connector pins and terminals.

Mechanical
Springs and clips.

2 PHYSICAL PROPERTIES

		Metric Units	English Units
2.1	Density at 20 °C *68 °F*	8.70 g/cm³	0.315 lb/in³
2.2	Melting range	1 000–1 070 °C	1 830–1 960 °F
2.3	Coefficient of thermal expansion (linear) at:		
	20 to 100 °C *68 to 212 °F*	0.000 016 per °C	0.000 009 per °F
	20 to 300 °C *68 to 572 °F*	0.000 017 ,, ,,	0.000 009 ,, ,,
2.4	Specific heat (thermal capacity) at:		
	20 °C *68 °F*	0.09 cal/g °C	0.09 Btu/lb °F
2.5	Thermal conductivity at:		
	20 °C *68 °F*	0.06 cal cm/cm² s °C	15 Btu ft/ft² h °F
2.6	Electrical conductivity (volume) at:		
	20 °C *68 °F* (annealed or cold worked)	3.2 m/ohm mm²	5.5% IACS
2.7	Electrical resistivity (volume) at:		
	20 °C *68 °F* (annealed or cold worked)	0.31 ohm mm²/m 31 microhm cm	189 ohms (circ mil/ft) 12 microhm in
2.8	Temperature coefficient of electrical resistance at:		
	20 °C *68 °F* (annealed or cold worked) applicable over range from 0 to 100 °C *32 to 212 °F*	0.000 3 per °C (5.5% IACS)	0.000 2 per °F (5.5% IACS)
2.9	Modulus of elasticity (tension) at 20 °C *68 °F*:		
	annealed	13 400 kg/mm²	19 100 000 lb/in²
	cold worked	14 000 kg/mm²	19 900 000 lb/in²
2.10	Modulus of rigidity (torsion) at 20 °C *68 °F*:		
	annealed	5 000 kg/mm²	7 100 000 lb/in²
	cold worked	5 200 kg/mm²	7 400 000 lb/in²

N.B.: The values shown in Section 2, which have been appropriately rounded in view of the composition range involved, are based on selected literature references. The melting range covers the highest liquidus and lowest solidus temperatures over the composition range quoted.

INDEX NUMBERS RELATE TO LITERATURE REFERENCES (see page 6); INDEX LETTERS RELATE TO FOOTNOTES AT END OF TABLE

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3 FABRICATION PROPERTIES

The information given in this table is for general guidance only, since many factors influence fabrication techniques.
The values shown are approximate only, since those used in practice are dependent upon form and size of metal, equipment available, techniques adopted and properties required in the material.

		Metric Units	English Units
3.1	Casting temperature range	1 150–1 225 °C	2 100–2 235 °F
3.2	Annealing temperature range	650– 800 °C	1 200–1 470 °F
	Stress relieving temperature range	250– 350 °C	480– 660°F
3.3	Hot working temperature range	850– 925 °C	1 560–1 695°F
3.4	Hot formability	Very limited	
3.5	Cold formability	Good	
3.6	Cold reduction between anneals	65% max.	
3.7	Machinability	See General Data Sheet No. 2	
	Machinability rating (free cutting brass = 100)	30	
3.8	Joining methods:	See General Data Sheet No. 3.10	
	Soldering	Excellent	
	Brazing	Excellent	
	Oxy-acetylene welding	Good	
	Carbon-arc welding	Not recommended	
	Gas-shielded arc welding	Fair	
	Coated metal-arc welding	Not recommended	
	Resistance welding: spot and seam	Good	
	butt	Good	

4 NATIONAL SPECIFICATIONS FOR MANUFACTURED FORMS

and ISO Recommendation

Country	Designation of Standards	Designation of Material in Standards	Specification for Chemical Composition [(a)]	Plate Sheet Strip	Rod	Wire	Tube	Sections / Shapes	Forgings
Australia	SAA	NS107	—	H 83	—	—	—	—	—
Belgium	NBN	Cu55 Ni18 Zn	—	266.41	266.41	266.41	—	—	—
Canada	CSA	HC. ZN2718 770	—	HC.4.4	—	—	—	—	—
Chile	NCh (INDITECNOR)	—	NCh 251 of. 68	—	—	—	—	—	—
France	NF	U-Z27 N18 × 85	—	A53-605	—	—	—	—	—
Germany	DIN	—	—	—	—	—	—	—	—
India	IS	Cn Ni18 Zn27	—	3332	—	—	—	—	—
Italy	UNI	—	—	—	—	—	—	—	—
Japan	JIS	NSSP NSBS NSSR NSWS NSSPS NSSRS	—	H3702	H3711	H3721	—	—	—
Netherlands	N or NEN [(b)]	Cu-Ni18 Zn27	NEN 6030	NEN 6033	—	—	—	—	—
South Africa	SABS	—	—	—	—	—	—	—	—
Spain	UNE	Cn Zn Ni54-18	—	37 103	37 103	37 103	—	—	—
Sweden	SIS	—	—	—	—	—	—	—	—
Switzerland	VSM	Cu Ni18 Zn27	10 804	10 804	—	—	—	—	—
United Kingdom	BS	NS107	—	1824 2870	—	2873	—	—	—
United States [(c)]	ASTM	No. 770	—	B 122 B 151	B 151	B 206	—	—	—
International Organisation for Standardization	ISO	Cu Ni18 Zn27	R430	—	—	—	—	—	—

(a) Applicable when the chemical composition is not given in the specifications for wrought forms.
(b) Older specifications bear prefix N; for new specifications the NEN prefix is used.
(c) In the United States, bar and flat wire are covered under the Plate-Sheet-Strip column.

5 MECHANICAL PROPERTIES

5.1 Mechanical properties at room temperature

Tensile properties	see tables 5.1.1/2/3
Hardness	,, ,, 5.1.1/2/3
Shear strength	,, ,, 5.1.1/2/3
Modulus of elasticity (tension)	see 2.9
Modulus of rigidity (torsion)	,, 2.10

5.2 Mechanical properties at low temperature

Tensile properties	no data
Impact properties	,, ,,

5.3 Mechanical properties at elevated temperature

Short-time tensile properties	see table 5.3.1
Impact properties	no data
Creep properties	,, ,,

5.4 Fatigue properties

Fatigue strength at room temperature	see table 5.4.1

5.1 MECHANICAL PROPERTIES AT ROOM TEMPERATURE *

5.1.1 Typical Tensile Properties and Hardness Values—Metric Units

This table is representative of practice in many European countries. For British and American practices, see tables 5.1.2 and 5.1.3, respectively.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.

For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper	Tensile Strength kg/mm²	Proof Stress 0.2% offset kg/mm²	Elongation % on 50 mm	Hardness		Shear Strength kg/mm²	Typical Size Related to Properties Shown (a)
					Brinell	Vickers		
Sheet Strip	Annealed	44	21	48	100	105	33	0.2–2 mm thick
	Typical Cold Worked Tempers	65	58	6	190	200	42	0.2–2 mm thick
		74	68	4	215	225	44	0.1–1 mm thick
		80	75	2	225	235	45	0.1–1 mm thick

(a) It is possible to obtain sizes outside the ranges given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.

5.1.2 Typical Tensile Properties and Hardness Values—SI and English Units

This table is based on British practice. For other European and American practices, see tables 5.1.1 and 5.1.3, respectively.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.

For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper (a)	Tensile Strength		Proof Stress 0.1% offset		Elongation		Vickers Hardness	Shear Strength		Typical Size Related to Properties Shown (b)
		hbar	ton/in²	hbar	ton/in²	%	gauge length		hbar	ton/in²	
Strip (c)	Annealed Grade 5—Soft (grain size 0.030 mm)	42	27	19	12	45	50 mm (2 in.)	100	31	20	0.2–1 mm (0.008–0.04 in.) thick
	Cold Worked Grade 4	53	34	37	24	25	50 mm (2 in.)	155	—	—	0.2–1 mm (0.008–0.04 in.) thick
	Grade 3	57	37	45	29	15	50 mm (2 in.)	180	—	—	0.2–1 mm (0.008–0.04 in.) thick
	Grade 2	63	41	54	35	8	50 mm (2 in.)	210	—	—	0.2–1 mm (0.008–0.04 in.) thick
	Grade 1—extra hard	77	50	68	44	~2	50 mm (2 in.)	240	46	30	0.2–1 mm (0.008–0.04 in.) thick
Rod (d)	Annealed	40	26	17	11	45	$5.65\sqrt{S_o}$	95	29	19	—
	Typical Cold-Worked Temper	60	39	48	31	10	$5.65\sqrt{S_o}$	190	42	27	4–12 mm (0.16–0.5 in.) diam. or equivalent area
Wire	Annealed	42	27	—	—	40	100 mm (4 in.)	—	31	20	0.5–2.5 mm (0.02–0.10 in.) diam.
	Cold Drawn Half Hard	68	44	—	—	<5	100 mm (4 in.)	—	—	—	0.5–2.5 mm (0.02–0.10 in.) diam.
	Hard	80	52	—	—	—	—	—	—	—	0.5–2.5 mm (0.02–0.10 in.) diam.

(a) The recognised temper designations used in the relevant British Standards are also given.

(b) It is possible to obtain sizes outside the ranges given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.

(c) Material for the telecommunications industry.

(d) The mechanical properties will be largely dependent upon the size and cross-sectional area or complexity of the product.

* It will be noted that tables 5.1.1, 5.1.2 and 5.1.3, giving typical tensile properties and hardness values in Metric, SI and English, and American units respectively are not directly comparable. This is because the properties quoted reflect to some extent the metalworking techniques, specification practices and testing procedures in the countries concerned, and in view of the different sizes of products referred to in these tables. Individual manufacturers of semi-fabricated products can, however, normally meet the requirements of any national standard.

5.1.3. Typical Tensile Properties and Hardness Values—American Units

This table is based on American practice and the temper designations shown are those referred to in ASTM and other American Standards. For British and other European countries' practices, see tables 5.1.2 and 5.1.1, respectively.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.

For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper	Tensile Strength psi	Yield Strength 0.5% extension under load psi	Elongation		Rockwell Hardness			Shear Strength psi	Typical Size Related to Properties Shown [a]
				%	gauge length	F	B	30 T		
Flat Products (Sheet, Bar and Strip, Flat Wire)	Annealed (grain size 0.035 mm)	60 000	27 000	40	2 in.	90	55	—	45 000	0.040 in. thick
	Cold Worked									
	Quarter Hard	78 000	—	—	—	—	72	—	54 000	0.040 in. thick
	Half Hard	90 000	—	—	—	—	83	—	62 000	0.040 in. thick
	Hard	100 000	85 000	3	2 in.	—	91	77	65 000	0.040 in. thick
	Extra Hard	108 000	90 000	2.5	2 in.	—	96	80	70 000	0.040 in. thick
	Spring	115 000	—	2.5	2 in.	—	99	81	74 000	0.040 in. thick
Rod[b]	Annealed	60 000	24 000	45	2 in.	—	50	—	45 000	1.0 in. diam.
	Cold Worked Hard	80 000	60 000	15	2 in.	—	80	—	56 000	1.0 in. diam.
Wire	Annealed (grain size 0.035 mm)	60 000	—	40	10 in.	—	—	—	45 000	0.080 in. diam.
	Cold Worked									
	Extra Hard	120 000	—	2	10 in.	—	—	—	78 000	0.080 in. diam.
	Spring (68%)	145 000	—	1.5	10 in.	—	—	—	87 000	0.080 in. diam.

(a) It is possible to obtain sizes different from those given in this column, but information on their mechanical properties should be obtained from metal manufacturers.

(b) The mechanical properties will be largely dependent upon the size and cross-sectional area or complexity of the product.

5.2 MECHANICAL PROPERTIES AT LOW TEMPERATURE

5.2.1 Tensile Properties—Impact Properties

At the date of publication of this sheet, no data relating to this material have been traced.

5.3 MECHANICAL PROPERTIES AT ELEVATED TEMPERATURE

5.3.1. Short-Time Tensile Properties

Form	Temper	Testing Temperature		Tensile Strength			Proof Stress 0.2% offset kg/mm²	Elongation % on 50 mm
		°C	°F	kg/mm²	ton/in²	psi		
Strip [1]	Cold Worked [a]	20	68	**80**	51	114 000	**69**	**2**
		100	212	**81**	51.5	115 000	**73**	—
		200	392	**78**	49.5	111 000	**77**	—

[a] Quoted as "hard, 240 HV" in original document, but amount of cold work not defined.

N.B. :— Original values are printed in **bold type**; other values are converted.
— Data not available : Proof stress, 0.1% offset,
Yield strength, 0.5% extension under load.

5.4 FATIGUE PROPERTIES

5.4.1 Fatigue Strength at Room Temperature

Form	Temper	Number of Cycles $\times 10^6$	Metric Units kg/mm²		English Units ton/in²		American Units psi	
			Tensile Strength	Fatigue Strength	Tensile Strength	Fatigue Strength	Tensile Strength	Fatigue Strength
Strip [2] 0.51 mm 0.02 in.	Annealed	100	43.5	11 [a]	28	7 [a]	**62 200**	**16 000** [a]
	Cold Worked 37.2%	100	67	14.5 [a]	42.5	9 [a]	**95 400**	**20 500** [a]
	50% [b]	100	76.5	16 [a]	48.5	10.5 [a]	**108 500**	**23 000** [a]
	60.5% [c]	100	79	16.5 [a]	50	10.5 [a]	**112 400**	**23 750** [a]
	68%	100	83	17.5 [a]	52.5	11 [a]	**117 700**	**25 000** [a]
Strip [2] 0.64 mm 0.025 in.	Cold Worked 20.7%	100	56	16 [a]	35.5	10.5 [a]	**79 300**	**23 000** [a]
Strip [3] 1 mm 0.04 in.	Cold Worked [d] 37%	100	76	20.5 [a]	48	13 [a]	**108 000**	**29 000** [a]
	60.5%	100	82.5	22.5 [a]	52	14.5 [a]	**117 000**	**32 000** [a]

[a] Reversed-bending test.
[b] Ready-to-finish grain size 0.022 mm.
[c] Ready-to-finish grain size 0.090 mm.
[d] Ready-to-finish grain size 0.015 mm.

N.B. :— Original values are printed in **bold type**; other values are converted.
— Further data can be obtained from the following paper:
■ Weldon, B.A., Towers, J.A. and Patton, A.M. Nickel Silver as an Engineering Material. Metals & Materials. Vol. 4 (1970), pp. 299-303.

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MECHANICAL PROPERTIES (SECTION 5)

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(3) France, W.D. and Trout, D.E. Selecting Copper Alloys for Fatigue Applications. Metal Progress, Vol. 101 (1972), No. 6, pp. 69, 71-72.

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