UDC 669.35'5

Cu Zn10

Common names: 90/10 Brass
90/10 Gilding Metal
Commercial "Bronze"

A copper–zinc alloy with an alpha phase structure. The alloy has excellent cold-working properties and is generally not susceptible to dezincification and stress corrosion. Due to its cold formability and attractive golden colour, the alloy is widely used for architectural and decorative applications.

COMPOSITION (weight %)

Cu	89.0–91.0
Zn	rem.

1 SOME TYPICAL USES

Architectural
Showcase and window fittings, grillwork, weatherstrip, cold-formed angles and channels, ornamental pressings and trim.

Decorative
Cosmetic compacts, lipstick cases, costume jewellery, emblems and medallions; base material for vitreous enamel.

Hardware
Marine hardware; rivets and screws; wire gauze; slide (zip) fasteners.

Munitions
Primer caps and shell bands; bullet envelopes (clad on steel).

2 PHYSICAL PROPERTIES

		Metric Units	English Units
2.1	Density at 20 °C *68 °F*	8.80 g/cm³	0.320 lb/in³
2.2	Melting range	1 025–1 045 °C	1 875–1 915 °F
2.3	Coefficient of thermal expansion (linear) at:		
	20 to 100 °C *68 to 212 °F*	0.000 018 per °C	0.000 010 per °F
	20 to 300 °C *68 to 572 °F*	0.000 018 ,, ,,	0.000 010 ,, ,,
2.4	Specific heat (thermal capacity) at:		
	20 °C *68 °F*	0.09 cal/g °C	0.09 Btu/lb °F
	200 °C *392 °F*	0.10 ,,	0.10 ,,
2.5	Thermal conductivity at:		
	20 °C *68 °F*	0.45 cal cm/cm² s °C	109 Btu ft/ft² h °F
	200 °C *392 °F*	0.54 ,,	131 ,,
2.6	Electrical conductivity (volume) at:		
	—196 °C *—321 °F* (annealed)	45 m/ohm mm²	78 % IACS
	20 °C *68 °F* (,,)	26 ,,	44 ,, ,,
	200 °C *392 °F* (,,)	19 ,,	33 ,, ,,
	—196 °C *—321 °F* (fully cold worked)	40 ,,	69 ,, ,,
	20 °C *68 °F* (,, ,, ,,)	23 ,,	40 ,, ,,

continued overleaf

INDEX NUMBERS RELATE TO LITERATURE REFERENCES (see page 10); INDEX LETTERS RELATE TO FOOTNOTES AT END OF TABLE

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DATA SHEET No. D 2
Cu Zn10

2 PHYSICAL PROPERTIES (continued)

	Metric Units	English Units
2.7 Electrical resistivity (volume) at:		
—196 °C —*321 °F* (annealed)	0.022 ohm mm²/m 2.2 microhm cm	13 ohms (circ mil/ft) 0.86 microhm in
20 °C *68 °F* (,,)	0.039 ohm mm²/m 3.9 microhm cm	24 ohms (circ mil/ft) 1.5 microhm in
200 °C *392 °F* (,,)	0.053 ohm mm²/m 5.3 microhm cm	32 ohms (circ mil/ft) 2.1 microhm in
—196 °C —*321 °F* (fully cold worked)	0.025 ohm mm²/m 2.5 microhm cm	15 ohms (circ mil/ft) 0.98 microhm in
20 °C *68 °F* (,, ,, ,,)	0.043 ohm mm²/m 4.3 microhm cm	26 ohms (circ mil/ft) 1.7 microhm in
2.8 Temperature coefficient of electrical resistance at:		
20 °C *68 °F* (annealed) applicable over range from 0 to 100 °C *32 to 212 °F*	0.001 9 per °C (44% IACS)	0.001 0 per °F (44% IACS)
20°C *68 °F* (fully cold worked) applicable over range from 0 to 100 °C *32 to 212 °F*	0.001 7 ,, ,, (40% IACS)	0.000 9 ,, ,, (40% IACS)
2.9 Modulus of elasticity (tension) at 20 °C *68 °F*		
annealed	12 700 kg/mm²	18 000 000 lb/in²
cold worked	12 000–12 700 kg/mm²	17 000 000–18 000 000 lb/in²
2.10 Modulus of rigidity (torsion) at 20 °C *68 °F*		
annealed	4 650 kg/mm²	6 600 000 lb/in²
cold worked	4 400–4 650 kg/mm²	6 250 000–6 600 000 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.

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	1 120–1 180 °C	2 050–2 155 °F
3.2 Annealing temperature range	425– 600 °C	795–1 110 °F
Stress relieving temperature range	200– 300 °C	390– 570 °F
3.3 Hot working temperature range	750– 900 °C	1 380–1 650 °F
3.4 Hot formability	Good	
3.5 Cold formability	Excellent	
3.6 Cold reduction between anneals	90% max.	
3.7 Machinability:	See General Data Sheet No. 2	
Machinability rating (free-cutting brass = 100)	25	
3.8 Joining methods:	See General Data Sheet No. 3.4	
Soldering	Excellent	
Brazing	Excellent	
Oxy-acetylene welding	Good	
Carbon-arc welding	Not recommended	
Gas-shielded arc welding	Good	
Coated metal-arc welding	Not recommended	
Resistance welding: spot and seam	Not recommended	
butt.	Good	

5.1 MECHANICAL PROPERTIES AT ROOM TEMPERATURE [a]

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		Hardness		Shear Strength kg/mm²	Typical Size Related to Properties Shown [b]
				%	gauge length	Brinell	Vickers		
Plate Sheet Strip	Annealed (grain size 0.025 mm)	28	10	48	50 mm	60	63	21	0.2–2.5 mm thick
	Typical Cold Worked Tempers	32	20	30	50 mm	75	79	22	0.2–3 mm thick
		35	28	22	50 mm	95	100	23	"
		43	35	10	50 mm	120	125	26	0.2–2 mm thick
		48	42	5	50 mm	125	130	29	0.2–1.5 mm thick
Rod	Annealed	26	9	50	$5.65\sqrt{S_o}$	55	58	20	—
	Typical Cold Worked Tempers	32	20	32	$5.65\sqrt{S_o}$	80	84	22	6–40 mm diam. or equivalent area
		40	32	15	$5.65\sqrt{S_o}$	115	120	26	6–12 mm diam. or equivalent area
Wire	Annealed	28	—	33	100 mm	—	—	21	1.5–6 mm diam.
		30	—	30	100 mm	—	—	23	0.2–1.5 mm diam.
	Typical Cold Drawn Tempers	48	—	4	100 mm	—	—	29	0.2–1.5 mm diam.
		57	—	—	—	—	—	30	"
Tube	Annealed	27	10	48	$5.65\sqrt{S_o}$	60	63	20	—
	Typical Cold Drawn Tempers	34	22	28	$5.65\sqrt{S_o}$	85	89	23	10–50 mm O.D. over 2 mm wall
		42	35	12	$5.65\sqrt{S_o}$	115	120	26	up to 25 mm O.D., up to 2 mm wall

(a) 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, 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.

(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.

5.1.2 Typical Tensile Properties and Hardness Values—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 ton/in²	Proof Stress 0.1% offset ton/in²	Elongation %	Elongation gauge length	Vickers Hardness	Shear Strength ton/in²	Typical Size Related to Properties Shown[b]
Sheet Strip	Annealed							
	grain size 0.035 mm	16	4	55	2 in.	60	11	0.01–0.125 in. thick
	grain size 0.025 mm	17	5	55	2 in.	65	12	,,
	grain size 0.015 mm	18	6	52	2 in.	80	13	,,
	Cold Worked							
	Quarter Hard	18	12	40	2 in.	90	14	0.01–0.375 in. thick
	Half Hard	21	17	25	2 in.	110	15	0.01–0.25 in. thick
	Hard	24	22	12	2 in.	125	16	0.01–0.1 in. thick
	Extra Hard	29	25	8	2 in.	140	17	,,
Rod	Annealed	16	5	50	$5.65\sqrt{S_o}$	60	11	—
	Cold Worked As Manufactured	20	12	35	$5.65\sqrt{S_o}$	90	14	0.25–1 in. diam. or equivalent area
		22	16	25	$5.65\sqrt{S_o}$	110	15	
Wire	Annealed	18	—	50	2 in.	—	13	0.02–0.10 in. diam.
	Cold Drawn							
	Half Hard	27	—	10	2 in.	—	19	0.02–0.10 in. diam.
	Hard	32	—	—	—	—	21	,,
Tube[c]	Annealed	16	5	50	$5.65\sqrt{S_o}$	60	11	—
	Cold Drawn or Temper Annealed							
	Temper Annealed	19	9	35	$5.65\sqrt{S_o}$	90	14	2–10 in. O.D., 0.08–0.2 in. wall
	As Drawn	23	17	25	$5.65\sqrt{S_o}$	125	16	,,
	Temper Annealed	19	9	35	$5.65\sqrt{S_o}$	90	14	0.25–2 in. O.D., 0.02–0.08 in. wall
	As Drawn	27	21	20	$5.65\sqrt{S_o}$	140	18	,,

(a) The recognised temper designations used in the relevant or nearest British Standards are also given in this table, to clarify the cold-worked tempers shown.

(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) Intermediate tube tempers are generally obtained by temper annealing. Drawn tubes are usually stress relieved after the final draw.

5.2 MECHANICAL PROPERTIES AT LOW TEMPERATURE

5.2.1 Tensile Properties—Impact Properties

Form	Temper	Testing Temperature		Tensile Strength			Proof Stress 0.2% offset kg/mm²	Elongation % on $4.52\sqrt{S_o}$	Reduction of Area %	Impact Strength	
		°C	°F	kg/mm²	ton/in²	psi				kg m/cm²	ft lb
Rod[1] **19 mm diam. 0.75 in. diam.**	Annealed	22	72	27	17	**38 500**	**6.75**[a]	**56**	**84**	19.4[b]	**112**[b]
		−78	−108	29.5	18.5	**41 800**	**7.17**[a]	**57**	**80**	19.7[b]	**114**[b]
		−197	−323	39	24.5	**55 200**	**9.28**[a]	**86**	**78**	19.4[b]	**112**[b]
		−253	−423	51.5	32.5	**73 200**	**11.0**[a]	**95**	**73**	19.9[b]	**115**[b]
		−269	−452	48	30.5	**68 200**	**10.5**[a]	**91**	**73**	—	—
Rod[2]	Annealed (grain size 0.022 mm)	−195	−319	40.5	25.5	**57 400**	**10.5**[a]	—	—	—	—

(a) This value was originally reported in psi; in this table it is given in kg/mm² to 3 significant figures.
(b) Charpy test, 10 × 10 × 55 mm specimen, 45° V-notch, 2 mm deep; cross-sectional area at the notch 0.8 cm².

N.B.:—Original values are printed in **bold type**; other values are converted.
—All converted values for impact strength are to be taken as indicative only; the impact energy has been converted from ft lb into kg m/cm² taking into account the actual cross-sectional area of the specimen at the notch.
—Data not available:
Proof stress, 0.1% offset,
Yield strength, 0.5% extension under load.

5.3 MECHANICAL PROPERTIES AT ELEVATED TEMPERATURE

5.3.1 Short-Time Tensile Properties

Form	Temper	Testing Temperature		Tensile Strength			Proof Stress		Elongation	
		°C	°F	kg/mm²	ton/in²	psi	0.2% offset kg/mm²	0.1% offset ton/in²	%	gauge length
Rod[3][a] **12 mm diam. 0.47 in. diam.**	Cold Worked 44% and Stress Relieved[b]	20	68	**63.3**	40	90 000	**57.1**	**32.0**[c]	**14.8**	$5.65\sqrt{S_o}$
		200	392	**54.9**	35	78 000	**51.7**	**30.5**[c]	**10.9**	$5.65\sqrt{S_o}$
		300	572	**47.2**	30	67 000	**43.3**	**25.0**[c]	**9.0**	$5.65\sqrt{S_o}$
Rod[4] **12.7 mm diam 0.5 in. diam.**	Annealed	25	77	26	16.5	**37 000**	**6.78**[d]	—	—	—
		300	572	18.5	11.5	**26 100**	**5.30**[d]	—	—	—
		500	932	9.5	6	**13 700**	**4.34**[d]	—	—	—
Rod[5] **12.8 mm diam. 0.505 in. diam.**	Annealed	25	77	26	16.5	**36 700**	—	—	**56**	2 in.
		250	482	20.5	13	**29 500**	—	—	**35**	2 in.
		375	707	14	9	**19 800**	—	—	**9**	2 in.
		500	932	9.5	6	**13 700**	—	—	**14**	2 in.
		625	1 157	6	4	**8 500**	—	—	**17**	2 in.
		750	1 382	3	2	**4 500**	—	—	**18**	2 in.
		875	1 607	2	1	**2 700**	—	—	**16**	2 in.
		975	1 787	1	0.7	**1 500**	—	—	**14**	2 in.

(a) Containing 0.4% Sn.
(b) Stress relieved for 1 h at 400 °C (*752 °F*).
(c) This value was originally reported in kg/mm²; in this table it is given in ton/in² to 3 significant figures.
(d) This value was originally reported in psi; in this table it is given in kg/mm² to 3 significant figures.

N.B.:—Original values are printed in **bold type**; other values are converted.
—The yield strength 0.5% extension under load values are not available.

5.3.2. Creep Properties

5.3.2.1. Original Creep Data

Form	Temper	Testing Temperature		Stress			Duration h	Total Extension %[a]
		°C	°F	kg/mm²	ton/in²	psi		
Rod[3][b] **12 mm diam. 0.47 in. diam.**	Cold Worked 44% and Stress Relieved[c]	200	392	**8.0**	5.1	11 000	**3 278**	**0.080**
				10.0	6.3	14 200	**3 386**	**0.081**
				12.0	7.6	17 100	**3 503**	**0.116**
				14.0	8.9	19 900	**3 160**	**0.154**
				16.0	10.2	22 800	**3 018**	**0.182**

[a] Total creep; does not include the initial elastic extension.
[b] Containing 0.4% Sn.
[c] Stress relieved for 1 h at 400 °C *(752 °F)*.

N.B.—Original values are printed in **bold type**; other values are converted.
—Data not available:
Intercept,
Minimum creep rate.

5.3.2.2. Stress for Designated Extension

Form	Temper	Testing Temperature		Stress for Designated Extension											
				0.1% in 1 000 h			0.2% in 1 000 h			0.1% in 2 000 h			0.2% in 2 000 h		
		°C	°F	kg/mm²	ton/in²	psi	kg/mm²	ton/in²	psi	kg/mm²	ton/in²	psi	kg/mm²	ton/in²	psi
R od[3][a] **12 mm diam. 0.47 in. diam.**	Cold Worked 44% and Stress Relieved[b]	200	392	**13.2**	8.4	18 800	**17.2**	10.9	24 500	**12.1**	7.7	17 200	**16.6**	10.5	23 500

[a] Containing 0.4% Sn.
[b] Stress relieved for 1 h at 400 °C *(752 °F)*

N.B.: Original values are printed in **bold type**; other values are converted.

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[6] **0.81 mm 0.032 in.**	Annealed (grain size 0.030 mm)	100	27.5	7[a][f]	17.5	4.5[a][f]	**39 000**	**10 000**[a][f]
	Cold Worked 21%	100	33	11[a]	21	7[a]	**47 000**	**16 000**[a]
	Cold Worked 37%	100	42	11.5[a]	26.5	7.5[a]	**59 700**	**16 500**[a]
	Cold Worked 60%	100	47	12.5[a]	30	8[a]	**66 900**	**18 000**[a]
	Cold Worked 68%	100	51.5	14[a]	32.5	9[a]	**73 300**	**20 000**[a]
Flat Products[7] **1 mm 0.04 in.**	Cold Worked[b]	15	50.5	15[a]	32	9.5[a]	**72 000**	**21 000**[a]
Wire[8] [c] **1.8 mm diam. 0.072 in. diam.**	Cold Worked 60%	100	43	15[d]	27	9.5[d]	**61 000**	**21 000**[d]
	Cold Worked 84%	100	51	16[d]	32.5	10.5[d]	**72 500**	**23 000**[d]
Wire[7] **2 mm diam. 0.08 in. diam.**	Cold Worked[e]	100	52	16[d]	33	10.5[d]	**74 000**	**23 000**[d]

(a) Reversed-bending test.
(b) Quoted as "spring" in original document, but amount of cold work not defined.
(c) Just outside the composition range (8.80% Zn).
(d) Rotating-beam test.
(e) Quoted as "hard" in original document, but amount of cold work not defined.
(f) By extrapolation.

N.B.: Original values are printed in **bold type**; other values are converted.