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PRODUCT DATA SHEET

Phosphor Bronze Alloys Specifications

Copper Alloys

Phosphor bronzes are alloys of copper with tin, which have been deoxidised with phosphorus.

Phosphor bronzes combine high strength with high elongation, and excellent corrosion resistance. They are commonly used for deep drawing into bellows, and for stamping and forming into spring devices and into terminals and connectors for electrical apparatus. The leaded phosphor bronzes are used where machinability is required as well as strength and corrosion resistance. Bearing bronzes are used in bushings, bearings, and load bearing thrust washers.

There are several different alloys in the series, many of which can be used interchangeably. This data sheet describes the specifications for the alloys.

Austral Wright Metals stocks the most commonly used 5% phosphor bronze alloys, and can obtain all of the phosphor bronze alloys for sufficient quantity. Please enquire about availability for your specific application.

The data contained in this document has been extracted from published standards. Please consult the current edition of the standard for your exact requirements.

PART A – Product Specifications for Phosphor Bronzes

Australian (AS) Specifications

Alloy	C51000	C51800
Standard and abbreviated title		
AS 2738 Compositions & designations	✓	✓
AS 1566 Rolled flat products	✓	
AS 1567 Rods, bars & sections		✓
AS 1573 Wire for engineering purposes		✓

USA (ASTM) Specifications

Alloy	C51000 5% A	C51100	C51900	C52100 8% C	C52400 10% D	C53400 B-1	C54400 B-2
ASTM B103 Sheet, strip & rolled bar	✓	✓	✓	✓	✓	✓	✓
ASTM B139 Rod, bar & shapes	✓			✓	✓	✓	✓
ASTM B159 Wire	✓			✓	✓		
ASTM B100 Bridge plates	✓	✓					

Japanese (JIS) Specifications

Alloy	C5102	C5111	C5191	C5210	C5212	C5341	C5441
JIS H3110 Sheets, plates & strips.	✓	✓	✓		✓		
JIS H3130 Sheets, plates and strips for springs.				✓			
JIS H3270 Rods, bars & wires.	✓	✓	✓		✓	✓	✓

PART B –Chemical Composition Specifications for Phosphor Bronze Alloys**Australian (AS) Specifications**

	Alloy	Copper	Tin	Phosphorus	Lead max	Iron max	Zinc max	Aluminium max
AS 2738 Compositions & designations	C51000	Rem	4.2 – 5.8	0.03 – 0.35	0.05	0.10	0.3	–
	C51800	Rem	4.0 – 6.0	0.10 – 0.35	0.02	–	–	0.01

Note: most material meeting C5100 also meets C51800

USA (ASTM) Specifications

	Alloy	Copper	Tin	Phosphorus	Lead max	Iron max	Zinc max
ASTM B103 Sheet, strip & rolled bar	C51000	Rem	4.2 – 5.8	0.03 – 0.35	0.05	0.10	0.30
	C51100	Rem	3.5 – 4.9	0.03 – 0.35	0.05	0.10	0.30
	C51900	Rem	5.0 – 7.0	0.03 – 0.35	0.05	0.10	0.30
	C52100	Rem	7.0 – 9.0	0.03 – 0.35	0.05	0.10	0.20
	C52400	Rem	9.0 – 11.0	0.03 – 0.35	0.05	0.10	0.20
	C53400*	Rem	3.5 – 5.8	0.03 – 0.35	0.08 – 1.2	0.10	0.30
	C54400*	Rem	3.5 – 4.5	0.01 – 0.50	3.5 – 4.5	0.10	1.5 – 4.5

* when specified for bearings, the phosphorus content shall be 0.01 – 0.15%

Japanese (JIS) Specifications

	Alloy	Copper	Tin	Phosphorus	Lead max	Iron max	Zinc max
JIS H3110 Phosphor bronze & nickel silver – sheets, plates & strips.	C5102	99.5 min Cu+Sn+P	4.5 – 5.5	0.03 – 0.35	–	–	–
	C5111	99.5 min Cu+Sn+P	3.5 – 4.5	0.03 – 0.35	–	–	–
	C5191	99.5 min Cu+Sn+P	5.5 – 7.0	0.03 – 0.35	–	–	–
	C5212	99.5 min Cu+Sn+P	7.0 – 9.0	0.03 – 0.35	–	–	–
JIS H3130 Copper beryllium alloy, phosphor bronze & nickel silver – sheets, plates and strips for springs.	C5210	99.7 min	7.0 – 9.0	0.03 – 0.35	0.05	0.10	0.20
JIS H3270 Copper beryllium alloy, phosphor bronze & nickel silver – rods, bars & wires.	C5341	99.5 min Cu+Sn+P	3.5 – 5.8	0.03 – 0.35	0.8 – 1.5	–	–
	C5441	99.5 min Cu+Sn+P	3.0 – 4.5	0.03 – 0.35	3.5 – 4.5	–	–

European (EN) Specifications

Material designation		Composition %					
Symbol	Number	Copper	Tin	Phosphorus	Lead max	Zinc max	Tellurium
CuSn4	CW450K	Rem.	3.5 – 4.5	0.01 – 0.4			
CuSn5	CW451K	Rem.	4.5 – 5.5	0.01 – 0.4			
CuSn6	CW452K	Rem.	5.5 – 7.0	0.01 – 0.4			
CuSn8	CW453K	Rem.	7.5 – 8.5	0.01 – 0.4			
CuSn8P	CW459K	Rem.	7.5 – 8.5	0.2 – 0.4			
CuSn4Pb2P	CW455K	Rem.	3.5 – 4.5	0.2 – 0.4	1.5 – 2.5		
CuSn4Te1P	CW457K	Rem.	4.0 – 5.0	0.1 – 0.4			0.5 – 1.0
CuSn5PbP	CW458K	Rem.	3.5 – 4.5	0.01 – 0.4	0.5 – 1.5		
CuSn8PbP	CW460K	Rem.	7.5 – 9.0	0.2 – 0.4	0.1 – 0.5		
CuSn3Zn9	CW454K	Rem.	1.5 – 3.5			7.5 – 10.0	
CuSn4Pb4Zn4	CW456K	Rem.	3.5 – 4.5	0.01 – 0.4	3.5 – 4.5	3.5 – 4.5	

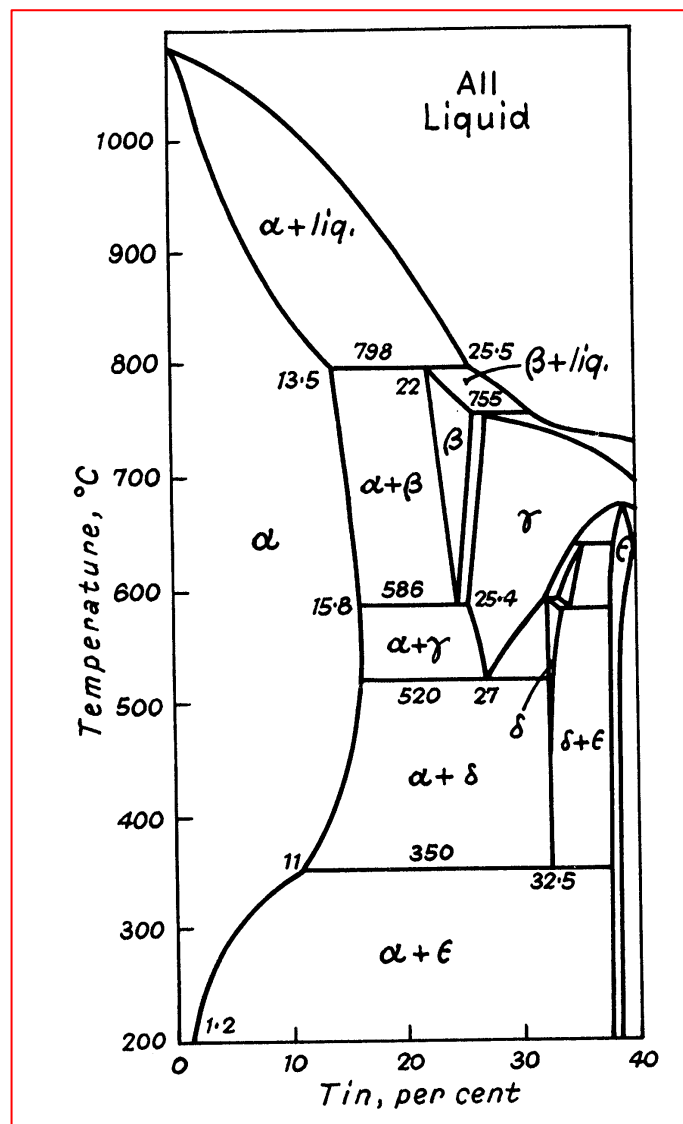
British Standard (BS) Specifications (obsolescent)

Alloy	Name	Copper	Tin	Phosphorus	Total Impurities % max	UNS No equivalent (approximate)	EN equivalent (approximate)
PB101	3% phosphor bronze	Rem	3.0 – 4.5	0.02 – 0.40	0.20	C51100	CuSn4
PB102	5% phosphor bronze	Rem	4.5 – 6.0	0.02 – 0.40	0.20	C51000	CuSn5
PB103	7% phosphor bronze	Rem	6.0 – 7.5	0.02 – 0.40	0.20	~C51900	CuSn6
PB104	9% phosphor bronze	Rem	7.5 – 9.0	0.02 – 0.40	0.20	C52100	CuSn8

British Standard (BS) Product Forms (obsolescent)

	PB101	PB102	PB103	PB104
BS2870 Sheet, strip & foil	✓	✓	✓	
BS 2872 Forging stock & forgings		✓	✓	✓
BS 2873 Wire		✓	✓	
BS 2874 Rods & sections		✓	✓	
BS 2875 Plate			✓	✓

Phase diagram of copper tin alloys



PART C1 – MECHANICAL PROPERTIES – Australian Standards**AS 1566-1997 Plate & rolled bar - C51000**

Temper	Specified thickness mm	Tensile strength MPa min	Elongation on 5.65 sqrt(S ₀) % min	Approximate hardness HV
M or O	>3.2 <=60.0	310	35	130
H	>3.2 <12.0	430	10	90

AS 1566-1997 Sheet in annealed tempers - C51000

Temper	Grain size	Vickers hardness HV max	Tensile strength MPa typical	Elongation on 50 mm % typical
O2	< 0.025 ⁼	95	-	-
O3	0.020 – 0.050	85	310	45

= - must be fully recrystallised

AS 1566-1997 Sheet in rolled tempers – C51000.

Temper	Tensile strength MPa min		Elongation on 50 mm % min	Vickers hardness HV	
	Thickness >0.15 <=2.0	Thickness >2.0 <=3.2		Thickness >0.15 <=2.0	Thickness >2.0 <=3.2
¼ Hard	360	360	35	110 – 160	80 – 100
½ Hard	500	500	10	160 – 180	110 – 140
Hard	590	590	4	180 – 200	130 – 150
Extra hard	650	-	-	200 – 220	140 – 165
Spring hard	-	-	-	>220	150 - 170

AS 1567-1997 Rods, bars & sections – C51800.

Temper	Specified size mm	0.2% Proof stress MPa min	Tensile strength MPa min	Elongation on 5.65 sqrt(S ₀) % min
M	>6 <=20	350	460	12
	>20 <=40	320	430	12
	>40 <=70	280	380	16
	>70 <=120	240	310	20
	>120	80	270	24

AS 1573-1995 Wire for engineering purposes – C51800

Temper	Specified diameter or width across flats, mm	Tensile strength Mpa	Elongation on 100 mm % min
O	0.5 – 10.0	>= 340	12
½ H	0.5 – 10.0	540 – 700	12
¾ H	0.5 – 10.0	700 – 850	16
H	0.5 – 2.5	>= 850	20
	2.51 – 6.0	>= 800	24
SH	<= 0.6	>= 990	–
	0.61 – 1.6	>= 930	–
	1.61 – 3.0	>= 900	–
	3.1 – 6.0	>= 870	–

AS 1573-1995 Wire for engineering purposes – C51800**Hardness of flat wire**

Temper	Hardness, HV
O	<= 85
½ H	170 – 240
H	<= 200

Corrosion resistance of phosphor bronzes

The corrosion resistance of 5% phosphor bronze is at least equal to copper, but the tin addition gives advantages in salt water and similar aggressive moist conditions where it is superior to copper.

Like copper, it does not suffer from dezincification and is seldom involved in stress corrosion failures unless there is a combination of very hard rolled material and specific chemicals such as mercury and ammonia compounds.

Please consult Austral Wright Metals for advice on your specific application.

PART C2 – MECHANICAL PROPERTIES – ASTM Standards**ASTM B103 Phosphor bronze plate, sheet, strip & rolled bar - C51000**

Temper		Tensile strength MPa	Rockwell hardness B Scale typical
Standard	Former		
M20	as hot rolled	275 – 415	–
O60	soft	295 – 400	12 – 64
H02	½ hard	400 – 505	60 – 85
H04	hard	525 – 625	84 – 93
H06	extra hard	605 – 710	89 – 96
H08	spring	655 – 760	92 – 98
H10	extra spring	690 – 790	94 – 99

ASTM B103 Phosphor bronze plate, sheet, strip & rolled bar - C51100, C53400, C54400

Temper		Tensile strength MPa	Rockwell hardness B Scale typical
Standard	Former		
M20	as hot rolled	275 – 415	–
O60	soft	275 – 380	7 – 50
H02	½ hard	380 – 485	53 – 81
H04	hard	495 – 600	80 – 90
H06	extra hard	580 – 685	86 – 94
H08	spring	625 – 720	88 – 96
H10	extra spring	660 – 750	89 – 97

ASTM B103 Phosphor bronze plate, sheet, strip & rolled bar - C51900

Temper		Tensile strength MPa	Rockwell hardness B Scale typical
Standard	Former		
O60	soft	330 – 435	18 – 66
H02	½ hard	440 – 545	65 – 88
H04	hard	550 – 660	86 – 95

ASTM B103 Phosphor bronze plate, sheet, strip & rolled bar - C52100

Temper		Tensile strength MPa	Rockwell hardness B Scale typical
Standard	Former		
M20	as hot rolled	345 – 485	–
O60	soft	365 – 460	20 – 70
H02	½ hard	475 – 580	69 – 91
H04	hard	585 – 690	89 – 97
H06	extra hard	670 – 770	93 – 100
H08	spring	720 – 820	95 – 102
H10	extra spring	760 – 830	96 – 101

ASTM B103 Phosphor bronze plate, sheet, strip & rolled bar - C52400

Temper		Tensile strength MPa	Rockwell hardness B Scale typical
Standard	Former		
M20	as hot rolled	380 – 515	–
O60	soft	400 – 505	25 – 75
H02	½ hard	525 – 625	74 – 95
H04	hard	650 – 750	92 – 101
H06	extra hard	740 – 830	97 – 103
H08	spring	790 – 890	98 – 104
H10	extra spring	830 – 920	99 – 105

ASTM B139 Phosphor bronze rod, bar & shapes

Alloy	Temper		Product	Diameter or distance between parallel surfaces	Tensile strength	Elongation
	Standard	Name		mm	MPa	min %
C51000	O60	Soft anneal	Round rod	< 6.0	275 – 400	–
			Round rod	< 6.0	550 – 880	–
	H04	Hard	Round & hexagonal	6.0 – 12.0	>= 485	13
				12.1 – 25.0	>= 415	15
				> 25.0	>= 380	18
			Bar: square & rectangular	6.0 – 9.0	>= 415	10
				> 9.0	>= 380	15
	H08	Spring	Round rod	0.65 – 1.6	>= 790	–
				1.61 – 3.0	>= 760	–
				3.1 – 6.0	>= 725	3.5
				6.1 – 9	>= 690	5.0
				9.1 – 12	>= 620	9.0
C52100	O60	Soft anneal	Round rod	< 6.0	365 – 470	
	H04	Hard	Round rod	< 6.0	720 – 1030	
			Round & hexagonal	6.0 – 12.0	>= 585	
				12.1 – 25.0	>= 515	
				> 25.0	>= 415	
			Bar: square & rectangular	6.0 – 9.0	>= 470	
	> 9.0	>= 415				
C52400	O60	Soft anneal	Round rod	< 6.0	415 – 515	
	H04	Hard	Round rod	< 6.0	725 – 1100	
			Round & hexagonal	6.0 – 12.0	>= 655	10
				12.1 – 25.0	>= 585	12
				> 25.0	>= 480	15
			Bar: square & rectangular	6.0 – 9.0	>= 525	10
	> 9.0	>= 480		15		
C53400 C54400	H04	Hard	Round & hexagonal	1.6 - 6.0	>= 450	8
				6.1 – 12.0	>= 415	10
				12.1 – 25.0	>= 380	12
				> 25.0	>= 345	15
			Bar: square & rectangular	6.0 – 9.0	>= 380	10
				> 9.0	>= 345	15

PART C3 – MECHANICAL PROPERTIES – Japanese Standards**JIS H3110, H3130 - Flat products**

Alloy	Temper		Tensile strength MPa	Elongation % min	Hardness
					HV min (0.2 mm min thickness)
C5102 (H3110)	O	Annealed	≥ 305	40	-
	¼ H	¼ hard	375 – 470	28	90 – 160
	½ H	½ hard	470 – 570	15	130 – 190
	H	Full hard	570 – 665	7	170 – 220
	EH	Extra hard	≥ 620	4	≥ 190
C5111 (H3110)	O	Annealed	≥ 295	38	-
	¼ H	¼ hard	345 – 440	25	80 – 150
	½ H	½ hard	410 – 510	12	120 – 180
	H	Full hard	490 – 590	7	150 – 200
	EH	Extra hard	≥ 570	3	≥ 170
C5191 (H3110)	O	Annealed	≥ 315	42	-
	¼ H	¼ hard	390 – 510	35	100 – 160
	½ H	½ hard	490 – 610	20	150 – 205
	H	Full hard	590 – 685	8	180 – 230
	EH	Extra hard	≥ 635	5	≥ 200
C5212 (H3110)	O	Annealed	≥ 345	45	-
	¼ H	¼ hard	390 – 510	40	100 – 160
	½ H	½ hard	490 – 610	30	150 – 205
	H	Full hard	590 – 705	8	180 – 235
	EH	Extra hard	≥ 685	5	≥ 210
C5210 (H3130)	½ H	½ hard	470 – 610	27	140 – 205
	H	Full hard	590 – 705	20	185 – 235
	EH	Extra hard	685 – 785	11	210 – 260
	SH	Spring hard	540 – 655	9	230 – 270

JIS H3270 – Rods, bars & wires

	Temper	Diameter	Tensile strength	Elongation	Hardness (0.2 mm min thickness)	
					min	
					mm	MPa
C5102	H	3.0 – 6.0	540	–	(150)	–
		6.1 – 13.0	500	10	(135)	–
		13.1 – 25.0	460	13	(125)	–
		25.1 – 50.0	430	15	115	–
		50.1 – 100.0	390	15	–	65 – 85
C5111	H	3.0 – 6.0	490	–	(140)	–
		6.1 – 13.0	450	10	(125)	–
		13.1 – 25.0	410	13	(115)	–
		25.1 – 50.0	380	15	105	–
		50.1 – 100.0	345	15	–	60 – 80
C5191	½ H	3.0 – 6.0	510	13	(150)	–
		6.1 – 13.0	460	15	(135)	–
		13.1 – 25.0	430	18	(125)	–
		25.1 – 50.0	410	18	120	–
		50.1 – 100.0	390	–	–	70 – 85
	H	3.0 – 6.0	635	–	(180)	–
		6.1 – 13.0	590	10	(165)	–
		13.1 – 25.0	540	13	(150)	–
		25.1 – 50.0	490	15	140	–
		50.1 – 100.0	440	15	–	75 – 90
C5212	½ H	3.0 – 6.0	540	–	(155)	–
		6.1 – 13.0	490	13	(140)	–
		13.1 – 25.0	440	15	(130)	–
		25.1 – 50.0	420	18	125	–
		50.1 – 100.0	410	18	–	72 – 87
	H	3.0 – 6.0	735	–	(195)	–
		6.1 – 13.0	685	10	(180)	–
		13.1 – 25.0	635	13	(170)	–
		25.1 – 50.0	560	15	150	–
		50.1 – 100.0	490	15	–	80 – 95
C5341 C5441	H	3.0 – 6.0	440	–	(125)	–
		6.1 – 13.0	410	10	(115)	–
		13.1 – 25.0	375	12	(110)	–
		25.1 – 50.0	345	15	100	–