

Bronzes

The bronzes are copper-tin alloys. The two major commercial products are phosphor bronze and aluminium bronze. Manganese bronze more correctly known as high tensile brass is covered on page 16.

Phosphor Bronze and Gunmetal

The phosphor bronzes are deservedly popular for their strength and hardness gained by the addition of phosphorus to a tin bronze rather than the more expensive nickel. PB1 is a high quality alloy only continuously cast by the best foundries for machining to components such as heavily loaded bushes and thrust washers used against hardened steel shafts under conditions where lubrication is generally good.

PB2 has a higher tin content which improves wear resistance. It is therefore popular for the manufacture of components such as gears and others with heavy sliding or reciprocating loads.

LPB1 has a reduced tin content and a lead addition that improves machinability. In hardness it is intermediate between the phosphor bronzes and leaded bronzes.

LB1, LB2, LB4 and LB5, the leaded bronzes, are useful general purpose bearing alloys, generally paired with non-hardened shafts. The series has an increasing lead content which improves plasticity, the ability to absorb slight mismatch on assembly and the ability to suffer intermittent or inadequate lubrication and the presence of hard particles in the lubricant. Because of its high lead content, LB5 should be machined with care in order to avoid the lead being excessively 'wiped' along the surface of the component.

G1, a gunmetal also known as 'Admiralty Gunmetal', is a strong, hard alloy originally developed for marine applications, especially the bearing components of reciprocating steam engines. It is now still used for sliding bearings and also for components in hydraulic pumps, shaft liners, slip rings and valve spindles.

SAE 660, a leaded gunmetal, is not yet included in BS 1400 but is popular as a general purpose bearing material with a good all-round balance of properties of strength, hardness, machinability and abrasion resistance.

PB102 is a very useful corrosion-resistant, high-strength, high-hardness wrought phosphor bronze with a very wide variety of applications. It is available in most forms. The main demand is for rods and sections from which are produced formed and machined components for the electrical, architectural and general engineering industries. It has a combination of good resistance to wear, sparking, corrosion and temperature that make it ideal as a contact material, for fasteners, masonry fixings and similar duties. A free-machining grade containing tellurium is available, this has slightly less ductility than the standard grade.

As wire and as strip, phosphor bronze has been used for many years as one of the main non-ferrous spring, contact and connector pin materials, also for the manufacture of wire mesh for filters. With controlled resistivity, it can be used for the manufacture of low power heating elements. In tube form, advantage is taken of its good fatigue resistance for the manufacture of reliable fuel feed lines and sometimes in heat exchangers.

Grades: Compositions/Mechanical Properties

Grade		Nominal Composition (%)			Typical Mechanical Properties				
BS	ISO	Copper	Tin	Phosphorus	Condition	0.2% Proof Stress N/mm ²	Tensile Strength N/mm ²	Elongation %	Hardness Hv
PB102	CuSn5	95	5	0.2	0-Annealed	125 to 155	<450	70 to 50	70 to 80
					1/8 - Hard	360 to 460	420 to 510	35 to 20	145 to 175
					1/4 - Hard	460 to 560	510 to 620	35 to 20	175 to 195
					1/2 - Hard	560 to 630	620 to 700	10 to 6	195 to 210
					H - Hard	630 to 770	700 to 850	6 to 3	210 to 240
					Spring Hard	>770	>850	<4	>230

Typical Physical Properties

Youngs Modulus	Density	Melting Range	Coeff of Lin Exp 20 to 300°C K ⁻¹ x 10 ⁻⁶	Thermal Conductivity	Electrical Resistivity	Electrical Conductivity
N/mm ²	Kg/m ³	°C		W/mK	μΩm	% IACS
100,000	8,890	950 to 1050	17.9	75	0.103	17

Fabrication

Machinability	Working	
Group	Cold	Hot
3	Good	Very Poor



Leaded Gunmetal Specification SAE660: Solid and Hollow Bar

Solid Dia (in) *	Kg/m
1/2	1.13
5/8	1.77
3/4	2.55
7/8	3.46
1	4.52
1 1/8	5.73
1 1/4	7.07
1 3/8	8.55
1 1/2	10.2
1 5/8	11.9
1 3/4	13.9
1 7/8	15.9
2	18.1
2 1/4	22.9
2 1/2	28.3
2 5/8	31.2
2 3/4	34.2
3	40.7
3 1/4	47.8
3 1/2	55.4
3 3/4	63.6
4	72.4
4 1/2	91.6
4 3/4	102
5	113
5 1/2	137
6	163
6 1/2	191
7	222
8	290
9	367
10	452
12	652

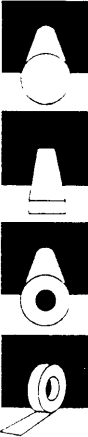
Hollow OD x ID (in) *	Kg/m
1 x 1/2	3.39
1 x 3/4	1.98
1 1/4 x 1/2	5.94
1 1/4 x 3/4	4.52
1 1/4 x 1	2.55
1 3/8 x 3/4	6.01
1 1/2 x 1/2	9.05
1 1/2 x 3/4	7.64
1 1/2 x 1	5.66
1 1/2 x 1 1/4	3.11
1 3/4 x 3/4	11.3
1 3/4 x 1	9.33
1 3/4 x 1 1/4	6.79
1 3/4 x 1 1/2	3.68
2 x 3/4	15.6
2 x 1	13.6
2 x 1 1/4	11.0
2 x 1 1/2	7.92
2 1/4 x 1	18.4
2 1/4 x 1 1/4	15.8
2 1/4 x 1 1/2	12.7
2 1/4 x 1 3/4	9.05
2 1/2 x 1	23.8
2 1/2 x 1 1/4	21.2
2 1/2 x 1 1/2	18.1
2 1/2 x 1 3/4	14.4
2 1/2 x 2	10.2
2 3/4 x 1	29.7
2 3/4 x 1 1/4	27.1
2 3/4 x 1 1/2	24.0
2 3/4 x 1 3/4	20.4
2 3/4 x 2	16.1
2 3/4 x 2 1/4	11.3
3 x 1	36.2
3 x 1 1/2	30.5
3 x 1 3/4	26.9
3 x 2	22.6
3 x 2 1/4	17.8
3 x 2 1/2	12.4
3 1/4 x 1 1/2	37.6
3 1/4 x 1 3/4	33.9
3 1/4 x 2	29.7
3 1/4 x 2 1/4	24.9
3 1/4 x 2 1/2	19.5
3 1/4 x 2 3/4	13.6
3 1/2 x 1	50.9
3 1/2 x 1 1/2	45.2
3 1/2 x 2	37.3
3 1/2 x 2 1/4	32.5
3 1/2 x 2 1/2	27.1
3 1/2 x 2 3/4	21.2
3 1/2 x 3	14.7
3 3/4 x 1 1/2	53.5
3 3/4 x 2	45.5
3 3/4 x 2 1/4	40.7
3 3/4 x 2 1/2	35.4

Hollow OD x ID (in) *	Kg/m
3 3/4 x 2 3/4	29.4
3 3/4 x 3	22.9
4 x 1	67.9
4 x 1 1/2	62.2
4 x 2	54.3
4 x 2 1/2	44.1
4 x 2 3/4	38.2
4 x 3	31.7
4 x 3 1/2	17.0
4 1/2 x 1 1/2	81.4
4 1/2 x 2	73.5
4 1/2 x 2 1/2	63.3
4 1/2 x 3	50.9
4 1/2 x 3 1/2	36.2
4 1/2 x 4	19.2
5 x 2	95.0
5 x 2 1/4	90.2
5 x 2 1/2	84.8
5 x 3	72.4
5 x 3 1/2	57.7
5 x 3 3/4	49.5
5 x 4	40.7
5 1/2 x 3	96.2
5 1/2 x 3 1/2	81.4
5 1/2 x 4	64.5
5 1/2 x 4 1/2	45.2
5 1/2 x 5	23.8
6 x 2	145
6 x 3	122
6 x 4	90.5
6 x 4 1/2	71.3
6 x 4 3/4	60.8
6 x 5	49.8
6 1/2 x 4	119
6 1/2 x 4 1/2	99.5
6 1/2 x 5	78.1
6 1/2 x 5 1/2	54.3
7 x 3	181
7 x 4	149
7 x 5	109
7 x 5 3/4	72.1
7 x 6	58.8
7 1/2 x 5 1/2	118
7 1/2 x 6	91.6
8 x 4	217
8 x 5	176
8 x 6	127
9 x 5	253
9 x 6	204
9 x 7	145
10 x 5	339
10 x 6	290
10 x 7	231
10 x 8	163
12 x 10	199

* Please note that the weights given in the tables for SAE 660 apply to the nominal sizes shown. The sizes supplied include a machining allowance which ensures that these nominal dimensions can be machined out. Thus the weight of the material supplied will typically be 10% more.

Features of this stock:

- 24-hour nationwide service
- Cutting service

**Phosphor Bronze Rod**

BS 2874 PB102M

Dia (in)	Kg/m
1/4	0.28
3/8	0.63
7/16	0.86
1/2	1.12
9/16	1.42
5/8	1.75
3/4	2.52
7/8	3.43
1	4.48
1 1/8	5.68
1 3/16	6.32
1 1/4	7.01
1 3/8	8.48
1 1/2	10.1
1 5/8	11.8
1 3/4	13.7
2	17.9
2 1/4	22.7
2 1/2	28.0
2 3/4	33.9
3	40.4
3 1/2	54.9
4	71.7

Phosphor Bronze Rod

BS 1400 PB1-C (Con. Cast)

Solid Dia (in)	Kg/m
1 1/32	4.79
1 9/32	7.39
1 17/32	10.6
1 25/32	14.3
2 1/32	18.6
2 17/32	28.9
3 1/32	41.4
3 17/32	56.2
4 1/16	74.3
4 9/16	93.8
5 1/16	115
6 1/16	166

Phosphor Bronze Flat Bar

PB 102M

Size (in)	Kg/m
1 x 1/4	1.43
1 x 1/2	2.85
1 1/2 x 1/4	2.14
1 1/2 x 1/2	4.28
2 x 1/4	2.85
2 x 1/2	5.71
2 x 1	11.4
3 x 1/2	8.56
3 x 1	17.1
4 x 1/2	11.4
4 x 1	22.8
4 x 2	45.7

Phosphor Bronze Rod and Flat Bar are also available in a range of metric sizes

Phosphor Bronze Hollow Rod BS 1400 PB1-C (Con. Cast)

O/D x ID (in)	Kg/m
1 9/32 x 23/32	5.07
1 9/32 x 31/32	3.17
1 17/32 x 31/32	6.33
1 17/32 x 17/32	3.87
1 25/32 x 17/32	7.60
2 1/32 x 31/32	14.4
2 1/32 x 19/32	7.14
2 9/32 x 15/32	13.7
2 9/32 x 123/32	10.1
2 17/32 x 31/32	24.6
2 17/32 x 17/32	22.2
2 17/32 x 15/32	19.1
2 17/32 x 131/32	11.4
3 1/32 x 31/32	37.2
3 1/32 x 15/32	31.7
3 1/32 x 123/32	28.1
3 1/32 x 131/32	23.9
3 9/32 x 31/32	44.3
3 9/32 x 15/32	38.8
3 9/32 x 131/32	31.0
3 9/32 x 15/32	47.5
3 13/32 x 223/32	19.7
3 17/32 x 31/32	51.9
3 17/32 x 15/32	46.5
3 17/32 x 131/32	38.7
3 17/32 x 215/32	28.7

O/D x ID (in)	Kg/m
3 17/32 x 231/32	16.5
3 25/32 x 15/32	54.7
3 25/32 x 131/32	46.9
3 25/32 x 215/32	37.0
3 25/32 x 231/32	24.7
3 29/32 x 37/32	22.1
4 1/16 x 31/32	70.1
4 1/16 x 15/32	64.6
4 1/16 x 131/32	56.9
4 1/16 x 215/32	46.9
4 1/16 x 231/32	34.6
4 9/16 x 15/32	84.1
4 9/16 x 131/32	76.3
4 9/16 x 215/32	66.3
4 9/16 x 231/32	54.1
4 9/16 x 315/32	39.6
5 1/16 x 131/32	98.0
5 1/16 x 215/32	88.0
5 1/16 x 231/32	75.7
6 1/16 x 231/32	126
6 1/16 x 329/32	96.8
6 1/16 x 429/32	57.1
7 1/16 x 415/16	115
7 9/16 x 57/16	124
8 1/16 x 515/16	134

Phosphor Bronze Strip in Coil

BS 2870 PB 102

Width (in)	Weight/100m (Kg) for given thickness				
	26G	24G	22G	20G	18G
1/2	5.14	6.28	7.99	10.3	13.7
5/8	6.42	7.85	9.99	12.8	17.1
3/4	7.70	9.42	12.0	15.4	20.6
1	10.3	12.6	16.0	20.5	27.4
1 1/2	15.4	18.8	24.0	30.8	41.1
2	20.5	25.1	32.0	41.1	54.8
3	30.8	37.7	47.9	61.6	82.2
4	41.1	50.3	63.9	82.2	110
5	51.4	62.8	79.9	103	137
6	61.6	75.4	95.9	123	164

Features of this stock:

- 24-hour nationwide service
- Cutting service