ALLOY DATA

the useful characteristics and applications of Olin Alloy 510

SHEET AND STRIP

OLIN ALLOY 510

PHOSPHOR BRONZE 5%

Nominal Composition: 95% Copper; 5% Tin; 2% Phosphorus

The "work horse" of the Phosphor Bronzes, Olin Alloy 510 combines strength, toughness and good ductility with excellent resistance to fatigue. It has the additional advantages of a high elastic limit—making it excellent as a spring material—plus good resistance to corrosion and corrosion-fatigue. These valuable properties cause Alloy 510 to be frequently chosen for such functional spring members as mechanical springs, electrical contact springs, spring-type electrical connectors and terminals, diaphragms and bellows.

Strength and Formability

Alloy 510, with its combination of high strength and good formability, is one of the most useful of all the high strength copper alloys. Its superior formability at high strength levels is particularly valuable because most parts produced from strip require drastic forming operations. Alloy 510 has an elongation of 6% in 2" at a tensile strength level of 90,000 psi—a high strength and maximum formability combination of properties. In comparison the popular tin brass, Olin Alloy 425 (Lubaloy X) has an elongation of 3% in 2" at the same tensile strength.

Alloy 510 is a single-phase, solid solution alloy which develops its strength rapidly during cold rolling. The ductility of metal decreases as the amount of cold rolling is increased. Because Alloy 510 requires less cold rolling to attain required strength than other high-strength metals, it retains more of its inherent ductility for the subsequent forming of parts. These characteristics—high strength coupled with excellent formability—make the alloy very valuable for the fabrication of spring-type electrical connectors and terminals, and for diaphragms used in pressure regulators, air horns and pressure-operated switches, bellows and spring clips—all of which are difficult to fabricate and require high functional strength.

Elasticity and Stiffness

With an elastic modulus of 16,000,000 psi, Alloy 510 has adequate stiffness for the load requirements of the many bellows and springs produced from it. These functional parts can be actuated by relatively low pressures and loads. Its modulus is slightly more than half of steel's modulus of 30,000,000 psi—which means that Alloy 510 will be displaced almost twice as far by a load within its elastic limit without taking a permanent set. Its elastic limit approaches 90% of its tensile strength, making it possible to utilize most of the alloy's available strength without causing permanent distortion. These superior elastic characteristics make Alloy 510 particularly valuable where spring properties are the most important consideration.

Fatigue and Corrosion Fatigue

The endurance limit of Alloy 510 is one of the highest available in the copper alloys. This characteristic, coupled with the alloy's excellent resistance to atmospheric corrosion, results in fabricated parts with excellent life expectancy in applications where resistance to alternating stresses are important. An endurance limit in air of 27,000 psi has been reported for this alloy, along with a corrosion fatigue limit of 22,000 psi for 5×10^7 cycles in salt water. Fatigue strengths of 30,000-34,000 psi at 100,000,000 cycles of reversed stress are also reported. An example of the use of these valuable characteristics is in the diaphragms in ship foghorns. Such diaphragms vibrate at rates from 200 to 400 times per second—and must stand up to salt-laden atmospheres without danger of failure. Most other corrosion-resistant metals would have difficulty meeting such requirements. Similar thin wafer-like diaphragms of Alloy 510 are used in altimeters and air speed indicators. They are also used in bellows, rang-

ing from the types used in large oil filled transformers to control the expansion of the oil—to the diaphragms used in "iron lungs" to simulate breathing.

Solderability, Brazeability, Weldability

Like many other copper alloys, Alloy 510 resists atmospheric corrosion and oxidation, forming a light protective surface film of oxides or other easily soluble compounds. These surface films are readily removed by relatively mild acid fluxes, and the clean metal surface responds well in soldering and brazing. Where acid fluxes cannot be used in soft soldering, pre-tinning is recommended to allow soldering to be done with rosin or other non-corrosive fluxes. Because hot tinning is usually very thin, and because solderability is rapidly reduced by diffusion of tin into base metal, tinned surfaces should be soldered within a few days of tinning, if they are to be effectively joined with the use of non-corrosive fluxes. Silver brazing can be readily done on this alloy where desirable for increased joint strength. Oxyacetylene, carbon arc and resistance welding also can be used for joining. In TIG welding the phosphorus in the alloy provides self-fluxing characteristics which are beneficial.

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NOMINAL COMPOSITION:	95% Copper 5% Tin 0.2% Phosphorus	Nearest Applicable Specification: ASTM B 103
COMPOSITION LIMITS:	Copper + Phos. + Tin Tin Phosphorus Lead Iron Zinc	99.5% Min. 4.2/5.8% 0.03/0.35% 0.05% Max 0.10% Max 0.30% Max

Physical Properties:

	English Units	Metric Units
Melting Point (Liquidus)	1920F	1050C
Melting Point (Solidus)	1750F	950C
Density	.320 lbs/cu in	8.86 gm/cu cm
Coefficient of Thermal Expansion	.0000099/F° (68-572F)	.0000178/C° (20-300C)
Thermal Conductivity (Annealed)	40 Btu-ft/sq ft-hr-F° @ 68F	.17 cal-cm/sq cm-sec-C° @ 20C
Electrical Resistivity (Annealed)	69.1 ohm circ mils/ft @ 68F	11.5 microhm-cm @ 20C
Electrical Conductivity (Annealed)	15% I.A.C.S.* @ 68F	.087 megmho/cm @ 20C
Thermal Capacity (Specific Heat)	.09 Btu/lb/F° @ 68F	.09 cal/gm/C° @ 20C
Modulus of Elasticity (Tension)	16,000,000 psi	11,200 kg/sq mm
Modulus of Rigidity	6,000,000 psi	4,200 kg/sq mm

*International Annealed Copper Standard

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Typical Mechanical Property Data—Annealed Tempers (Soft):

Average Grain Size mm (a)	Tensile Strength ksi (b)	Yield Strength ksi (c) (0.2% offset)	Elongation % in 2" (d)	Hardness Range (e) Rockwell F
.040/.060	46/49	19/20	60/62	73/75
.020/.040	49/51	19/22	54/60	74/78
.015/.030	50/52	20/24	52/58	74/79
.010/.025	51/53	21/26	49/56	76/82
.005/.015	52/56	24/29	48/53	79/83

Typical Mechanical Property Data—Rolled Tempers:

Temper Name	Tensile Strength ksi (b)	Yield Strength ksi (c) (0.2% offset)	Elongation % in 2" (d)	Approximate Rockwell Hardness (f)			
				Rockwell "B"		Superficial 30-T	
				.020/.039 Incl	Over .039	.010/.029 Incl	Over .029
1/4 Hard	49/61	22/52	32/50	45/72	49/75	43/63	46/65
1/2 Hard	58/73	47/68	10/38	60/82	64/85	53/69	59/73
3/4 Hard	68/79	61/75	10/20	76/86	79/89	66/73	70/77
Hard	76/91	74/88	9/11	84/91	86/93	71/75	73/78
Extra Hard	88/103	85/102	2/6	89/95	92/96	74/78	77/81
Spring	95/110	92/108	1/3	92/97	94/98	76/80	79/82
Extra Spring	100/114	98/110	1/3	94/98	95/99	77/81	80/83
Super Spring	106 Min.	105 Min.	2 Max.	—	—	78 Min.	—

(a) Grain size is the standard test for all thicknesses in annealed tempers; acceptance or rejection depends on grain size.

(b) Tensile strength is the standard test for all thicknesses of rolled tempers; acceptance or rejection depends on tensile strength. **ksi = 1000 psi.**

(c) Yield strengths are not used or accepted as specifications by brass mills; but, because of their usefulness, values are given here for design purposes. **ksi = 1000 psi.**

(d) Elongation values vary considerably with thickness. The annealed temper data given are based on .012" thick strip. The rolled temper data given are based on thicknesses ranging from .015" to .040".

(e) Hardness values for annealed metal vary considerably with thickness of strip, and therefore are not recommended as specifications. Values are given to demonstrate that when using an appropriate scale they do generally follow the changes in grain size, with higher values being obtained with smaller grain sizes.

(f) Hardness values for rolled tempers are indicative of tensile strength if properly applied. Although the B-Scale is suitable for rolled tempers down to .020", the Superficial 30-T is better for 1/4 Hard and 1/2 Hard tempers in gauges down to .012". If hardness tests are desired on thinner gauges, an appropriate scale, range, and technique should be worked out between the brass mill and the user.

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METAL CHARACTERISTICS NEEDED

TYPICAL APPLICATIONS

	Corrosion Resistance	Wear Resistance	Formability	Functional Strength	Spring Properties	Color	Solderability	Weldability	High Softening Temperature	Resistance to Stress Corrosion Cracking
Diaphragms	•		•	•	•		•		•	•
Terminals	•		•	•	•		•		•	•
Fuse Clips	•		•	•	•					•
Electrical Springs	•		•	•	•		•		•	•
Thermostat Bellows	•		•	•	•		•	•	•	•
Contact Washers	•	•		•						•
Grommet Washers	•	•		•						•
Welded Tubing	•			•				•	•	•
Flexible Hose	•		•	•				•	•	•
Retainer Rings	•	•		•	•					•
Spring Washers	•	•		•	•					•
Bellows	•		•	•	•		•		•	•
Bellows Cups	•		•	•			•		•	•
Brush Holders	•	•	•	•			•	•	•	•
Contact Arms	•	•		•	•		•		•	•
Bourdon Tubing	•			•	•		•	•	•	•
Fasteners	•	•		•	•	•				•
Bushings	•	•		•						•
Microphone Assemblies	•		•	•			•	•	•	•

Olin BRASS

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OLIN DATA SHEET 510

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