Olin BRASS

ALLOY DATA

Characteristics and Applications of Olin Alloy C194

SHEET AND STRIP

OLIN ALLOY C194

Nominal Composition: 2.4% Iron, 0.03% Phosphorus, 0. 1 % Zinc; Balance Copper

ALLOY C194 - is a High Performance Copper Alloy used worldwide. Developed by Olin in 1964 the alloy continues to be used for a variety of applications including automotive and electrical connectors, semiconductor leadframes, sockets, and mass terminations. C194 combines good electrical and thermal conductivity with high strength, good solderability, and plateability. These properties make C194 the alloy of choice to replace copper and brass for enhanced performance.

Chemical Composition and Metallurgy

C1 94 has a nominal composition of 2.4% Iron, 0.03% Phosphorus, and 0.1 % Zinc, with the balance copper. Tables 2 and 3 provide the chemistry ranges along with physical properties. Alloy C194 is produced in accordance with ASTM specification B465.

Alloy C194 is a dispersion strengthened alloy. Iron and phosphorus are added to copper during alloy processing, which form fine second phase particles. Once the dispersion of precipitates is formed, the alloy's strength is controlled by cold rolling. Heat treating C194 will not increase strength as in beryllium copper, however the precipitates enable C194 to work harden more rapidly than pure copper. The precipitates also act to limit grain growth during annealing and thus produce a fine, uniform grain structure.

Strength and Formability

Strength is increased by cold rolling for most copper alloys. For a given alloy, as strength increases, formability decreases. Since alloy C194 is dispersion strengthened before cold rolling, less reduction is required to attain strength, therefore, formability is maintained. *(Consult Olin Market Development for formability recommendations in your applications.)*

Leadframe Applications

C194 is a high volume copper alloy used for leadframes. Spring Temper Relief Anneal (SPR - RA) was the standard temper of C1 94 used for stamped leadframes at a yield strength of 63 ksi min. This was an improvement over the previously used Half Hard (HH) temper C194 with a 46 ksi yield strength. The increase in strength was made as the industry desired stronger leads, resistant to damage during device assembly . This significantly improved finish product yield.

Extra Spring Relief Anneal (Ex SPR - RA) offers property improvements over C194 SPR-RA. This temper offers a 5 ksi improvement in the yield strength, from 63 to 68 ksi min. This comes about with no change in minimum conductivity and equal or better lead bend fatigue and softening resistance. The formability of C194 ExSPR RA will meet the forming requirements of a standard dual-in-line package (DIP), a 0.010' x 0.060" lead bent .good way" over a 0.010" radius. This temper can also be used for molded carrier ring (MCR) versions of Quad Flat Packs (QFP's), .006" x .012" leads bent 900 over a .010" radius. This combination of strength, good conductivity and modulus fill the needs of applications such as semiconductor leadframes, application specific integrated circuits, printed circuit board connectors, and memory devices. This temper is the result of Olin's commitment to optimize material properties for specific applications. Olin's engineering staff continues to assist customers by designing processes for application specific needs.

P-DIP Leadframe Tempers

	C194 EXSPR(RA)	C194 SPR(RA)
Tensile Strength	77-83	70-76
Yield Strength	68 Min.	63 Min.
Elongation (% in 0)	5 Min.	4-8
Conductivity (%IACS)	60 Min.	60 Min.
Lead Bend Fatigue	5 Min.	4 Min.
Formability - R/t (1-060" wide)	0.6	Sharp

Corrosion Resistance and Solderability

Alloy C194 has good corrosion resistance and exhibits the nobility inherent to all high copper alloys. Unlike brasses, C194 is essentially immune to stress corrosion cracking. In atmospheric corrosion tests, C194 has slightly better corrosion resistance than C122 copper.

C194 exhibits excellent solderability and plateability due to the benign nature of its oxides. The surface of C194 is easily cleaned, fluxed and wet by solders or brazing alloys. The solderability of C194 is equal to that of C110, C197, and C510 bronze. C194 has superior solderability compared to C260 brass. Table 1 shows the dip solderability and solderability shelf life of C194 and the competitive alloys.

Dip solderability testing was conducted on freshly cleaned samples using rosin based, nonactivated flux. The solderability rating of Class I being the best and Class V the worst. For most electrical/ electronic applications a Class I to 11 solderability rating (MIL-SRD-883) is considered acceptable.

C194 is also available preplated with tin, solder, or other coatings. For optimum solderability and solderability shelf life, a preplate of **Hot Air Leveled Tin** with a thickness of 100 microinches minimum is recommended. Contact your local Olin sales office for information on **Hot Air Leveled Tin** plating.

Table 1

Dip Solderability* and Shelf Life of C194 and other common alloys.

	Exposure Time (hours)			
Alloy	**0**	**100**	**1000**	**5000**
C110	I	II	II	III
C194	**I**	**II**	**III**	**IV**
C260	IV	IV	IV	IV
C425	II	III	IV	IV
C510	I		III	III

*Unactivated Rosin Flux (Alpha 100)

Alloys are ranked according to the dip test method performed to MIL Std. 202D Method 208B. After cleaning and ageing, rankings are defined as:

I - Ideal coating, bright, smooth, and no surf irregularities.

II - Continuous coating, no dewetting, 1% or less pin holes, non-uniform solder thickness.

III - Dewetting on up to 50% of the test area, up to 10% pin holes.

IV - Dewetting on more than 50% of the test area, more than 10% pin holes.

Softening Resistance

Copper and high copper alloys, when cold worked, anneal at low temperatures and the recrystallized grains grow rapidly. This results inconsiderable softening and loss of strength. Parts which are exposed to elevated temperatures during fabrication and assembly may subsequently fail because they have softened excessively.

Leadframes are a perfect example of the type of processing that can cause parts to soften and subsequently fail. During packaging, they may be subjected to temperatures as high as 350°C for several minutes. Figure 1 shows the softening behavior of C194 and some other copper leadframe materials at 350°C. The resistance to softening exhibited by C194 enables it to maintain the strength required to resist deformation in handling and automated assembly of the device onto a printed circuit board.

Softening resistance is achieved through the dispersion of fine intermetallic particles in the matrix.

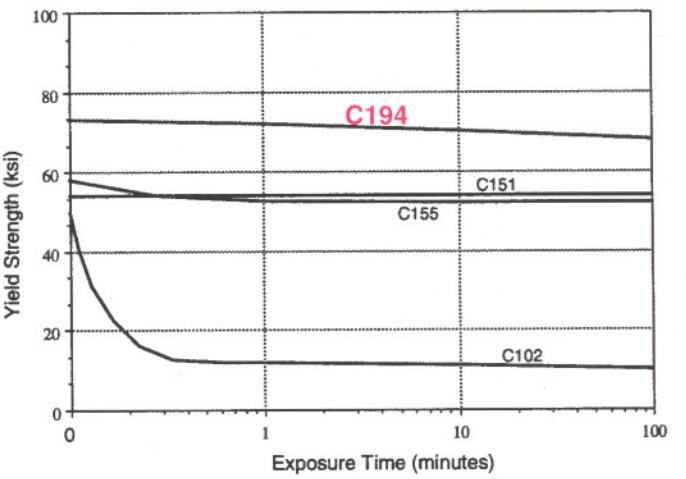

Figure 1: *Softening Behavior of Leadframe Materials at 350°C*

Connector Applications

Alloy C194 offers a combination of strength, good formability, electrical and thermal conductivity which are useful to the interconnect designer. C194 can be used when copper C110 and others lack sufficient strength. Furthermore, C194's resistance to softening allows it to retain strength after extended periods at elevated temperatures. C194 can be selected to replace the brass alloys when improved solderability is required.

Reliability of the interconnect is vitally important as well. Stress Relaxation resistance is critical to the maintenance of contact force over the life of an interconnect and therefore plays a role in the reliability of the system. Figure 2 shows the stress relaxation behavior of C194 as it compares to other copper alloys. Alloys C110 and C260, though commonly used, exhibit quite poor stress relaxation behavior and are not recommended for stress relaxation critical applications at elevated temperatures. Alloy C194 has good stress relaxation resistance to temperatures of 105°C and is superior to copper C110 and brass C260.

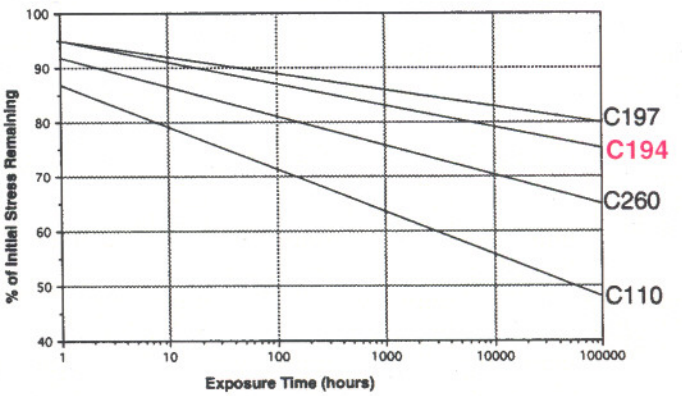

Figure 2: *Stress relaxation performance of C 194 Hard (HR04) vs. selected hard temper copper alloys at 75°C.*

Olin Brass is fully committed to the research and development of copper base alloy strip. In total, Olin offers eight high performance copper alloys including: C151, C194, C195, C197, C638, C654, C655, C688, C7025. Olin also offers beryllium copper strip, which compliments a portfolio of alloys unequaled in the world.

OLIN ALLOY C194

TABLE 2: Composition and Physical Property Data for C194

NOMINAL COMPOSITION:	97.4% Copper 2.4% Iron 0.03% Phosphorus 0.1% Zinc	
COMPOSITION LIMITS:	Copper Iron Phosphorus Zinc Lead Other Impurities	97.4% Min. 2.1-2.6% 0.015-0.15% 0.05-0.2% 0.03% Max. 0.1% Max.
Physical Properties:	**English Units**	**Metric Units**
Melting Point (Liquidus)	1992°F	1089°C
Melting Point (Solidus)	1981°F	1083°C
Density	.322 lbs/ in^3	8.92 gm/cm^3
Thermal Conductivity (Annealed)	150 Btu-ft/ft^2-hr-F° @ 68°F	0.625 cal-cm/cm^2 -sec-C° @20°C
Coefficient of Thermal Expansion	0.0000097/°F (68 - 572°F)	0.0000174/°C (20 - 300°C)
Electrical Resistivity (Annealed)	17 ohm circ mils/ft @ 68°F	2.87 microhm-cm @20°C
Electrical Conductivity (Annealed)	60% I.A.C.S.† @ 68°F	0.348 megmho/cm @20°C
Modulus of Elasticity (Tension)	17,500,000 psi	12,300 kg/mm^2
Coefficient of Thermal Expansion	0.0000098 / °F (68 – 572 °F) 0.0000096 / °F (68 – 392 °F) 0.0000093 / °F (68 – 212 °F)	0.0000176 / °C (20 – 300 °C) 0.0000172 / °C (20 – 200 °C) 0.0000167 / °C (20 – 100 °C)

†International Annealed Copper Standard

TABLE 3: Typical Mechanical Property Data for C1 9400

Temper	Tensile Strength		Yield Strength (0.2% offset) Nominal		Elongation % in 2" (51mm.)
	ksi	kgf/mm	ksi	N/mm^2	
(Annealed Tempers)					
Soft Anneal	40-50	275-345	22 Max.	152 Max.	29 Min.
Light Anneal	45-55	310-380	23	160	26
Special Light Anneal	53-63	365-435	37	255	14
(Rolled Tempers)					
1/2 Hard (1-102)	53-63	365-435	45	310	17
Hard (1-104)	60-70	413-483	60	413	7
Extra Hard (1-106)	67-73	460-503	67	460	2
Spring (1-108)	70-76	483-525	70	483	2
Extra Spring (1-110)	73-80	503-552	73	503	2 Max.

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PRINTED IN U.S.A. ZBSA-93 (300)