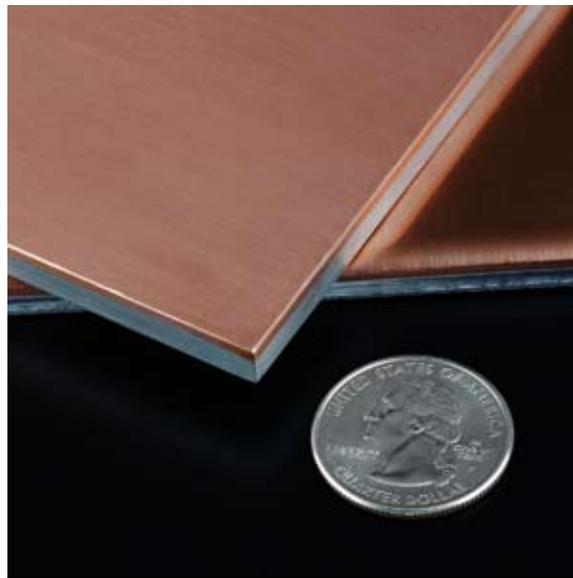


# Copper Clad Aluminum



New thicker composites reduce cost  
versus heavy gauge solid copper.



Engineered Materials Solutions  
A member of the Wickeder Group

# Reduce copper content—reduce product costs.

With copper costs continuing to be at high levels, anything engineers can do to reduce product copper content will save a lot of money. Thicker copper clad aluminum, now available from Engineered Materials Solutions, offers just such savings.

EMS has produced copper clad aluminum for many decades for use in a wide range of products in the electrical, automotive and cookware markets, among others. EMS engineers have developed the technology to produce materials in thicknesses currently up to 6.5 mm with electrolytic copper on one or both sides of the aluminum core. Both materials retain their original structure and properties.

Copper clad aluminum can be used



New thicker clad composite demonstrating roll bond process.

in the same thickness as solid copper or brass. Due to its lower density, the clad material produces more pieces for the same weight. The corollary:

1000 kg of solid copper can be replaced by 372 kg of 10% copper clad aluminum.

## Copper clad aluminum offers many benefits.

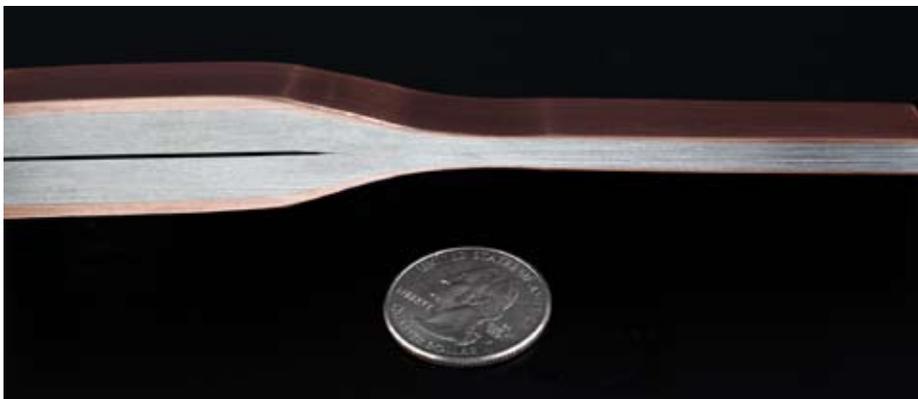
- High electrical and thermal conductivity.
- Superior heat dissipation.
- Excellent soldering and electroplating properties.
- Highly malleable, easy to fabricate.
- Low density of aluminum with the advantages of copper.

In many applications copper clad aluminum can directly replace solid copper or aluminum. Following are just a few of the ways the material is being used.

In **electrical applications**, copper clad aluminum parts solve many problems encountered in the termination of aluminum conductors. The aluminum side contacts the aluminum cable and the copper side contacts the copper terminal of the switch gear virtually eliminating galvanic corrosion.

**Electronics chassis and enclosures** are easily drawn and formed from copper clad aluminum for minimum weight, low resistance shielding and electroplating. The material is especially applicable for electrically or thermally conductive parts.

In **food service and cookware applications**, copper clad aluminum provides the classic appearance and superior conductivity of copper with the conductivity, strength and light weight of aluminum.



New bonded composite with copper on both sides.

## Solid Phase Bonding

The individual metal layers in copper clad aluminum are metallurgically and permanently joined by a solid phase roll-bonding process. No brazing alloys or other intermediate materials are used. This unique process assures the absence of voids, oxides and compound inclusions. The result is a continuous and uniform bond with strength as great as solid aluminum.

## Ratio

Copper clad aluminum is produced with copper on one or both sides. The most popular ratio for single-side material is 15/85 (15% copper, 85% aluminum by thickness), although other ratios from 5/95 to 50/50 can be produced. The most common ratio for materials with copper on both sides is 10/80/10. The inverse material, Al/Cu/Al, can also be supplied with comparable thickness ratios.

## Formability

Copper clad aluminum is sufficiently malleable to permit fabricating operations such as forming, deep drawing, and spinning. In many cases, parts are fabricated from temper rolled and work hardened material rather than annealed copper clad aluminum. Where greater strength is required, aluminum alloys such as 5052 type aluminum can be substituted for the 1350 type aluminum generally used in the composite.

## Drawability

Reduction should be limited to 45% when determined by the following formula:

$$\frac{D-d}{D} = \% \text{Total Reduction}$$

$D$  = diameter of blank

$d$  = diameter of drawn shell

Draws are generally made in one

operation. Reductions up to 60% have been made in two or more operations, but require close attention to tool design, blankholder pressure, lubrication and other variables.

The thickness to diameter ratio (T/D x 100%) is very important, and generally should be lower than 40%. These recommended reductions are lower than those typically used for either solid aluminum or solid copper because of the unique annealing process used for copper clad aluminum.

## Temper

Tempers are available from “annealed” to “hard.” The work hardening rate is not as rapid as copper: for example, in applications that call for copper at “¼ hard” temper, copper clad aluminum frequently can be specified as “½ hard.”

To classify the strip tempers, these designations have been assigned:

- Temper A – maximum softness and ductility for deep drawing and spinning
- Temper B – equivalent to skin to ¼ hard, suitable for medium draws and spinning
- Temper C – equivalent to ½ and ¾ hard, suitable for shallow drawing, blanking and forming
- Hard temper – cold rolled to maximum hardness and rigidity

## Sizes and Forms

Copper clad aluminum sheet or strip is currently available up to 6.5mm (0.256") total thickness and up to 635mm (25") wide. The material is shipped in continuous coil up to 1275mm (50") coil diameter or in cut to length (CTL) sheets.

## Annealing and Cleaning

The maximum process annealing temperature for copper clad aluminum strip depends on the thickness, although it should never exceed 343°C (650°F). For example, for strip under 0.75mm (0.030") an annealing temperature of 343°C (650°F) can be used. For strip at 1.5mm (0.060") a temperature range of 260 to 288°C (500-550°F) is suggested if a “fast” annealing process is employed, and 232°C (450°F) for a slow annealing procedure that exceeds one hour. Furnaces should be accurately controlled to insure against overheating.

The light discoloration on the copper layer after annealing in air can be removed easily with a pickle such as 10% sulphuric or 10% hydrochloric acid. The pickling time should be kept short to prevent unnecessary attack on the aluminum.

## Weight Values

Because of the low density of aluminum, more pieces can be produced from a kilogram of copper clad aluminum than from a kilogram of solid copper. The weight advantage is demonstrated in the chart:

Cu/Al Clad Thickness Ratio	Density Cu/Al (g/cm <sup>3</sup> )	Density Solid Cu (g/cm <sup>3</sup> )	Weight ratio Copper to Cu/Al
10/80/10 or 20/80	3.95	8.93	2.26:1
10/90	3.33	8.93	2.68:1

To obtain the pieces per kg of Cu/Al vs. solid copper, use the formula:

$$(pcs/kg \text{ from Cu}) * (\text{weight factor}) = (pcs/kg \text{ from Cu/Al})$$

For example 10/80/10:

$$(3 \text{ pcs/kg from Cu}) * (2.26) = (6.78 \text{ pcs/kg from Cu/Al})$$

## Standard Tolerance

Thickness (mm)	Tolerance (mm)
0.20 to 0.25	±0.025
0.26 to 0.70	±0.040
0.71 to 1.20	±0.050
1.21 to 2.0mm	±0.060
2.1mm and above	±0.100

Maximum thickness is currently 6.5mm.

Width tolerance (mm)
±0.25 (up to 150mm)
±0.40 (over 150mm to 400mm)
±0.75 (over 400 mm)

Special tolerances for rolling and slitting are available upon request.

## Physical and Mechanical Properties

Type			Temper	Yield Stress -0.20%	Tensile Strength	Elongation	Hardness DPH 100g		Modulus of Elasticity	Density	Thermal Conductivity	Coefficient of Thermal Expansion	Electrical Conductivity	Erichsen Cup 0.5mm	
Cu	Al	Cu	Hard= 50% CR	MPa (Ksi)	MPa (Ksi)	% min	Al	Cu	GPa (10 <sup>3</sup> Psi)	g/cm <sup>3</sup> (lb/in <sup>3</sup> )	cal/cm/sec/°C	0 -100°C ppm	%IACS	Cu out, mm	Al out mm
10	90		Soft	39—49 (5.7—7.1)	83—110 (12—16)	28	33	70	71.8 (10.4)	3.33 (0.12)	0.54	23.3	61-63	6.5	6.3
10	90		Hard	124—152 (18—22)	173—200 (25—29)	5	47	105							
20	80		Soft	44—54 (6.4—7.8)	97—117 (14—17)	30	33	70	74.5 (10.8)	3.95 (0.144)	0.58	22.5	64-66	6.9	6.7
20	80		Hard	152—179 (22—26)	186—207 (27—30)	5	46	105							
10	80	10	Soft	44—54 (6.4—7.8)	97—117 (14—17)	30		70	71.1 (10.3)	3.95 (0.144)	0.58	22.5	64-66		
10	80	10	Hard	152—179 (22—26)	186—207 (27—30)	5		105							
30	70		Soft	49—56 (7.1—8.1)	117—138 (17—20)	34	33	69	79.4 (11.5)	4.5 (0.162)	0.62	21.8	68-70	6.9	6.7
30	70		Hard	167—186 (24.2—27)	193—228 (28—33)	6	47	104							
15	70	15	Soft	49—56 (7.1—8.1)	117—138 (17—20)	34		70	73.1 (10.6)	4.5 (0.162)	0.62	21.8	68-70		
15	70	15	Hard	167—186 (24.2—27)	193—228 (28—33)	6		105							
Aluminum			Soft	13 (5)	90 (13)	35	27		67.6 (9.8)	2.71 (0.098)			57		
Aluminum			Hard	145 (21)	166 (24)	5	49				0.52	23.8			6.4
Copper			Soft	76 (11)	244 (35)	36	52		110 (16.0)	8.93 (0.321)			100		
Copper			Hard	317 (46)	380 (55)	5	105				0.92	16.8			7.5

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