TECHNICAL BULLETIN
Mitsubishi Plastics Composites America
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Copper ALPOLIC Panels

ALPOLIC Metal Composite Material (MCM) is available with skins formed from a variety of natural metals including Titanium (TCM), Stainless Steel (SCM), Zinc (ZCM) and Copper (CCM). There are no additional finishes applied to the natural metal and when exposed to the elements each element will weather with the skins natural characteristics.

ALPOLIC Copper Composite Material (CCM) is manufactured using 99.5% pure elemental copper coils. Copper is a very reactive material. This means that as the natural oxide layers form, the copper surface can exhibit a number of very vivid and extreme color changes before settling into the mottled reddish / brownish / grey-greenish surface that is often associated with weathered copper. Remember copper is a durable variable hued construction material not a predefined color!

During the CCM manufacturing process, there is an amount of heat generated in the lamination process. While this heat is less than that typically generated by your kitchen oven, it is enough to start the oxidation process. This means that when first installed, the CCM panels may exhibit the array of colors described in the attached paper from the Copper Development Association Inc. Specifically bright pinks, oranges, purples, etc. may be in evidence. As the copper surface continues to oxide, over time these colors will weather into the colors seen on exposed and aged copper.

Attached is a very informative paper from the Copper Development Association Inc. which describes the types of appearances and third party finishes that may be applicable to copper surfaces.

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Copper Development Association Inc.

A Copper Alliance Member

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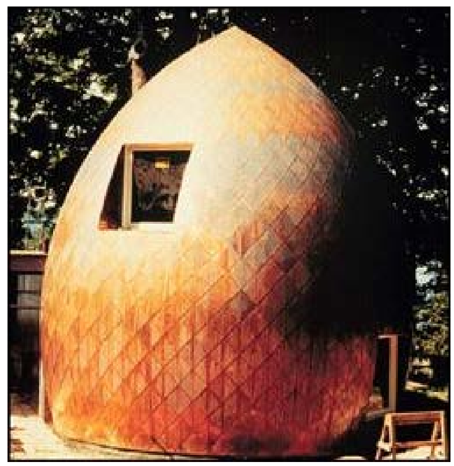
Finishes - Introduction

Copper and its principal architectural alloys are relatively active metals which, when left unprotected, tend to oxidize (weather). Long term atmospheric exposure generally results in the formation of the naturally protective gray-green patina.

Because copper and its alloys afford a broad spectrum of both natural and weathered colors, much effort is expended to either hasten the natural weathering by chemical means or to preserve the bright natural colors through the application of clear protective coatings.



Natural Weathering
Chemical Coloring
Clear Coatings
Opaque Coatings
Lead Coating

Natural Weathering

The natural weathering of copper to the characteristic blue-green or gray-green patina is a direct consequence of the mild corrosive attack of airborne sulfur compounds.

As natural weathering proceeds, the metal exposed to the atmosphere changes in hue from the natural salmon pink color through a series of russet brown shades to light and dark chocolate browns and finally to the ultimate blue-green or gray-green patina.

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Building & Architecture News

October '11: The Fall issue focuses on the benefits of copper at healthcare institutions. Read about a new copper HVAC system that makes AC systems more energy efficient; a medical campus that relies on copper

Click here to view Copper Weathering Chart [pdf - 3.61MB].

During the initial weeks of exposure, particularly in a humid atmosphere or in areas of frequent rainfall, radical color changes often take place with iridescent pinks, oranges and reds interspersed with brassy yellows, blues, greens and purples. During continued exposure, these interference colors fade and are replaced by relatively uniform russet brown shades referred to as statuary or oxidized finishes.

Due to varying fabricating procedures, some mills may coat coiled or flat sheet stock with a thin coat of anti-stain oil film. This film may give rise to dark purple or black surface colorations soon after installation and exposure. This is a temporary color phase caused by the thin oil film, which is quickly washed off by rain allowing the natural weathering of copper to proceed.

In industrial and seacoast atmospheres, the natural patina generally forms in from five to seven years. In rural atmospheres, where the quantity of air-born sulfur dioxide is relatively low, patina formation may not reach a dominant stage for 10 to 14 years. In arid environments, the basic sulfate patina may never form due to the lack of sufficient moisture. Similarly, exposed horizontal surfaces develop the patina more rapidly than sloping surfaces which, in turn, patinate more rapidly than vertical surfaces. The critical variable, in all instances, is the dwell time of moisture on the exposed surfaces.

The progressive oxide, sulfide and sulfate films which develop on copper exposed to the atmosphere are quite thin two to three thousandths of an inch highly adherent, but with relatively low abrasion resistance. Neither the oxide nor sulfide films are particularly corrosion resistant. The sulfate patina, on the other hand, is highly resistant to all forms of atmospheric corrosion, once it has had an opportunity to form completely. It thus significantly increases the durability and, hence, the service life of copper roofing and flashing. The natural weathering cycle of copper is illustrated by the 12 sequential color plates in the Weathering Chart.

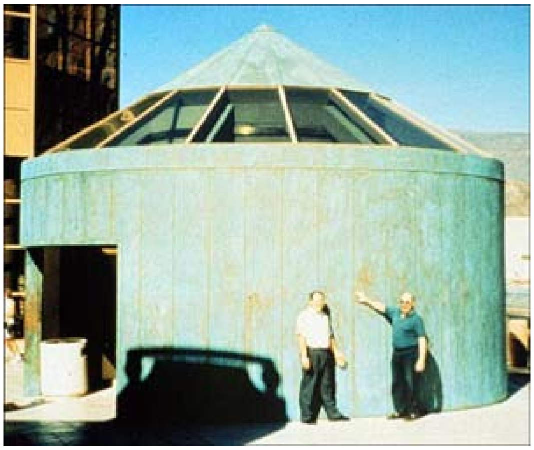
Although the plates represent a typical sequence, the weathering of any installation will depend on local environmental factors, orientation and amount of residual lubricants.

The weathering of copper will reach a final equilibrium with its local environment. This state of equilibrium is very stable and no further weathering will occur after this state is reached. However, the final equilibrium color will vary depending on orientation, slope, and local weather conditions.

Chemical Coloring

Because of the time required for copper to weather to the ultimate blue-green or gray-green patina, men have sought for centuries to hasten the process by chemical means.

Coloring however is an art, mainly a matter of craftsmanship and experience. Chemical coloring techniques depend upon time, temperature, surface preparation, humidity and other variables which influence the ultimate result. A wide range of colored finishes may be produced on architectural copper-base alloys by conversion coatings that are chemical in nature. The purpose is to hasten the natural weathered effect that generally results from exposure to the elements.



Several conversion treatments are in general use which produce the patinas (verde antiques) and statuary (oxidized) finishes.

Patinas are primarily developed using acid chloride treatments or acid sulfate treatments. Because of the number of variables involved, chemically induced patinas are prone to such problems as lack of adhesion, excessive staining of adjacent materials and inability to achieve reasonable color uniformity over large surface areas. These potential shortcomings should be considered when specifying such treatments. Due to the large number of requests for historical chemical applications CDA has compiled the most prevalently used chemical processes.

Because production of an artificial patina on copper is dependent upon a number of variables, including temperature, humidity, wind velocity, surface condition of the copper and method of application, wide variations in the result achieved have been experienced. Reliability of all present methods can, at best, be considered only fair to poor

The following treatments have exhibited some degree of success:

Statuary Finish
a). Ammonium Sulfide base.
b). Potassium Sulfide base.

Green Patina Finish
a). Ammonium Sulfate base.
b). Ammonium Chloride base.
c). Cuprous Chloride/Hydrochloric Acid base.

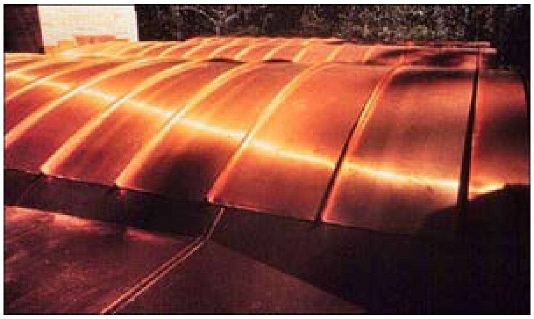
For specific solution specifications and application procedures see How to Apply Statuary and Patina Finishes, or order the printed version from our Publications List.

Factory applied pre-patination systems are continuously being investigated for architectural applications. Contact a CDA Project Managers & Architectural Applications Specialists for updated information on such systems.

See also Pre-Patination Systems.

Clear Coatings

Frequently, it is desired to preserve the original salmon or gold tones of copper or brass surfaces. This can be achieved by applying clear protective coatings. The coatings create a weather barrier and prevent the further oxidation of copper, brass and bronze surfaces. However, as with any coating, degradation over time will require the stripping and replacement of the clear coating.



Opaque Coatings

These coatings are used primarily for work applied over copper when substrate integrity and longevity are desired but a specific color other than the naturally occurring copper hues is required.

Paints: Copper is an excellent substrate for a painted finish. Prior to painting, the surface must be free of grease, oil, dirt, fingerprints, drawing compounds and surface passivation treatment chemicals.

A first coat of an industrial wash primer should be applied according to the specific manufacturers recommendation. The finish coat should be two coats of an oil alkyd enamel designed for exterior (or interior) use. Appropriate finish coatings are industrial enamels and silicone alkyd enamels of the specified color.

Gilding: The lamination of very thin gold leaf to copper is a very old tradition. The physical advantages of gold's color and weatherability with copper's sub-surface integrity combine into a very durable, long lived, maintenance free surface. Most gilding is done on historical statuary or domes that are difficult to maintain.

Specifying gilded surfaces includes the following:

Cleaning	Removal of oil, dirt and any surface oxides. Mechanical etch with fine grit sand paper or acid etch to bare metal.
Primer	The application of zinc chromate or VOC compliant primers. Butyl based or moisture cured urethane. Universal metal primer. Two coats.
Adhesive	Compatible with the selected primer. Acrylic size or slow drying alkyd resin, catalyzed marine epoxy.
Gold	18 gr. per 1000 sheets. 23.5-K gold leaf. Applied to dried adhesive. Burnish.

Leaf

Lead Coating

Lead-coated copper is copper in sheet or strip form coated on both sides with lead. The lead coating is applied to the copper by hot dipping the sheet or strip in a bath of molten lead.

Coating Weights

ASTM Standard B101 recognizes one weight of lead coating at 12 to 15 pounds per hundred square feet. The weight specified is per hundred square feet of coated surface applied to both sides of the copper sheet or strip. For the Standard coating, therefore, the weight of lead per side is from 6 to 7-1/2 pounds per hundred square feet.

Lead-coated copper was developed and gained widespread use between the turn of the century and World War I. Its development was spurred by two principal desires: to provide a metal for roofing and flashing with the appearance and corrosion resistance of lead at a lower cost and with significantly less dead weight; and to provide a roofing and flashing material whose runoff stains would be compatible with white painted woodwork and light colored masonry, particularly the more porous materials including marble, limestone, mortar and concrete. Lead-coated copper fulfills the first objective and very nearly satisfies the second. The stains produced range from light to dark gray in color and resemble the natural atmospheric weathering of the masonry or paint.

Gauge Selection

Lead-coated copper is suitable for a broad range of roofing and flashing applications. The strength and stiffness of the material are supplied by the copper. Normally, cold rolled temper copper is employed as a substrate for lead coating. Recognizing that the hot dip process of lead coating may remove some of the temper previously imparted to the the copper sheet, some specifiers call for lead coated copper one ounce weight heavier than for plain, cold rolled copper. For example, if 16 ounce cold rolled copper is deemed adequate for a particular flashing application, the specifier may utilize 20 ounce lead-coated copper in recognition of the slight loss of temper induced during the lead coating process.

The ease of forming of lead-coated copper is quite good, since the lead coating acts as a lubricant. Stamping and embossing of bas-reliefs and decorative ornament are more easily executed and produce finer detail when lead-coated copper rather than plain cold rolled copper is employed.

Soldering

Lead-coated copper solders readily. In order to assure sound joints of good strength, excessive fluxing, particularly when using fluxes of the zinc-chloride type should be avoided. During soldering the lead coating tends to diffuse into the solder layer. If common 50-50, tin-lead, bar solder is used, it tends to produce lead rich joints of lower than normal strength. In order to counter the potential strength reduction of the joints, it is desirable to specify the use of a tin rich solder. A 60-40, tin-lead solder is satisfactory.

Recognizing that the lead coating on sheet and strip copper is quite soft and relatively thin, reasonable care should be exercised during fabrication and installation in order to avoid cuts and scratches which expose the copper. When the copper is exposed, rapid pitting corrosion due to galvanic action can occur in instances where the lead coating is porous or incomplete.

Lead-coated copper takes paint readily and holds it well. In fact, the durability of properly applied paint is usually enhanced by the lead coating, provided that the paint selected is suitable for the purpose. When permitted to weather naturally, lead-coated copper gradually darkens to a soft gray color. Because of lead's inherent corrosion resistance, chemical coloring to speed the dulling produced through natural oxidation is not deemed practicable.

Although copper of any gauge and temper can be lead-coated, for roofing and flashing applications, lead-coated copper is generally stocked in nominal 16 and 20 ounce weights of cold rolled temper; in sheets 24, 30 and 36 inches wide by 96 or 120 inches long. Continuous coils are also available.