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Electrolytic Coloring: A Primer

The electrolytic coloring, or two-step process of coloring aluminum, starts when bare aluminum parts are anodized in a conventional sulfuric acid anodizing bath to produce a porous anodic coating, which is necessary for accepting color.

After thorough rinsing, the parts are transferred to a second bath, where AC voltage is used to deposit the metal coloring agent into the base of the pores of the anodic coating (this is why the process is called two-step).

The most popular system uses tin sulfate as the metal salt, although baths containing nickel or cobalt salts can produce similar colors. Shades ranging from champagne to bronze and black are possible, and are comparable to those obtained from integral color anodizing (Kalcolor or Duranodic). Baths containing copper can produce shades of red, and blues can be produced using molybdenum solutions. Golds and yellows are obtained using silver solutions.

The two-step process has several advantages over the once widely used integral color anodizing. Color is not dependent on the alloy treated. Most common aluminum alloys can be colored electrolytically. Color is not dependent on oxide thickness. All shades, except black, can be produced on anodized aluminum with oxide thicknesses less than AA Class I (0.7 mil).

Bath makeup and operating costs are less. The cost of organic acids (and the difficulty obtaining these chemicals) caused the price of integral color anodizing to be high. Less wattage is required to develop the desired color because the process uses AC rather than DC current. This also reduces coloring time. Less refrigeration is required. Because the system uses AC current and has shorter coloring times, there is less heat build up. Bath control is easier and more forgiving. Operating parameters are much wider with the typical two-step bath. Colors develop, and good color matches can be obtained over a wide range of operating conditions.

The fade resistance of electrolytically colored aluminum is excellent, because the color is developed using a metal oxide. This makes these coatings excellent candidates for exterior outdoor applications, such as buildings, store fronts and windows.

Operating Parameters

The typical electrolytic coloring bath is essentially made up of two components: tin sulfate and sulfuric acid. The thing that sets the different baths apart is the additional additives the proprietary baths contain, as well as the detrimental chemicals that are absent. Additions such as stabilizers and color enhancers are added to improve the working of the bath and to increase its overall longevity. Impurities such as chlorides and lead are removed from select proprietary baths to reduce electrode corrosion, and to keep harmful metals from getting into the finisher’s effluent.

Electrodes (or counter-electrodes) can be made of carbon, tin, or stainless steel. The most popular electrode materials are 316 stainless steel or pure tin. The bath should be constantly filtered and the solution temperature maintained at 70-75°F for consistent results. This assures the removal of any tin sulfate precipitate that could otherwise deposit itself on the colored surface as a “smut.” This constant filtration also affords the necessary agitation for the bath. Air agitation is not recommended because of the oxidation effect it has on the stannate (tin) in the solution.

Additions of the stabilizer/color enhancer are required when the bath is left idle for long periods of time. Even though the bath is not being used, **the stabilizer is still working to hold the tin in solution**. The additions of stabilizer will assure that this is affected.

As mentioned earlier, AC voltage is used in the coloring process. The color range, therefore, is a function of voltage and time. For instance, a champagne color can be obtained in 20–25 seconds, whereas an ebony black will only take 9–10 minutes.

Over-dyeing

Over-dyeing (or three-step) involves dyeing previously electrolytically colored parts with an organic (or inorganic) dyestuff. This is a separate step following the electrolytic coloring process, hence the term three-step.

Anodized and previously electrolytically colored work is immersed in an organic dye bath for 20–45 minutes. This longer dye time colors the anodic film to complete saturation with the dye. The correct immersion time is necessary for long-term exterior applications. For interior applications, it is only necessary to dye the part to the desired shade. The over-dye system produces a new range of interesting fade-resistant exterior colors, as well as a kaleidoscope of interior shades never before available on anodized aluminum.

Sealing

Processed work must be sealed to achieve excellent light-fastness, as well as the necessary corrosion resistance. Hydrothermal sealing is the seal of choice, although the cold seal has shown excellent results when processed correctly. *P&SF*