Finishers' Think Tank

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More on Aluminum ...

Last month we reviewed some important surface preparation facts related to processing aluminum before plating. Each cleaning step (soak, ultrasonic and etch) provides unique chemical blends, especially tailored for processing aluminum. Organic soils, such as buffing and polishing compounds, along with oils and grease must be removed. The aluminum oxide layer and remaining alloy metal oxides must be removed. Because aluminum is amphoteric (sensitive to acids and bases), etchants can vary in solution pH. Depending on the magnitude of etching and alloy composition, specific acid mixtures are selectively used to desmut the surface. Because aluminum is the most electropositive metal, we can't successfully plate directly over it. In other words, aluminum quickly reacts with oxygen in the air to form a surface oxide layer. Therefore, the zincate immersion treatment steps in. Let's pick up the cycle at this point.

Zincating

This is an immersion treatment where a coating of zinc or a zinc alloy is deposited over cleaned and activated aluminum. In this respect, we are to plate over a unique deposit covering the aluminum substrate, not the base metal itself. There are three common zincating solutions that can be employed:

1. Conventional Zincate. This solution contains one metal, zinc, which is immersion-deposited over aluminum. It also contains an oxidizer, such as sodium nitrate, conditioning the aluminum surface by mildly etching it. Tartrates are included as complexors. The viscous working solution is concentrated in sodium hydroxide. Baths prepared from powdered concentrates must be cooled for several hours before use.
2. Conventional Alloy Zincate. Similar to the conventional zincate, except as follows: contains iron, which forms an Fe-Zn alloy immersion deposit over aluminum, and contains up to four times more sodium hydroxide. Powdered concentrates must be cooled at least 24 hr before use.
3. Modified Alloy Zincate. Similar to conventional alloy zincate, but differing as follows: contains several metals (commonly from among copper, iron, nickel, tin and zinc) forming a unique alloy immersion deposit. Gluconate complexors (small amounts of cyanide optional) are used in place of tartrates, and much less sodium hydroxide. Concentrates are liquids and ready to use. This eliminates the problem of initially hot solutions and dissolving powders. The working solution is much less viscous.

In each zincate described, the type and concentrations of complexors are critical to maintain solubility of the metals.

How Does It Work?

A common mechanism of application is shared by each of these zincates. Sodium hydroxide dissolves the reformed surface oxide, then zinc or zinc-metal(s) alloy galvanically deposits on the active aluminum surface. This coating covers all the aluminum surface area that was immersed during treatment. Two benefits are achieved: The zincate or alloy zincate film prevents re-oxidation of the aluminum surface, and the film itself is an effective base for application of many electroplated or electroless coatings.

Which Zincate To Use?

The conventional zincate is a good process when applied to high-purity aluminum alloys, but it does not as effectively provide a strong adhesion to aluminum when processing certain alloys, such as 500 and 600 series. Conventional alloy and modified alloy zincates are far superior for strength of bonding to a wider range of aluminum alloys. This is due to formation of less porous, denser, uniform alloy zincate films. They also protect sharpened corners and edges of parts from being worn and abraded in barrel plating, minimizing plating blisters. Over the years, lab evaluations and, more importantly, field experience has shown the modified alloy zincate to be the best performing and reliable zincating system. User and process related benefits include:

- Forms a thinner, yet denser film.
- More resistant to lateral corrosion.
- Low viscosity results in effective solution penetration into odd geometric shapes and recesses. It also reduces solution drag-out and improves overall rinsing of parts.

Each of the zincating solutions is temperature-sensitive, optimally at 65–80 °F (18–27 °C). Immersion times vary, but may range from 30–90 sec. The conventional and especially the modified alloy zincates are best to use on high copper and silicon castings. Double zincating, or "double-dip," is sometimes preferred over high magnesium and silicon alloys and castings. The first immersion deposit is stripped in nitric acid or a substituted persulfate and sulfuric acid solution (non-fuming). After

rinsing, the part is immersed in the zincate again, for about 75 percent of the initial immersion time. What actually happens is the first zincate film is not totally stripped but leaves a thin "seed" coating upon which the second immersion zincate can form an even tighter, denser, adherent film. The double-dip cycle is preferred by OEM automotive and aftermarket finishers, such as wheel platers and other critical parts handlers, to greatly minimize costly plating rejects.

Strikes

A. Copper

This bath is designed to coat the zincated surface with a strong bond, without attacking it in the process. The deposit serves as an active site for reception of subsequent electrodeposits, some of which might be highly aggressive toward the unprotected zincate film. If the strike bath attacks the zincate, zinc contamination of this bath will occur and the zincate integrity will be compromised (see chart).

Suggested Copper Strike Formulations

Component	Concentration, oz/gal
Copper cyanide	3.50
Sodium cyanide	4.25
Sodium carbonate	4.00
Rochelle salts	4.00

Component	Concentration
Copper cyanide	1.5-3.0 oz/gal
Free sodium cyanide	0.2-0.4 X the copper cyanide conc.
Potassium hydroxide	0.1-0.5 oz/gal

Both of these formulas operate at 4 ASF for five minutes or at 25 ASF for 10 seconds, 110-125 °F (43-52 °C). pH of the first bath at 10-10.5, pH of the second bath at 11.5-12.0. A proprietary grain refiner and anode corroder may also be added.

B. Electrolytic Nickel

The purpose is the same as the copper strike—protect the zincate film and prepare it for reception of additional plated deposits.

Suggested Watts Strike Formulation

Component	Concentration, oz/gal
Nickel metal	10-12
Nickel chloride	8-10
Nickel sulfate	32-37
Boric acid	5-6

The bath is operated at the same ASF for respective Watts bright barrel and rack plating baths. Time is just sufficient to cover the zincate. Bath pH should be maintained at 4.4–4.6 to minimize attack on the zincate. Proprietary wetting agents and Class 1 brightener (or zinc tolerant carrier) are normally added. Routine LCD dummying at 5–10 ASF is recommended to minimize zinc contamination.

Where possible, live entry into the strike bath is preferred. This can be accomplished by using an auxiliary cable, while the parts are in transit "live" toward the bath. Plating begins as soon as the parts contact the solution, minimizing attack of the zincate.

C. Alkaline Electroless Nickel

The additional benefit of this bath is the total, even nickel thickness of all exposed surfaces, because this is an immersion process. The zincate itself is catalytic toward the electroless nickel solution. For a 10-min cycle time, the deposit thickness may range from 20-30 millionths of an in., at 110 °F (43 °C). The bath pH is 8.5-10.0, which minimizes attack of the solution on the zincate.

Plating

Several baths can be plated directly over the zincate film, with especially good effect over the modified alloy zincate type. Cyanide brass, alkaline copper and cyanide copper, nickel, acid tin and zinc deposit very well.

Aluminum is certainly a unique metal when it comes to plating. Etch, desmut and zincate are special and tailored to aluminum. With all the steps involved, care must be taken to prevent rejects, which in all cases are quite expensive to preprocess or even scrap. Some tips on zincating include:

- Rinse well before the zincate bath to prevent drag-in of desmut acid solution. For example, fluoride will detrimentally affect structure of the zincate film. The acid will neutralize the zincate's alkalinity.
- The zincate should be an even gray or blue-gray color. Splotching may indicate zincate additives are out of balance.
- Poor adhesion may be due to bath temperature out of range or poor cleaning and surface preparation.
- Spongy zincate is usually the result of excess immersion time.
- Just like testing adhesion of a chromate, an adherent zincate will pass a Scotch tape pull.

The Aluminum Association has just reported that U.S. annual production of aluminum was more than 3.7 million metric tons for the period January to November 1998, a 3.1-percent increase from the same period in 1997. Aluminum is in a strong market position for finished goods, much of which will be plated. Aluminum finishing is alive and well!

The Mail Bag

Q. Please provide the following advice for low current electrolysis for the purification of Watts bright nickel plating solution: 1. Design details of corrugated cathode for low current density purification procedure, and 2. Electrolytic purification procedure.

A. To answer part 1, the material of construction should be steel (*e.g.*, mild steel). Outer and inner corrugations may be 3-6 in. The corrugated sheet should be continuous, sized to fit within the dimensions of the nickel plating tank. A corrugated cathode provides a wide range of current densities. Sufficiently clean and activate. Then plate in the nickel bath at 40 ASF for the amount of time necessary to deposit nickel over the entire dummy sheet's immersed surface area. We are now ready to proceed to part 2 of the question.

A. (Part 2) The electrolytic purification is usually undertaken when copper and zinc contaminants are present. The accompanying table provides related information.

Metal	Dummy Current Density	Tips
Copper	2-5 ASF	ramp to 40 ASF, for 10 min. every 40 min to seal deposit
Zinc	5 ASF	

Zinc and copper plate out as black/gray deposits, with zinc forming striated bands. Depending on configuration of the parts, as little as 10-15 ppm of copper or zinc may affect the quality of nickel-plated parts. The copper deposit is friable, requiring the "sealing" tip. A sufficient amount of either metal will be dummied out when the inner corrugations accept a preferential deposit of "white" nickel.

Trivia

- Hot black oxide coatings average 0.06-1.0 mil thickness. Most parts are post-oil-dipped to improve corrosion resistance and enhance the black, shiny appearance.
- Microcrystalline structure of zinc phosphates are preferred for increased adhesion of subsequent paints.
- Three reasons for nickel anode polarization in Watts baths: Clogged anode bags; low anode area; using cheap, low-purity anodes. P&SF

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