**Operating Conditions for Tin Reflowing:**

| | *Optimum* | *Range* |
|---|---|---|
| Plating thickness, in. | 0.00025 | 0.0001-0.0003 |
| Immersion time, sec. | 6 | 2-10 |
| Temp. of oil bath, °F | 490 | 480-510 |
| Acid neutralization value, mg KOH/gm of oil | 2.7 | 2.3-6.6 |

**Troubleshooting for Tin Reflowing**

| *Problem* | *Cause* | *Remedy* |
|---|---|---|
| Etching | Acid neutralization value too high | Remove part of oil bath and replace with new oil |
| Dewetting | Tin coating too thick<br>Part not cleaned well before plating | Plate for shorter time<br>Check cleaning cycle |
| Streaky | Acid neutralization value too low | Add fatty acid flux |
| Not fully bright | Tin coating too thin | Plate for longer period of time |
| Spangling | Molten tin comes in contact with water in quench | Increase in quench. Lower parts more slowly |

**Determination of Acid Neutralization Value:**

1. Weigh 6 to 10 grams oil in a 250-ml Erlenmyer flask and add approximately 50 ml of 3A alcohol (a methanol-ethanol mixture) previously neutralized to a pH of 7.0.

2. Carefully heat the solution on a hot-plate with stirring until one or two bubbles appear on the surface of the solution.

3. Remove the solution from the hot-plate, add five drops phenolphthalein indicator and immediately titrate with 0.1N sodium hydroxide from clear to a pink endpoint that persists for 10 seconds.

$$\text{Acid Neutralization Value mg KOH/gm oil} = \frac{\text{ml NaOH} \times 5.611}{\text{weight oil sample, gm}}$$

# TIN-NICKEL ALLOY PLATING

by S.K. Jalota

*Electromanufacturing, Inc.*
*Milford, CT*

Tin-nickel may be electroplated directly on basis metals such as steel, copper, brass and on an undercoat of copper or nickel on zinc diecastings. The alloy is an intermetallic compound of approximately 65% tin and 35% nickel.

Tin-nickel alloy plating offers a replacement or an alternative to decorative chromium plating for a number of indoor and outdoor applications because of its attractive faint rose-pinkish color which gives it a very pleasant appearance. The alloy is resistant to corrosion and tarnish and has good contact and wear resistance. Its hardness lies between those of nickel and chromium. It has excellent frictional resistance and the ability to retain an oil film on its surface. Tin-nickel alloy plating solutions have deep throw so that where there is a problem in plating chromium in deep recesses, tin-nickel is an alternative. Because of these and a number of other properties, tin-nickel alloy has found its use in light engineering fields and in the printed circuit board manufacturing industry as an excellent etch resist and a substitute for gold.

## Tin-Nickel Alloy Plating from Fluoride Baths:

*Solution Composition:*

| | | |
|---|---|---|
| Stannous chloride anhydrous ($SnCl_2$) | 6.5 oz/gal | 49 g/L |
| Nickel chloride ($NiCl_2 6H_2O$) | 40.0 " | 300 " |
| Ammonium bifluoride ($NH_4HF_2$) | 7.5 " | 56 " |

*Control Limits:*

| | | |
|---|---|---|
| Stannous tin | 3.5- 5.0 oz/gal | 26-38 g/L |
| Nickel | 8.0-11.0 " | 60-83 " |
| Total fluoride | 4.5- 6.0 " | 34-45 " |
| pH | 2-2.5 | |

The solution pH can be adjusted by additions of ammonium hydroxide (to raise) and ammonium bifluoride (to lower). The total fluoride content should be at least as high as the total tin content (both stannous plus stannic).

*Operating Conditions:*

| | | |
|---|---|---|
| Temperature | 150°F | 65°C |
| Voltage | 2-4 V | |
| Cathode current density | 25 amps/ft² | 2.8 amps/dm² |

Agitation is not necessary for thin deposits but mechanical agitation may be necessary for thick deposits. Continuous filtration is necessary to remove the suspended matter.

*Anodes:*

Only nickel anodes may be used. Alternately, tin anodes may be used in conjunction with nickel anodes in the ratio of 2:1 respectively. When tin anodes are used, they have to be taken out of the solution during idling periods. It is not necessary to take out the nickel anodes. When only nickel anodes are used, tin content of the solution is maintained by regular additions of anhydrous stannous chloride.

*Solution Preparation:*

The plating tank is 2/3 filled with water and heated. The required quantity of nickel chloride is dissolved first. Ammonium fluoride is added next. Stannous chloride is added when both the nickel chloride and ammonium bifluoride have been dissolved. Ammonium hydroxide is used to adjust the pH between 2 and 2.5. The solution is dummied for 4 to 6 hours while filtering it through activated carbon before it is put to use

*Effect of Process Variables and Contaminants:*

For a given concentration of tin and nickel in a solution, the factor exerting the most profound influence on the deposit is the fluoride content. Since fluoride has complexing action on tin (stannous), an increase in fluoride content will decrease the tin content of the deposit and vice versa.

Free hydrofluoric acid content should be maintained between 6 and 12 g/L to avoid loss of brightness and burning in the high current density areas.

The presence of grease, oil and organic contaminants in the solution will give rise to serious pitting of the deposit. The presence of lead over 25 ppm is very harmful to the solution. Metallic impurities such as copper, antimony, iron, zinc, cadmium, etc, under 200 ppm have no detrimental effect on the deposit but can be removed by dummying.

*Troubleshooting:*

1. Cloudy deposits are due to lack of nickel content, low temperature or organic contamination.
2. Dark deposits in low current density areas are due to metallic contamination, copper in particular if more than 50 ppm.
3. Gray deposits in high current density areas are due to high tin (stannous) content, lack of free fluoride content, iron contamination above 750 ppm or chromium contamination over 50 ppm.
4. Burnt deposits are due to lack of tin content, low temperature, and pH imbalance.
5. Loss coverage is due to excessive iron contamination.
6. Poor solderability is due to surface passivation and aging.

*Plating from Proprietary Baths:*

Tin-nickel alloy may be electroplated with the use of proprietary additives in fluoride baths. Incorporation of proprietary additives allows the operation of the process at a little lower temperature range (120-130°F) and pH between 4 and 5, resulting in bright and ductile deposits.

## Tin-Nickel Alloy Plating from Pyrophosphate Baths:

Because of the corrosive and toxic nature of fluorine in fluoride baths, pyrophosphate baths have been developed which operate at lower temperatures and near neutral pH.

Bright deposits of tin-nickel alloy have been successfully obtained from baths consisting of the following composition and operating parameters:

| | | |
|---|---|---|
| Stannous chloride ($SnCl_2 2H_2O$) | 3.8 oz/gal | 28.2 g/L |
| Nickel chloride ($NiCl_2 6H_2O$) | 4.2 " | 31.3 " |
| Potassium pyrophosphate ($k_4P_2O_7 3H_2O$) | 25.8 " | 192.2 " |
| Glycine | 2.7 " | 20.0 " |
| Temperature | 122°F | 50°C |
| pH | 7.5–8.5 | |
| Current density | 4.8–14 amps/ft² | 0.5–1.5 amps/dm² |

The composition of the alloy obtained from this solution does not vary with changes in pyrophosphate concentration, but variation in the content of individual metals, tin or nickel, changes the composition of the alloy. pH values below 7.5 or above 8.5 are undesirable.

# ZINC PLATING

## by Herb Geduld

*Columbia Chemical Corp., Macedonia, OH*

Each of the three general types of bright zinc plating electrolytes in general use today (cyanide zinc systems, alkaline non-cyanide baths, and acid zinc baths), will produce bright, acceptable deposits when operated correctly. To help the electroplater determine which electrolyte would be best for his particular installation, their advantages and disadvantages are given below.

### BRIGHT CYANIDE ZINC PLATING ELECTROLYTES

*Advantages:*

1. Oldest processes in use; familiarity of employees with operation.
2. Most forgiving electrolytes to poor pre-cleaning.
3. Excellent covering power.
4. Analysis and control of bath relatively easy.
5. Good ductility of deposits.
6. Non corrosive electrolyte.

*Disadvantages:*

1. Highly toxic electrolytes requiring cyanide waste treatment.
2. Will not deposit on most cyanide heat treated and cast iron parts.
3. High temperature operation, above 105°F costly or impractical for bright deposits.
4. Relatively poor bath conductivity.
5. Cathode current efficiencies drop dramatically at higher current densities.

Among the three cyanide systems themselves, the overall ease of operation, control and minimization of rejects is parallel to the cyanide content of the bath. The regular cyanide baths are the most trouble-free to run simply because their higher overall formulation makes them more tolerant to dragged-in organic and metallic impurities and to variations in the bath content due to drag-out. The mid-strength baths, however, perform so closely to the regular bath with substantially less drag-out, that most cyanide plating is now done in these lower cyanide content formulations.

### BRIGHT ALKALINE NON-CYANIDE ZINC PLATING ELECTROLYTES

*Advantages:*

1. Least toxic zinc electrolyte.
2. Waste treatment simplest, requiring only zinc precipitation.
3. Low make-up costs.
4. Good plate distribution.
5. Can be used in steel plating tanks.

*Disadvantages:*

1. Requires close control of zinc metal content, usually daily analysis.
2. Low tolerance to poor pre-plate cleaning.
3. Efficiency drops rapidly with lower metal contents.
4. Low tolerance to metallic impurities in make-up salts and hard water impurities.
5. Deposits have a greater tendency to brittleness than cyanide baths.