Some Production Plating Problems & How They Were Solved—Part 15

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1. Reflections on a nickel-plated surface.

Most bright nickel plating solutions require organic addition agents to give useful deposits. The organic additives are believed to codeposit with metallic nickel at a rate determined by the laws of diffusion. The rate of nickel metal deposition is, at normal operating current densities, determined by Faraday's Law.

The relative weights of such addition agents and nickel are given by the expression:

$$\frac{M_a}{M_m} = K + \frac{DC}{\delta\ i_c E_m}$$

in which:

M_a = weight of addition agent in deposit.
M_m = weight of nickel in deposit.
K = a constant.
D = the diffusion coefficient for the addition agent.
C = concentration of the addition agent in solution.
∂ = thickness of the diffusion (cathode) film.
i_c = cathode current density.
E_m = cathode efficiency for nickel deposition.

The ratio M_a/M_m is directly related to such characteristics of the nickel solution as the degree and rate of brightening and leveling, ductility, chromium receptivity and purity (*e.g.*, sulfur content) of the deposit. In general, when the ratio is high, the degree and rate of brightening and leveling will be high. Ductility, chromium receptivity and purity will be low.

Raising the operating temperature will tend to increase diffusion (*D*) and increase the ratio unless the brightener concentration is proportionately reduced.

Increasing the agitation of the solution will reduce the thickness of the diffusion film (∂) and permit operation at lower brightener concentrations (*C*) or temperatures or both to obtain the same M_a/M_m ratio.

Reducing the cathode current density (i_c) and increasing agitation (reduces ∂), as in dummying, can greatly increase the ratio. This is a common way to reduce brightener concentration with minimum nickel loss. If, on the other hand, it is desired to increase the nickel plating production rate by raising i_c, it may be desirable to raise operating temperature (raises *D*), brightener concentration *C* and increase agitation to maintain the desired M_a/M_m ratio.

These principles have proved useful in economic operation of nickel solutions and in troubleshooting. For example, they provide the explanation for the quick test for high primary brightener by reducing agitation just before removing work from the tank. They are also general in that they can be applied to any plating process whose brightener system operates according to the laws applying to present day bright nickel baths.

A. M. Linn—Supervisor, Laboratory Services,
M&T Chemicals, Inc., Detroit, Michigan (1968)

2. The impossible takes a little thought.

In nickel electroforming a part with a nearly right angle corner, it was found practically impossible to get enough nickel deposited in this low current density area. The "thieving" effect of the sides of the corner further complicated the usual problem in plating an inside right angle.

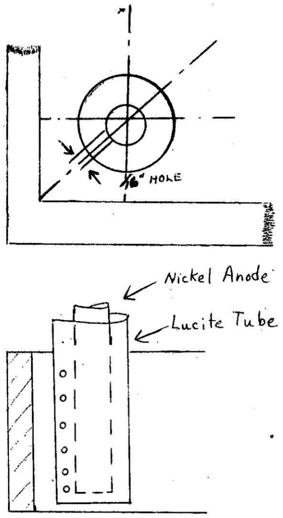

Figure 1—Sketch of the device used to increase throw to the recess.

Many different anode arrangements were tried but none was successful. The problem was finally solved by using a cylindrical Lucite tube closed at the bottom. A row of 1/16 in. holes was drilled longitudinally in the tube and a nickel anode placed inside. The tube was arranged so that the holes pointed at the corner (Figure 1). This arrangement put plenty of nickel in the low current density area.

Ralph A. Boyd—Technical Service Engineer,
M&T Chemicals, Inc. (1968)

3. A burn Is not always a burn.

Chromium burning occurred in a hoist line plating copper, nickel and chromium on steel. It was an unusual burn in that under microscopic examination it appeared beaded rather than rough and nodular and appeared more on shelf-type areas and at the top of racks. Hull Cell investigation

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and chemical analysis indicated chromium and nickel solutions to be in excellent condition. Chemical and mechanical changes in chromium and nickel baths did not show any improvement.

A film was noted on the nickel dragout recovery tank which at first appeared to be grease. Further investigation established it as ferric hydroxide. It was theorized that the ferric hydroxide particles were kept in suspension by the air agitation in the dragout recovery rinse. The particles attached themselves to the work. There was no acid and only one water rinse between the nickel dragout and the chromium solution. Chromium was then being plated over a surface partly coated with a hydroxide film. When the pH of the dragout rinse was lowered to 2.5, the ferric hydroxide dissolved and no more beaded burning was noticed.

V. E. Guernsey—Technical Service Engineer,
M&T Chemicals, Inc. (1968)

4. Chromium cracking caper.

"Chicken wire" cracking occurred after grinding hard chromium plate on aluminum. The process called for a room temperature chromium strike directly over a zincate film. At first it was felt that the parts were being overheated in grinding. It was found, however, that the grinding was being done very carefully with adequate cooling.

Some of the parts were given a copper strike over the zincate film and plated in the same chromium tank at 54°C (130°F). These parts were very good after grinding.

In checking the chromium plating process, it was found that it took from 5 to 6 hr for the tank to be loaded and heated up to operating temperature. Additional heating coils were added so that the tank heated up in about 1 hr. There was no more trouble with cracking after that.

It was theorized that the cold chromium layer was highly stressed, more brittle and fragile than the normal chromium layer. Since the cold chromium layer was so thick, the grinding wheels were removing material to this layer causing it to form large cracks. With a faster heat up, the cold chromium layer was thin enough so that the grinding wheels did not grind into this layer.

Ralph A. Boyd

5. Nervous about the surface.

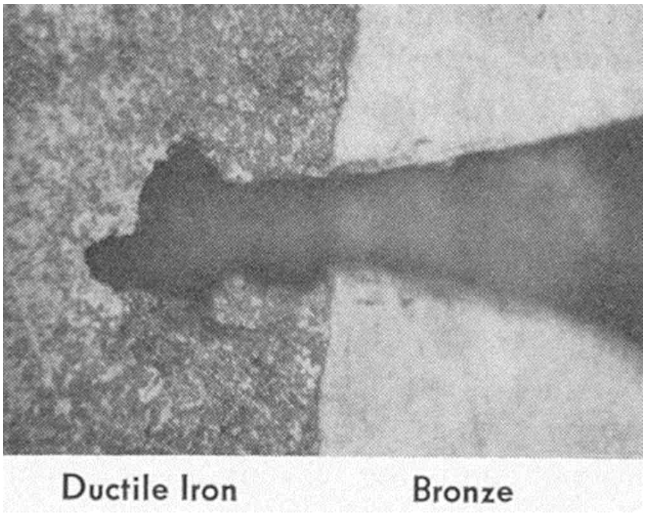

Figure 2—Cross-section of pit in bronze-plating ductile iron casting.

An installation plating ductile iron castings with heavy (1.27-mm; 0.050-in.) copper-tin bronze deposits encountered severe pitting in one batch of work. Poor cleaning was suspected. The cleaners were dumped and the plating solution was carbon treated. The work was stripped and replated and steel panels were plated with the castings.

The ductile iron work was still pitted the second time but the steel panels were free of pits. Upon sectioning some of the pits, they were found to start from a void in the basis metal about 38 to 51 ìm (0.0015 to 0.0020 in.) in diameter (Figure 2). Larger voids were filled in. Further machining of the ductile iron to a better surface solved this problem.

Ralph A. Boyd

6. The heat in the kitchen.

Getting bright nickel to stand the heat. A plater had a requirement for bright nickel deposits withstanding temperatures of 480°C (900°F). It was acceptable for the deposit to darken but not to flake. He was experiencing a severe powdering when he subjected his bright nickel deposit to the heat requirement.

A check of his solution showed a high carrier (sulfo-oxygen) brightener level. This resulted in the sulfur content in the deposit being higher than that required to maintain bright deposits. The excessive sulfur content was causing the severe powdering condition.

The problem was eliminated by making up a new bath with a lower sulfo-oxygen carrier brightener content. The sulfur in the deposit was controlled between 0.03 and 0.04 % for best results.

Albert A. Nortof—Technical Service Engineer,
M&T Chemicals, Inc. (1968)

7. When all else falls, read the directions

Transcript of telephone conversation: C = customer; *M = me*.

C: Just put in one of your new, fangled potassium stannate tin baths. It doesn't work.
M: What do you mean it doesn't work?

C: Can't get any plate.
M: No plate at all?

C: Well, a little, but it's thin and dark and just no good.
M: Sure the bath is of proper composition?

C: Analyzed it; it's right on the button.
M: (beginning to be definitely puzzled): What's the voltage?

C: Just about six volts; and the current's all right too.
M: Sure you haven't any stray currents? The current is getting to the work?

C: Couldn't be; it's a lined tank.
M (grasping at straws): Impurities? Lead, antimony, chromates, things like that?

C: Can't see where they would come from.
M (now desperate): What material are your heating coils made of?

C: Come again?
M: I say, what are your heating coils made of?

C: What heating coils?
M: The coils to heat the solution.

C: I'm supposed to heat the solution?
M: (This journal goes through the U. S. mails. Remainder of conversation omitted).

F. A. Lowenheim—Technical Editor, Plating *(1968)*