Some Production Plating Problems & How They Were Solved—Part 7

Contributed & edited by Dr. Samuel Heiman
Updated by Dr. James H. Lindsay, AESF Fellow

1. More on Chisholm's Laws

Dear Dr. Heiman:

Apropos of the correspondence on Chisholm's Laws which appeared in the May 1966 issue of *Plating* [December 2003 of *Plating & Surface Finishing*], I would like to call your attention to an article which appeared in the April 21, 1958, issue of *Product Engineering*, entitled "Finagle's Laws … or why nothing in Research and Development happens the way it should." This establishes Finagle's priority over Chisholm in enunciating these laws. Without trying to abstract this article, which has to be read in its entirety to be fully appreciated, I would like to quote the following excerpts:

On Experiments

First Law: If anything can go wrong with an experiment, it will.

From a Series of Rules

In case of doubt, make it sound convincing.

Human Foibles

Fourth Law: Even if it is impossible to assemble a part incorrectly, a way will still be found to do it wrong.
Corollary: After adding two weeks to a schedule for unexpected delays, add two more weeks for the unexpected unexpected delays.

Finagle's Creed

Science is truth—don't be misled by facts.

Finagle's Motto

Smile—tomorrow it will be worse.

The Finagle Factor

This consists of a simple additive constant in the form $X^l = X + K_f$, where any measured variable x can be made to agree with the theory, x^l, by simple addition of the Finagle Factor, K_f.

E. T. Myskowski, Strafford, PA.

Dear Mr. Myskowski:

Chisholm was not the first man who tried to explain the frustrations and delays which happen when supervisory people try to get things done. Clearly he is indebted to his predecessors. And these include not only Finagle but also Shakespeare, who called fortune "outrageous" and Burns, who noted that plans "gang aft agley."

Chisholm's genius was to generalize these observations from various and sundry fields into an underlying, perfectly general, unifying principle, operative in all situations involving human purpose. By the way, Dr. Chisholm (1905–1965) was a professor at Wisconsin State University, River Falls, Wisconsin. Who was Finagle?

Samuel Heiman

2. Measurement of Plating Thickness With Magnetic Instruments

This case refers to the difficulty encountered during the manufacture of steel washers which were cyanide zinc plated and given a bright chromate conversion coating. The specification called for a minimum of 12.7 to 17.8 μm (0.5 to 0.7 mil) of zinc plate to be measured after the application of the chromate. The trouble was that the quality control inspector began rejecting entire lots of washers on grounds that the plate thickness was less than that required by the specification.

All electrical circuits in the zinc plating tank were checked and found to be O.K. Analysis of the chromate bright-dip showed that it was operating within the limits recommended by the manufacturer. However, to guard against the possibility that its chemical polishing action might be removing an excessive amount of zinc, a fresh solution was made up and only one-half the amount of nitric acid recommended was included. When the Q.C. Inspector rejected still more washers because they did not pass the minimum requirements of the thickness test, attention was turned to the device in which parts were tested. A thickness gage operating on magnetic principles was used in the measurements. It was finally noticed by chance that, on any single washer, vastly different readings of plate thickness could be obtained, depending on the position of the washer with respect to the small magnet in the thickness gage. Reversing the north and south or top and bottom of the washers led to wide fluctuations in the apparent thickness of the zinc plate. Further investigation revealed that the washers were transported through the manufactur-

Based on an original article from the "Plating Topics" series [*Plating*, **53**, 1122 (July 1966)]

ing plant upon electrically magnetized conveyor belts and so were magnetized themselves.

Installation of a unit for demagnetizing those washers upon which thickness checks were made eliminated this particular production bottleneck. [Sometimes the most innocuous of factors can give the plater fits.]

George McDowell, Allied Research Products, Inc. Baltimore, MD

3. Silver Plating—Poor Solderability

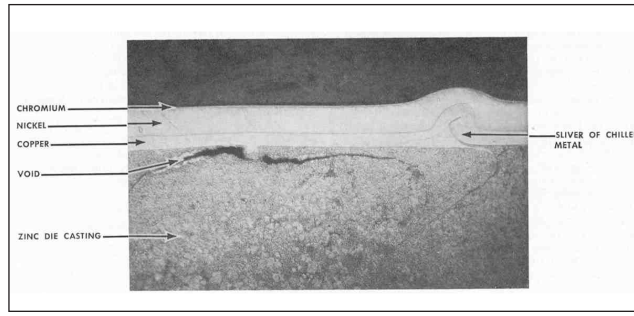
This is another case of poor solderability, this time on silver plated on brass pins. I was sent to the vendor's plating facility to find the cause.

The plating was being done in the conventional manner and the silver plate had a good appearance. One thing, however, was unusual. The parts had a fire scale, which the vendor removed by a sand tumbling operation. The parts had a clean, burnished appearance at this point. They were given a mild alkaline clean and then plated.

I decided to bright dip the brass parts just before silver plating in order to duplicate the cycle used successfully in our "captive" shop. The solderability of the resultant silver plate was vastly improved and satisfactory for our purpose.

Here again the condition of the basis metal affected the solderability of the plated coating. This seems to indicate that the preparation of a basis metal for a plated coating which is going to be soldered is not necessarily the same as for a coating which is plated for appearance, corrosion resistance or some other function.

Edwin F. Ottens, Philco Corporation, Philadelphia, PA.



Sliver of chilled metal protruding from the surface of a zinc die casting.

4. Chromium Plating — Removal of Chromic Acid Stains

1. Problem:
- Soil: Chromic acid stain
- Objects: Various chromium plated parts
- Subsequent Operations: None

2. Equipment used:
- Dip tank
- Rinse tank

3. Former method:
- Hand wipe

4. Solution:
- Alkaline deruster – 60–75 g/L (8-10 oz/gal), 77 - 88°C (170–190°F), 1 - 5 min.
- Rinse

5. Results:
- Very good. Have eliminated the necessity for the hand wiping operation to remove stains from the chromium plate. The alkaline deruster does a better job than hand wiping and is faster.

5. Copper-nickel-chromium on Zinc Die Castings—Roughness Problem

The parts were made of Zamak #3 alloy in our own die casting shop. They were plated with copper, dual nickel and dual chromium in a full automatic, high volume machine.

Roughness is usually caused by solid particles in the plating solutions. An inspection was made of all of the filtration equipment, the clarity of the solution and possible sources of solid particles, such as broken anode bags and sediment on the bottom of the tanks. An inspection was also made of the work coming out of the various plating tanks to track down the source of the roughness. At the same time, as a matter of routine, a photomicrograph was made of the rough deposit.

This figure clearly pinpointed the source of the trouble. There were slivers of zinc metal protruding from the surface of the zinc die casting. This was caused by chilled metal forming on the walls of the die cavity, which was too cold during the casting cycle. Furthermore, voids under the surface of the zinc, which are also seen in the photomicrograph, were also caused by chilled metal. Once this was conclusively demonstrated by the photomicrograph, the die casting machine was adjusted to operate properly and smooth plating was once more obtained.

This story, therefore, has not one moral but two. First, it points up the use which should be made of photomicrographs [SEM as well as metallography today] as a tool in trouble-shooting plating problems. Without this picture, it would have been difficult to present the case so forcibly. Secondly, it shows the importance of spending time early in the investigation in isolating the specific source of the trouble, rather than taking remedial steps which ordinarily solve the general problem. However, very often, under the pressure of production, both of the above methods of attack have to be undertaken concurrently.

Louis A. Rupprecht
Ternstedt Division
General Motors Corporation, Trenton, NJ.

6. Hard Anodizing —Stopoff

An aluminum part required 63.5 μm (2.5 mil) of hard anodize on certain areas only. An important requirement was that the edges of the hard anodized coating be sharp and well defined. Early attempts with various maskants and shielding techniques resulted in somewhat ragged and crumbly edges.

The problem was solved by using a method developed by H. J. Wiesner [H. J. Wiesner and H. J. Meers, *Proc. AES*, **45**, 105 (1958), in the old "red books"]. The part was first anodized all over in a chromic acid solution and then sealed in hot water. The area to be hard anodized was then lightly machined to remove the chromic acid anodized coating. The hard anodized coating was then applied.

The thin oxide film produced in the chromic acid bath served as an excellent stopoff during the hard anodizing process and resulted in well-defined edges.

7. Nickel Plating —Copper Contamination

This problem concerns the periodic recurrence of poor deposits from a Watts nickel bath. Over a period of time, the nickel plate became dark, less ductile and even pitted.

The trouble was completely removed by dummying the tank at low current; but, after several weeks, the quality of the plate began to deteriorate again. This tank was part of a model shop operation and we could find no source of metallic contamination, such as impure chemical additions, dripping from copper work bars or work falling to the bottom of the tank.

The difficulty was finally traced to the Monel hooks which were noticed to be thinning out somewhat. Monel contains about 30% copper. The anodes were bagged at the top of the anode and the strings fastened around the hooks. It was assumed that the plating bath was brought in contact with the hooks by capillary action and this resulted in the anodic dissolution of the Monel.

The Monel hooks were replaced with titanium hooks and the trouble has not cropped up since. It should be pointed out, however, that fluoborates, which are sometimes added to keep iron in solution, should not be used, since they attack titanium.

According to the Inco booklet, *Practical Nickel Plating*, 10 ppm of copper (0.010 g/L) in a nickel bath will cause poor ductility, poor throwing power, dark deposits and poorer resistance to corrosion.

Howard G. Lasser
U.S. Army Research & Development Laboratories
Fort Belvoir, VA

The edited preceding article is based on material compiled and contributed by Dr. Samuel Heiman, as part of the "Plating Topics" series that ran in this journal. It dealt with everyday production plating problems in the mid-1960s, many of which are still encountered in the opening years of the 21st century. Much has changed ... but not that much. The reader may benefit both from the information here and the historical perspective as well. For many, it is fascinating to see the analysis required to troubleshoot problems that might be second nature today. In some cases here, words were altered for context.