# *Plating & Surface Finishing* Retrospective

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*Based on an original article from the early "Finishers Think Tank" series*
*[Plating & Surface Finishing, **69**, 16 (April 1982) and **69**, 24 (May 1982)]*

## *Thickness of cadmium and zinc*

**Q:** One of our older employees mentioned that he remembered a chemical test that approximated the results of salt-spray tests on plated parts. Such a test would be very helpful because we don't have access to a salt-spray laboratory. We presently use both cadmium and zinc.

**A:** Your colleague may be referring to the Preece Test, which consists of the gradual removal of the zinc coating via repeated immersion in copper sulfate solution. However, I understand the test may fall short of the accuracy you should be looking for in thickness measurement.

Salt-spray testing (per ASTM B-117) is the preferred test for chromated zinc and cadmium coatings because it quantifies the quality of the chromate coating. Thickness tests should suffice for non-chromated zinc or cadmium.

The lead acetate test (per ASTM B-2011 will detect the presence of a chromate or other type of film over the zinc or cadmium deposit. The diphenylcarbazide test (annex to ASTM B-635) also may be used to detect chromate finishes.

## *Plate selected areas*

**Q:** We produce mild-steel frames that must be drilled, tapped and matched with mating parts in remote assembly. These areas rust very quickly. We would like to know of an economical process to plate selected areas, protecting them from exposure and corrosion.

**A:** The simple answer would be to paint after drilling, but this may cause cosmetic problems unless the coating matches the rest of the finish. I'm sending you a list of names and addresses of companies supplying selective-plating equipment and a recent article on brush plating. The latter technique could be economical if all you are interested in is coverage for protection. Rust-preventative oils applied after-spot phosphating might also be a thrifty answer.

## *PC board problem*

**Q:** We use two different plating resists in our PC board manufacturing process. One comes out of our pyrophosphate copper solution with alternate bright (heavy) and dull (thin) deposits, but the other resist emerges even. Cleaning in all cases is good, and all baths have been changed and/or analyzed by outside labs. Pitting is also a problem with the copper.

**A:** The problem seems to be in the removal of the resist material. Good cleaning is a relative term, but the preplate cleaner may not be the best available to remove the resist. Perhaps an electrocleaner to replace the soak type will do a better job.

A bad development cycle may also cause skumming and incomplete removal of the partially dissolved polymer. Good water pressure at the end of the developer cycle probably is the first thing you should check. Perhaps you could also try an acid cleaner at the end of the line.

The copper problem would seem to be a result of contaminants due to the drag-in of organics. This can be prevented using carbon treatment in accord with your supplier's recommendations.

## *Vermeil changes color*

**Q:** We have some problems with our gold-plated vermeil chain, which turns purplish or copper-colored over time. Could this be a problem of the silver or nickel seeping through the gold, or is it more likely a result of something in the atmosphere?

**A:** The first thing to look for is condensation on top of the gold. Place the part in a cleaner, rinse and check it again. With luck, your problem is simply due to a film on the surface. Since you say this happens only in isolated cases, you might check the storage area in which the plated material was kept before it was returned to you.

A barrier plate of 1.0 $\mu$m (40 millionths of an inch) of nickel should be deposited on the substrate to prevent silver migration. The added brightness of a thick deposit may even improve the appearance of the product. Using about 1.5 $\mu$m (60 $\mu$-in.) of 23-karat gold, as you do, should be enough to prevent attack of the nickel from external elements. Migration through the gold from the basis material usually shows up as spottiness and unevenness.

## Adhesion test

**Q:** Can you suggest a simple quantitative test (*e.g.*, peel or tensile type) for adhesion of nickel deposits on copper?

**A:** I really wish you had asked for qualitative tests, but – of those available – the Ollard test (or modified sheet adhesion test) required the use of an accurate machine lathe and a tensile testing machine [See A. Brenner & V.D. Morgan, *Proc. AES Annual Tech. Conf.,* **37**, 51 (1950)]. With what is known as the "nodule test," a mushroom-shaped nodule is electroformed on the surface to be tested and a modified spring balance is used to measure the adhesion. Another option, the adhesive-cement test, is self-explanatory, but the bond to be tested should not exceed about 6,000 psi (41.4 MPa). If accuracy and reproducibility are needed, proper equipment also will have to be obtained.

For a more comprehensive discussion of the problem to which you refer, you might check the following reference: H.C. Schlaupitz & W.D. Robinson, *Plating*, **39** (7), 750 (1952).

## Mist pollutants

**Q:** Are there any successful solutions to the problems of air pollution in plating shops? So far, wet scrubbers seem to be the best answer, but we might be interested in a dry absorbent system.

**A:** After checking with several suppliers of equipment for air-pollution control, the comments were that wet scrubbing can be 95 to 98% if properly employed. They say that the problem with dry systems is the constant cleaning – either rinsing or changing filters – required if the pollutant is a fog or mist. The representatives also said that the efficiency drops below that obtained with wet methods and that fumes of hydrochloric or nitric acid and even ammonia would go right through the average dry-type system. However, even if the dry unit were designed to remove the particular fume, constant cleaning and rinsing still would be needed, according to the suppliers whom I talked to.

## Bend-test blues

**Q:** We manufacture handlebars made of 7/8-in. (2.4-cm), 26-gauge, mild-steel pipe and plate them with 0.0006 in. (15 $\mu$m) of nickel and then a flash of chromium. Our vendors are objecting to our 90° bend test for adhesion of the plate. Their contention is that PIPE of this diameter and thickness will have low flow property of the basis metal during bending and that the nickel will flake off. They also say the plate would not flake off of a SHEET of the same material, even after bending at 180°, because the base metal would flow adequately. What do you think?

**A:** There should be no difference in the results when bending flat stock vs. tubular for this application. The nickel plate is just not thick enough to cause a problem; but, if there is one, it might be because cleaning of dirt or oil is inadequate or because acid dipping of scale or rust leaves something to be desired. I would expect the nickel to crack, leaving a void, but not to flake.

Other problems may include:

1. Nickel-to-nickel adhesion: For any number of reasons, including rectifier problems or a failure to activate parts before replating nickel, double plate may be occurring.
2. A contaminated bath: Copper, lead, zinc, iron, chromium and other metals that may have dissolved from fallen parts or racks, plus organics caused by the breakdown of addition agents, could cause a brittle nickel deposit.

If your vendors continue to object to the bend test, a spiral contractometer developed by Brenner and Senderoff [*J. Res. National Bureau of Stds.*, **42**, 105 (1949) or *Plating*, **36**, 810 (1949)] can be used to measure tensile or compressive stress. This method and others, however, require a history from the supplier about what is expected from the bath. All in all, the bend test is your best bet as an easy and reproducible method. You might also consult the excellent comments that appeared in a previous *Finishers' Think Tank* [J. Laurilliard, *Plating & Surface Finishing*, **68** (8), 25 (1981)].

## Scratches on discs

**Q:** We are plating over polished brass discs. We are not permitted to use a brightening agent in the nickel bath for this application. Probably due to some minor scratches, there are occasional irregular curves on the part surface. How can we cover these scratches?

**A:** Upon examination, the part appears to be stained under the electrodeposit. This could be due to poor surface preparation prior to plating. It appears the scratches could be covered by using an acid copper solution with brighteners to give superior leveling and brightness, but you say this is not permissible. So, if the part must be kept dull for cosmetic or other reasons, a semibright nickel plate would provide leveling without full brightening, and might be your best answer.

## Treating silver rinse

**Q:** We currently plate silver with a cyanide bath. The main problem is that the rinsewater used after plating must be treated, and this is an expensive proposition. Is there an alternative?

**A:** There are many contaminants in impure water that cause silver to tarnish or stain. To avoid these problems, these contaminants must be removed. Deionizing the water is not considered a costly treatment procedure. For your information, there are non-cyanide silver baths ommercially available to produce bright, semibright and electronic-grade silver deposits.

## Chemical additions

**Q:** What is the safest and most efficient way to make additions of toxic chemicals such as 15-lb (6.8-kg) quantities of copper cyanide? We experience dustiness and operator exposure when doing this. A respirator helps, but still leaves everyone downwind exposed.

**A:** Most of the single cyanide salts such as copper cyanide are available in liquid form from various suppliers. To dissolve 1 lb (454 g) of copper cyanide (CuCN), it takes 1.1 lb (0.5 kg) of sodium cyanide (NaCN) or 1.4 lb (500 g) of potassium cyanide (KCN) and the result is a copper sodium (or potassium) cyanide - $CuNa(CN)_2$ or $CuK(CN)_2$.

The only drawbacks are the costs, including those for someone to mix it for you, and shipping all that water with the product. Control of free cyanide in a brass or bronze bath may be a problem, since only CuCN additions will use up any extra NaCN in the bath.

## Anodizing problem

**Q:** I am anodizing aluminum watch-cases in 20% sulfuric acid at 50 to 54°F (10 to 12°C), subsequently dying them black, and sealing at 194 to 203°F (90 to 95°C). Quite often, I observe that the tips and edges exhibit a white base after a slight buff with a cloth wheel. What do you think the problem is? Also, I'd like to know of test procedures for checking the fading of the dye.

**A:** A 15% concentration of sulfuric acid in the electrolyte is common, so perhaps lowering your concentration would better suit your needs. I know your present 20% concentration gives you a more porous deposit, but perhaps it isn't needed. The thickness of the deposit may be the key. Obviously, it's thin, but thick deposits may be a problem if a bright finish is desired. The source of your problem also could have something to do with process parameters. Make sure to check the amount of dissolved aluminum in the bath, as well as your immersion time, voltages and temperatures.

Fading of the dye is covered by several standard test methods. ASTM G-23 and G-26, which cover operating procedures for light and weather testing on non-metallic substrates, and detail the weatherometer and Fade-a-Meter tests. ASTM E-42, E-188 and G-25 recently were incorporated into ASTM G-23. Most of these were written for painted finishes, but the same principle of testing applies. Other materials can be found in ASTM D-3361 (Recommended Practices for Light and Weather Testing) and ASTM D-822 (on light and weather testing with carbon arc).

***Editor's note**: The edited preceding article is based on material compiled by Ronald Kornosky, then of Hager Hinge Co., in Montgomery, AL, as part of the Finishers Think Tank series, which began its long run in this journal 26 years ago. It dealt with everyday production plating problems, many of which are still encountered in the opening years of the 21st century. As we have often said, 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.*