Plating & Surface Finishing Retrospective

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Needs specifications

Q: We are in need of some finishing specifications for our medical products. We're going to prepare source-control documents for our engineers. Our fields of interest include decorative precious and non-precious-metal plating, engineering finishes and anodizing.

A: The U.S. Department of Defense will supply you with their standards if you write to: Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120.[1] The material available is quite extensive and very specific with regard to technical information. Also, the "Index of Federal Specifications and Standards" is available from the Supt. of Documents, U.S. Govt. Printing Office, Washington, DC 20402, or start at http://apps.fss.gsa.gov/pub/fedspecs/.

Another good source of information is the American Society for Testing and Materials (ASTM). Their specifications can be secured by writing ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA, 19428-2959 (www.astm.org). Large companies (*e.g.*, those in the automotive industry) usually have their own specifications for what they manufacture. However, for your products, you might find useful information .in "Finishing Specifications and Standards for the Hardware Industry." That is published by the American National Standards Institute, Inc. (ANSI), 1819 L Street, NW, 6th Floor, Washington, DC 20036 (www.ansi.org).

Most importantly, you must first decide what is required of your products and what would be the best basis material for manufacture, before you select the finish.

[1] *Naval Publications and Forms Center announced (March 1990) they are no longer handling DoD Specs & Standards. Future mail requests should be sent to: Standardization Document Order Desk, Bldg. 4, Sec. D, 700 Robbins Ave., Philadelphia, PA 19111-5094.*

Overseas corrosion

Q: We manufacture office furniture with chromium-plated parts finished by a local jobshop. Much of the furniture is shipped overseas and many shipments of the chromium-plated products have arrived with corrosion. We attribute this problem to the salt atmosphere of the ocean. What do you recommend?

A: If the plating process is fixed, the application of a clear lacquer or wax should help to give the finish external protection. But the best way is to use the proper electrodeposits to begin with. Since even very thick deposits of bright nickel provide rather poor corrosion protection, semibright nickel should be substituted for 50 to 75% of the total nickel plated. The semibright, sulfur-free deposit provides leveling and a very corrosion-resistant deposit. The bright nickel gives the required brightness, and together with a suitable (microcracked) chromium plate, should give good protection, providing a satisfactory thickness is used. It's not uncommon in the exterior automotive market to use a three-nickel system, where the third layer provides microporosity for the chromium deposited over it.

Lou Gianelos of The Harshaw Chemical Co., adds the following:

"With any reasonable thickness of nickel and chromium deposited from well-run processes, there should not be any type of corrosion, even after the usual time span of an ocean shipment. The most.likely cause of failure is either very poor packaging, allowing direct contact with seawater, or poorly rinsed parts, introducing a corrosive environment within the package."

Classes of anodizing

Q: What is the difference in life expectancy between a Class I anodized product and a Class II type? Specifically, we are anodizing aluminum handrails and were wondering how the lifetime of the product would vary, under the same conditions, using Class I vs. Class II finishes.

A: Class I anodizing simply denotes a non-dyed surface, whereas Class II specifies dyeing. The longevity of either finish would depend on the thickness and method of seal-

ing employed. The type of dye, the time of immersion, the temperature, the pH and the concentration of the solution also play major roles with any dyeing application. Military specification MIL-A-8625, "Anodic Coatings for Aluminum and Aluminum Alloys," spells out the requirements and will give you an idea of what to expect.

Cracking of nickel

Q: One of the parts we manufacture is a tubular shaft of nickel-steel alloy (MAR-247). We had a jobshop plate hard nickel on one end of the shaft to correct the dimension of the part. After plating, another jobshop ground the part to tolerance. At this point, we experienced excessive cracking of the deposit. Was it the plating or the grinding that caused the problem? Would a low-stress nickel help?

A: It appears the conditions used for nickel plating were not adjusted to obtain a ductile deposit. Good ductility is more important than low stress. An excellent report on the properties of electrodeposited nickel, for your information, was published in *Plating* (**39**, 865, 927 and 933) back in 1952. The report was written by A. Brenner, V. Zentner and C. W. Jennings. A Watts-type bath at 135 to 140°F (51 to 60°C) with a pH of 2.5 to 3.0 and free of impurities yields nickel with high ductility. Sulfamate, chloride and other solutions produce nickel with less ductility. Even so the ductility of nickel deposited in chloride or sulfamate baths is high enough to prevent cracking during grinding if (1) the nickel is ground slowly with good lubrication and (2) impurities are kept out of the nickel solution.

A nearly stress-free nickel deposit can be obtained in the sulfamate bath or in a Watts-type solution by adding a stress reducer, but this will increase hardness and reduce ductility. A stress reducer normally should not be used for nickel that must be ground after plating. If it is used, it should be controlled at a low level.

Restoring anodes

Q: I found some old anodes used for plating chromium. They are fluted and it is very hard to scrape the rust off. What do you suggest?

A: The lead chromate that has formed on the anodes is soluble in a solution containing 1.0 lb/gal (119.8 g/L) of caustic soda (sodium hydroxide) and 1.0 lb/gal of Rochelle salts (sodium potassium tartrate). When made up fresh, the temperature of the bath will rise as the caustic soda dissolves, so use care and makes additions slowly.

Filtration problem?

Q: I've been having a lot of trouble with breakdown, or "plating out," of our electroless nickel solution. We run the line 16 hours/day. The plating department is located in the middle of the machine shop, and I was wondering if dust and oil in the air might be a problem, even though the plating area is sealed and the air going in is filtered.

A: Dust and dirt could be a tremendous problem for electroless baths. Each tiny particle could provide a nucleus for electroless nickel deposition. Bubbles of hydrogen gas, a byproduct of electroless deposition, could attach to such particles and promote their floating in solution. For these reasons, filtration is very important. Cleaning the filter as needed is also a must.

You do not mention one important factor: whether you use a "homebrew" or proprietary solution. Most proprietary baths contain controlled amounts of stabilizing agents, which slow up the plating speed but inhibit decomposition. Heating the electroless bath also can be a problem. Localized heating, like using an electric heater in a corner with no agitation, can be a cause of plating out. A double-boiler-type arrangement seems to be the best way to heat these baths.

Heat exchangers and other part surfaces exposed to the electroless nickel solution should be examined for evidence of plating out. If nickel has been deposited on any of these, they should be cleaned (with nitric acid) and thoroughly rinsed before electroless solution is returned to the tank. Chemical and thermal controls then should be used to prevent reoccurrence.

Nitric acid solution should also be used to dissolve the deposits on tanks. If plastic tanks are used, the smoother the plastic surface the better. If stainless steel, the tank surface should be passivated before reuse. Anodic protection of stainless-steel tanks also could be considered.

Spotting on satin finish

Q: We've been hand brushing nickel parts to give them a satin appearance, then chromium plating them. The nickel often water spots and it shows on the product. What should we do?

A: For one thing, you might try using hot deionized water as a final rinse. With care in handling, this should eliminate the spots. You could also try a water-shedding material as a final rinse. More importantly, however, there are satin-nickel plating processes on the market that eliminate hand brushing if the correct surface preparation is employed before electrodeposition. Make a phone call to your local supplier for details.

Plating on tantalum

Q: How can I put an electroless deposit of a solderable metal on pure tantalum wire and small parts?

A: After talking to Jack Dini, Lawrence Livermore National Labs., Livermore, CA, I feel free to say that plating on tantalum is a real "bear!" However, one way to complete your task would be to cathodic etch in a solution of 2.5 vol% hydrofluoric acid and 2.5 vol% hydrochloric acid in methanol at 40 to 50°C (104 to 122°F) and about 18 A/ft^2 (2.0 A/dm^2) for 20 to 30 min, and follow with nickel plating. Some success has been reported using that etch anodically, but a cathodic treatment usually results in a more uniform surface. This results in a mechanical etch.

After plating, the parts should be heated in a vacuum to 500 to 650°C (932 to 1202°F). This is really the key to good adhesion. For your information, I am sending you a copy of "Electrodeposition of Nickel on Tantalum," (*Trans. IMF*, **48**, 5 (1970) by A.E. Yaniw and F. Lasfewska.

Some success also has been reported using vapor blasting of the tantalum followed by nickel plating and vacuum baking. Again, the bake is a must for good adhesion. Mr. Dini also suggests you look into ion plating as an alternative.

Tough-to-plate plastic

Q: We've received a request to electroless nickel plate all surfaces of a polyphenylene sulfide (PPS) injection-molded cap. What preplate preparation would be required and what plating sequence would be appropriate?

A: After some discussion with several specialists, I think it's safe to say there is no commercial process for plating PPS, a strong material that has high heat resistance. Its sulfur content could be

the problem, according to representatives of MacDermid, Inc., Waterbury, CT.

As with every plating-on-plastic process, the etch is the key. If you could at least wet the surface of the plastic, the rest of the process (activation, acceleration and electrode position) might be easy. I expect the surface of the PPS would be excessively roughened using a regular etchant for plastics. The etch is the key to good adhesion, and, in this case, I don't know of one.

Poor electroless adhesion

Q: I have a problem in that I'm not getting good adhesion plating electroless nickel on leaded steel alloy 1214 (contains 0.15% maximum carbon, 0.85 to 1.15% manganese, 0.04 to 0.09% phosphorus, 0.15 to 0.35% lead, and 0.26 to 0.35% sulfur). The cycle we used is (1) vapor degrease; (2) soak clean; (3) rinse; (4) electrolytic periodic-reverse clean in a proprietary solution with 1.0 oz. of cyanide; (5) rinse; (6) acid dip in 25% fluoboric acid; (7) rinse and (8) electroless nickel plate. What are we doing wrong?

A: In general, I see nothing seriously wrong with the preparation cycle. Don Baudrand, CEF, of the Allied-Kelite Division of Witco Chemical Corp., Des Plaines, IL, agrees, but adds the following:

"All solutions must be clean and especially free of copper and other metallic contaminants that could lead to immersion deposits. The alkaline descaler is usually a reasonable step. However, perhaps the periodic-reverse current is part of the problem. If you remove the work after a cathodic cycle, poorly adherent lead may deposit. The anodic cycle may leave the lead oxidized to the extent that the fluoboric acid cannot remove all the oxide.

"The following cycle is suggested: alkaline soak clean; rinse; cathodic electroclean; rinse; alkaline descale (soak only); rinse; fluoboric acid dip (very clean); rinse and electroless nickel plate."

Mr. Baudrand concludes you might use, as an alternative, a sulfamate nickel strike before electroless nickel plating because it can be very helpful in promoting good adhesion. It can be made up as follows: 6 to 10 oz/gal of nickel sulfamate as nickel metal, 4.0 oz/gal of boric acid and 4.0 oz/gal of sulfamic acid. Use a pH of 1.5 to 2.0 and a cathode current density of 20 to 100 A/ft^2 at room temperature for 40 to 90 sec (cathodic only).

The edited preceding article is based on material compiled by Mr. 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.