Finishers' Think Tank



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Nickel Plating: Putting it Together

Last month we reviewed critical nickel plating factors, such as: covering power, throwing power, plating thickness versus current density and time, and deposit thickness distribution. Now, in a sense, let us put it all together this month. Our focus will be on substrates that are nickel plated and types of nickel baths. In every aspect of this review, bear in mind the expense associated with nickel anodes and plating salts. Be sure to know the facts and apply them properly. Otherwise, any rejects could quite readily wipe out any profit anticipated with the job or project.

The prices for metal anodes and metal salts have increased substantially during the past decade. It is doubtful that we will again acknowledge nickel anodes at below \$3/lb. Referring to plating baths, they each provide specific benefits that regardless of cost have become necessary for various on-demand finishes. These include: decorative, functional, wear resistance and corrosion protection. Nickel encompasses many plating systems, each of which is very important to many aspects of metal finishing. Even though the prices of nickel anodes and related salts have increased sharply, the importance of nickel in plated finishes is still of great significance. More importantly, these finishes are still in demand. Let us review some pertinent facts regarding practical nickel plating. The information should balance or support the need for nickel plating, even if the finishing cost has increased.

For industrial purposes, almost any metal can be nickel plated. The inherent properties of nickel can be combined with the unique properties of other metals. Some examples of metals commonly plated with nickel are: steel (high strength), brass (easily bent and formed), aluminum (impact extrusion) and die castings (design flexibility). Plastics, which have been treated for conductivity, are also commonly nickel plated. Nickel can be directly plated over several metals. This is commonly performed directly over steel, brass and copper. In some cycles, appropriate immersion treatments or preplate deposits precede nickel. This is especially prevalent when plating a copper strike and copper plate over zinc parts before nickel. Aluminum, because of its unique electropositive nature, must first be conditioned by immersion zincating, before plating either by electrolytic or electroless nickel.

The application of a suitable nickel deposit can be of significant benefit to the parts, ultimate quality of the finish, and meet or exceed specifications. These advantages can actually reduce related manufacturing costs, improve marketability and increase production throughput.

Depending on the finishing requirements or service life of parts, nickel provides several advantages: good electrical conductivity, a low coefficient of thermal expansion, magnetic influence, variations of internal stress, tensile strength, ductility and good heat conduction. Nickel can be plated as a soft deposit (not far off from copper) or almost as hard as chromium. In fact, nickel can be plated to almost any desired deposit hardness in between this wide range. Aesthetically, nickel can be plated in decorative applications to achieve a wide range of brightness and leveling, still retaining sufficient deposit ductility.

Finished parts can be assembled or mechanically formed into selected commercial products. Along with these benefits, duplex nickel forms an excellent corrosion barrier, especially in the plating of exterior automotive parts. Nickel deposits form an important barrier, to prevent the migration of zinc on tin plated parts. In engineered finishes, nickel decreases contact resistance and friction. Solderability and brazing are improved. Resistance to galling and wear are also enhanced. Plating with nickel can salvage worn or mismachined parts. Almost all nickel deposits can be machined. Incorporating nickel into the deposit, in place of solid metal, reduces some manufacturing costs.

As mentioned previously, nickel can

be plated to provide rapid leveling, filling voids and eliminating microscopic "peaks and valleys," while plating a relatively thin deposit. For this reason the basis metal may not have to be mechanically polished, buffed or mass finished. If this is acceptable, cost savings to prepare the surface for plating may be realized. Nickel can be plated from a variety of specific bath formulations (usually Watts and sulfamate types) to develop deposits that range from flat to dull to semi-bright to bright. This affords the finisher the capability to provide nickel deposits that meet engineering requirements, corrosion protection and aesthetic preferences. The Woods strike effectively activates stainless steel for subsequent nickel plating. Duplex nickel, as mentioned earlier, promotes exceptional corrosion protection, by plating a balanced ratio of semi-bright (especially formulated for this purpose) and bright nickels. The Step Test is a specific quality control procedure for this application. In recent years Watts baths containing modified organic additives, have successfully replaced cyanide copper strikes over zincated aluminum.

Decorative chromium, either trivalent or hexavalent, continues to be a specified finish over nickel. The chromium topcoat enhances overall appearance and maintains an excellent scratch-resistant, hard finish. Although we commonly refer to it as the bright chromium finish, it is primarily nickel (usually bright) with a thin chromium flash. The combination of these deposits gives the assembled parts a preferred pleasing appearance, along with exceptional corrosion and wear resistance. For several decades, the combination of bright nickel and flash chromium has been the best selection for plating parts subject to outdoor exposure. That is, until the advent of alloy zinc technology, this has been an alternative for functional applications.

Nickel can be plated as a very ductile deposit. In combination with a proper basis metal conditioning and any preplate deposits, the finished items can be stamped, drawn or formed in a variety of shapes. This is very common in the strip plating of continuous coils that will be used in the manufacture of different types of consumer and industrial goods. In this application, the organic brightener and leveling additives may be kept at lower levels, to achieve the required ductility. The final aesthetic appearance of nickel occurs in a short buffing cycle before optional chromium plating. Parts that require exceptional brightness and leveling may be stamped before the plating cycle.

Nickel can be plated to meet any thickness requirement. Industrial based coatings usually require 0.005 to 0.020 inch. For decorative purposes, nickel deposits may range from 0.0003 to 0.001 inch (or up to one mil). As indicated by the application ranges, there is a minimum that should be plated to meet the intended use of finished parts. As a guide, one pound of plated nickel is required for every 22 ft² of intended parts coverage. Depending on the nickel bath and plating parameters, the deposit tensile strength can range from 50 to 220 thousand lb/in.². Nickel anodes, as we are aware, are quite expensive. Be certain that the certificate of analysis confirms the quality. Anything less than sufficient purity material could result in severe contamination of the nickel bath. A typical assay is: nickel (99.950%), cobalt (0.03%), copper (0.005%), carbon (0.001%), iron (0.001%) and sulfur (0.01%). Anodes are provided in various shapes, including: spears, buttons, rounds (sulfur-containing S and sulfur-free R), pellets and chunks.

There are many applications for plating nickel, using several types of process baths. The demand for nickel plating continues to be relatively strong. Although the prices for nickel anodes and salts have markedly risen, the consumer market for plated finishes keeps this plating service very active. Bright nickel / chromium finishes are popular in the sporty automotive / motorcycle market. The decorative plumbing industry is very positive on nickel / chromium and brushed nickel finishes. Clothing and apparel manufacturers now feature nickel finishes (e.g., oxidized, brushed, under flash brass or gold). Nickel anodes and salts may not be cheap (compared to a few years ago), but decorative and industrial finishes for nickel are still in strong demand. Put it together and maintain an optimum nickel plating operation. P&SF

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Test Your Plating I.Q. #459 By Dr. James H. Lindsay

Platinum Group Metals

- 1. Name the platinum group metals.
- 2. What two properties of the platinum group metals are the primary reasons for their applications?
- 3. All six platinum group metals can be readily electroplated from aqueous solutions. True or false?
- 4. Most platinum group metals are used only when no other metal will do. Why??
- 5. Which platinum group metal is used as a partial substitute for gold in electronic applications?

Answers on page 53.

* As of March 29, 2010.