Smooth Finish

SATIN NICKEL SCORES IN AUTO AND OTHER APPLICATIONS

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A satin nickel finish is any nickel plate that has an even, non-reflective texture. The texture can be produced through mechanical means such as shot peening or abrasive polishing. Chemically altering the nickel plating bath with very small (micron-size) particles is a second method. The chemical approach is most widely used for high-production purposes.

The first U.S. patent title containing the term "satin nickel" dates to 1964. A key to producing the finish was co-deposition of inorganic particles with nickel. These particles, including kaolin clay, mica and glass, had to be small and evenly dispersed in the bath and into the nickel plate to produce an even, reproducible textured finish.

By the early 1970s, satin nickel plating had found acceptance as an under-layer deposited before chromium plating. End uses for this type of coating include camera bodies, hardware and automotive interior trim. Satin nickel is particularly useful for interior car trim, because the driver will not be distracted by the typical mirror-bright nickel finish. Its fingerprint resistance also affords greater durability as an interior finish.

Around the same time, researchers developed a new method of producing the satin finish. New chemistries used wetting agents to produce the insoluble particles that result in the satin, rather than bright, nickel finish. Wetting agents of choice had a low-temperature "cloud point"—that is, they precipitated as the bath reached a critical elevated temperature. Satin nickel processes based on this mechanism produced a superior finish that was more reproducible and gave a more evenly textured appearance on plated parts than the particle-based process.

Use of wetting agents required special process equipment. Although not commonly used in conventional nickel plating operations, satin nickel processes using wetting agents required a tank with a weir filtration system. The weir separated particles of coagulated wetting agent (or other particles) that grew too large to produce a satin finish. The larger particles floated to the bath surface and were selectively removed by the weir. The separated wetting agent could then be re-dissolved at temperatures lower than the cloud point and reintroduced to the bath.

Insoluble particles were permanently captured on the filter, and constituents of those particles were replenished to the bath by specific chemical additions.

Fast-forward 30 years or so. Recently, a resurgence in satin nickel plating has occurred. Automotive designers in particular have given renewed attention to this finish for interior and some exterior trim applications. Satin nickels also continue to provide modern, fingerprint-resistant coatings for many hand-held electronic packages, plumbing fixtures and door/cabinet hardware pieces.

Chromium, the traditional final coat for a satin nickel finish, may now be inhibiting its continued expansion. Increasing regulation based on chrome's hazardous and environmentally toxic properties limit its continued use. Chromium alternatives, as well as alternative color finishes, do have the potential to replace chrome for many decorative applications. Combining the satin nickel finish with chrome alternatives can potentially propel the process into more applications.

Products plated with satin nickel are quite common today; most of us see them and use them every day. The majority can be classified into three broad end use categories: automotive, plumbing and hardware.

Specific automotive applications include manufacturer emblems, interior decorative trim items, and radio and control knobs. In plumbing applications, satin nickel-plated parts are used in sink and tub faucets, shower heads and drain plugs and strainers. Satin nickel-plated hardware components run the gamut from towel bars and racks, soap trays, curtain poles and shower arms to stair rods, switch plates, door knobs and locks, hinges and light fixtures.

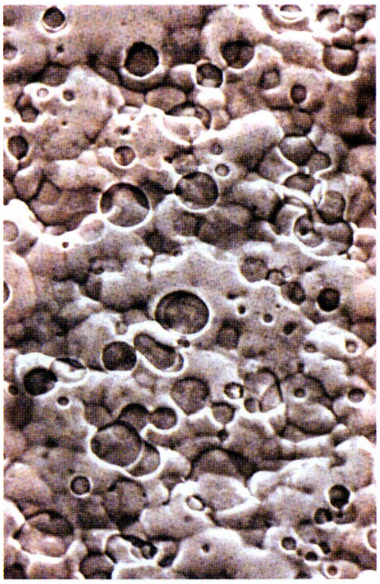
THE PROCESS

These days, most satin nickel plating is done on molded plastic parts. The process can use a variety of preparation methods prior to the introduction into the satin nickel chemistry. A typical preparation and plating sequence is outlined here.

The first step is a cleaner, which is used to remove light organics such as fingerprints, mold releases, dirt and so on. Typically, cleaners consist of mild alkaline solutions. Some applications that require more aggressive cleaning use a chromic acid solution ensuring complete wetting of parts prior to etching.

Cleaning is followed by a pre-dip used mainly to swell the plastic. This allows the following chemical etchant to uniformly attack the resin. Pre-dips are generally solvents, and usually different solvents are used for different substrate resins.

Etchants are oxidizing solutions that eat away the plastic surface at a controlled rate. The etchant increases the substrate surface area by creating microscopic cavities that act as attachment sites for the metal being plated and improving plating adhesion. Typical etchant chemistries include chrome-sulfuric (chromium trioxide and sulfuric acid) or all chrome (chromium trioxide). Dwell times and temperatures are changed to achieve the best adhesion for specific substrate materials. Etchant performance decreases as the concentration of trivalent chromium (Cr^{3+}) ions builds up in the bath. Frequent additions of hexavalent chromium (Cr^{6+}) increase bath life.



Scanning electron micrograph at 1,000× magnification shows the microscopic surface irregularities that produce the lustrous, matte appearance of satin nickel.

Etched parts require neutralization. Even when excellent rinsing conditions exist, Cr^{6+} can be trapped in etch cavities or other tight spaces. This leads to a defect known as "skip plate." Sodium bisulfite is a commonly used neutralizer. The bath is changed frequently due to its important function and the low cost involved.

The next step is pre-activation. Pre-activators enhance activator absorption and render unplateable resin surfaces plateable by filming the surface and changing the static charge. The choice of pre-activator, dwell time, and temperature depends on the type of plastic being plated.

Activators, sometimes referred to as catalysts, usually work by depositing a seed layer of a precious metal—palladium, platinum, or gold—that provides a surface for deposition of an upcoming electroless copper or nickel layer. Activators can contain tin chloride, palladium, and chloride ion. Activity and stability of the colloidal particles depend on the chloride and tin ion concentration. Platers maintain the activator bath based on chemical analysis and precious metal concentration.

Next, an accelerator removes excess tin from the activated part while leaving embedded precious metal sites ready for the deposition of an electroless copper or nickel layer. Excess tin must be removed from the surface because it interferes with the next step: an electroless copper or nickel pre-plate.

The pre-plate bath contains the metal (copper or nickel), a reducer, a metal complexor, a stabilizer, and a buffer system. Chemical reduction of the palladium metal begins when the palladium-bearing surface contacts this bath and continues through autocatalysis until a film thick enough to provide complete coverage is achieved.

Pre-plating renders parts conductive to prepare them for a strike electroplating step using copper or Watts nickel. The purpose of the strike is to build up sufficient copper thickness (0.0001 inch) to prevent loss of electrical contact to the rack.

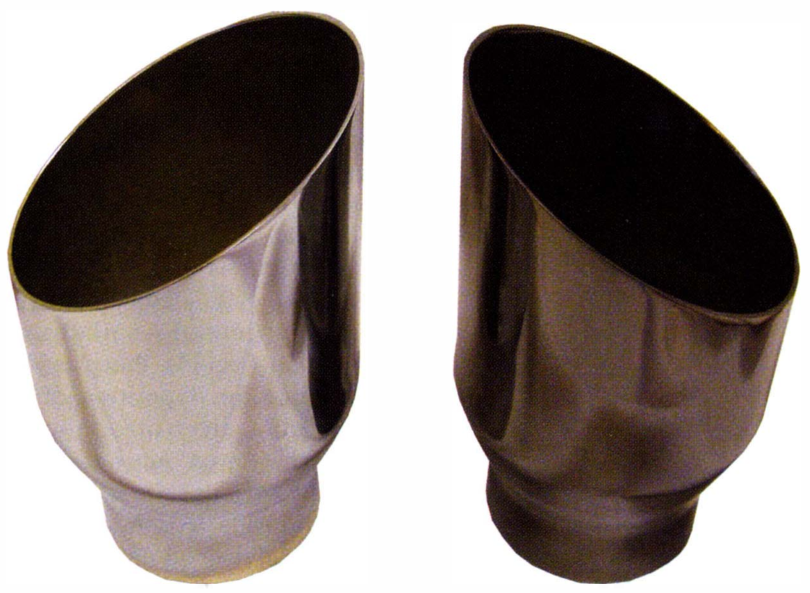
Next, a bright acid copper bath builds a thickness of about 0.0005 to 0.001 inch of bright copper. This ductile copper prevents blisters and cracks and levels any small cosmetic defects to prepare the surface for subsequent satin nickel plating.

The satin nickel process deposits a uniform, fine-crystalline nickel deposit regardless of base material. Platers can achieve the required degree of dullness by adjusting additives. Deposit thickness ranges from about 10-25 μm depending on the application.

Finally, a layer of electrolytic chromium is plated over the satin nickel to improve the nickel's durability. This layer is often 5-10 μinch thick, and both hexavalent and trivalent chromium baths are used.

CHROME EXPOSURE, HEALTH AND SAFETY

Chrome, the topcoat used in most satin nickel applications, is associated with environmental and health concerns. Hexavalent chromium (Cr^{+6}) exposure may occur in the chromium plating operation. The main exposure concern is the chromic acid mist that is formed when chromic acid solutions are electrolyzed. The amount of chromic acid mist generated depends on several variables such as part loading, time, current density and concentration. Potential adverse health effects associated with Cr^{+6} exposures include lung cancer, asthma, and damage to the nasal epithelia and skin. On February 28, 2006, the Occupational Safety and Health Administration (OSHA) published the final Hexavalent Chrome Standard. The three separate standards covering occupational exposures to Cr^{+6} included general industry (1910.1026), shipyards (1915.1026), and construction (1926.1126). The Permissible Exposure Limit (PEL) of 5μg/m^3 was established in all three versions. OSHA requires employers to use monitoring and analytical methods to measure airborne levels of Cr^{+6}.



Tin-cobalt alloy topcoats eliminate chrome and can be formulated to provide appearances from bright to dark, as these muffler components illustrate.

ALTERNATIVE TOPCOATS

Decorative chrome gives a hard scratch- and stain-resistant surface, and parts finished with chrome set the standard for excellent salt-spray and environmental corrosion resistance. The drawbacks of hexavalent chromium for the plater are significant, however. As the industry becomes sensitized to the potential health and environmental concerns associated with chromium, alternatives have surfaced into the marketplace that provide equivalent protection.

Replacements do exist. Trivalent chrome, tin-nickel and tin-cobalt are the three that currently are commercially available. Of the three, tin-cobalt seems to have the most operational benefits. These include reduced regulation and waste treatment concerns, elimination of worker exposure to chrome, lower electricity costs, and improved throwing power.

Black nickel with a topcoat offers benefits similar to those of satin nickel, and is being evaluated for use in new automotive interior applications.

These benefits are achieved with virtually no sacrifice in quality. The finish color is almost indistinguishable from chrome, and tin-cobalt reproduces the corrosion protection afforded by chrome.

Cost is a big consideration for platers. Margins are thin, particularly when you're supplying to the automotive industry. Direct cost comparisons will undoubtedly show chrome as the more economical finish. Indirect costs, such as waste treatment, building and land contamination concerns, strong oxidizer fire concerns and personnel health and safety, go a long way toward balancing the economic scales.

Satin nickel may also require other topcoats for appearance or for protection in specific applications that involve exposure to water and humid environments. Besides chromium, topcoat materials include brass, silver, gold, and bronze. An organic topcoat is also commonly used to improve finish durability. Relatively new topcoat materials that can eliminate use of chromium while providing a decorative appearance and durability include tin/cobalt and tin/nickel alloy electroplate.

Expanded decorative options are made possible by mixing satin nickel finishes with contrasting coatings. For years, companies have put gold plating on top of, or next to, satin nickel for dramatic effect. Using satin and bright nickel side by side also provides visual appeal. Newer black nickel finishes, which can stand alone or be contrasted with satin nickel, are now in demand. These black nickels, usually a combination of nickel-zinc or nickel-zinc-cobalt, offer sleek, dark, non-reflective appearances.

The automotive industry is investigating black nickel-plated interior trim for the next generation of interior styles. Black nickel with a topcoat potentially offers the same types of benefits presently associated with satin nickel finishes, such as glare-free surfaces and high scratch and fingerprint resistance. Black nickel also offers the novelty of a new interior appearance.

SATIN PLUSES AND MINUSES

Application of satin nickel has grown significantly due to the variety of appealing, uniform appearances the process can produce on plastic or metal surfaces. The latest chemistries are relatively easy to control and operate, and allow users to consistently reproduce the desired degree of satin appearance by adjusting additive targets and ranges. Appearance can also completely be modified by changing the metallic topcoat. The resulting surface has excellent wear and corrosion resistance, and, due to its non-reflective matte finish, is not susceptible to fingerprinting. Matte finishes are also highly resistant to scratching and have non-slip properties.

As discussed earlier, satin nickel applications require additional process equipment that provides both continuous filtration and periodic transfers into a storage tank through additional filtration. Process parameters typically must be controlled more tightly than a bright nickel system. Early satin nickel systems experienced issues with reproducibility, but newer chemistries have overcome that issue and can now consistently reproduce the desired appearance.

LEARN MORE

Saving Valuable Bath Chemicals

Regardless of the type of plating, wringing the most life out of the bath is critical to maintaining thin margins. To find out how one company used automated feeders to help increase bath life and decrease chemical use, read *Saving Valuable Bath Chemicals*.

Find the link to this article online at *www.pfonline.com/articles/060701.html*

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