Hands-on Management



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U sed around the world, mechanical plating has been a viable finishing method for more than 45 years. Mechanical plating aliases include mechanical galvanizing, peen plating and impact plating.

Base metals that can be finished consist of ferrous alloys (including stainless steels), copper alloys, lead and some types of castings. As a process, mechanical plating can apply a ductile, corrosion-resistant coating of zinc, cadmium, tin, copper or aluminum. Coating metals can be laid down as individual layers or as a mixture of two or more co-deposited metals. Mechanical plating can offer another option for achieving sound engineering, good economics and reduced pollution as part of the surface finishing arsenal.

Mechanical plating is achieved at room temperature with a mixture of the parts, aqueous chemistry, powdered metals and glass beads. While the mixture tumbles, the glass beads provide the required peening energy to pound the metal particles onto the surface of the parts. This results in a compact, cohesive metallic coating produced by the "cold welding" of fine metallic powders to the surface of the parts.

"Recent improvements in deposit quality, cost effectiveness and ease of application have induced many finishing engineers to investigate and adopt mechanical plating for certain applications.

Special advantages of the mechanical plating and galvanizing process are that it:

• Greatly reduces part susceptibility to hydrogen embrittlement.

Mechanical Plating

- Can be used to deposit a wide variety of metals in a broad range of coating thicknesses.
- Consumes comparatively low amounts of energy.
- Does not require the use of toxic chemicals.
- Simplifies waste treatment.
- Does not require baking in most cases.
- Provides greater uniformity of coatings (when used for galvaniz-ing)"¹

Hydrogen Embrittlement Hydrogen embrittlement prevention was one of the major motivations for the creation and continued use of mechanical plating. As the hardness of ferrous alloys increases, so does the concern in electroplating and other coating processes for the embrittling effects of hydrogen absorbed into the part. Catastrophic part failures can happen because the hydrogen migrates through the steel base metal and gathers in areas of high stress. This causes an increase of internal pressures that lower the steel's ability to resist applied stresses in real-world conditions. "The current used in electroplating acts to enhance the possibility of hydrogen embrittlement-both because most electroplating generates hydrogen at the cathode and because the negative charge acts to pull hydrogen into the part The risk increases for parts that have high hardness from cold working or heat treating, especially those made of high-carbon steels."1

A significant source of hydrogen gas, with the electroplating process, is the reaction between the acids and metals in the plating solution. Other environments that can contribute to embrittlement are heat-treating furnaces, precleaning solutions, strippers and pickling baths. The mechanical process uses no electrical current to produce the coating, unlike electroplating, which does pass current through the plating solution. The mechanical plating process is capable of supplying the same mechanical and galvanic properties as electroplating, but with an extremely low risk of hydrogen embrittlement. Any hydrogen generated during the mechanical process can escape through a more porous grain structure than the one produced by electroplating. Because of the permeable metallic composition, the hydrogen gas is more likely to vent from the deposit than diffuse into the base metal.

Mechanical Plating Equipment Variable speed tumbling barrels are made using an abrasion-resistant coating on mild or stainless steel. The barrel needs to be coated because the entire process takes place at a low (1 to 2) pH. Tumbling barrels can have a wide range of capacities (1.5 to 50 ft³), with the largest barrels holding more than 2,000 pounds of work.

Kinetic energy is generated by the tumbling of parts and glass beads (a mixture of different bead sizes) and serves to cold-weld the sphericalshaped metal particles to the substrate. "The ratio of glass beads to parts is about 1.5:1 by weight, but varies depending on the part mass and geometry and on the coating thickness required (greater thicknesses sometimes require a higher ratio of beads to parts and use larger beads). The barrels rotate at a surface speed of 43 to 75 m/min (140 to 250 ft/min) and at a tilt angle of about 30 degrees from horizontal The glass beads are constantly reused and recycled through a glass bead recovery and pumping system, which is part of the standard mechanical plating equipment package."¹

Process Steps & Capabilities After removal of heavy oil or scale (if needed, this is performed outside of the barrel), the parts are placed in the barrel, where all of the subsequent plating steps are performed. The preclean, surface preparation and metal coating normally happen without rinsing or stopping the rotation of the barrel.

A gentle cleaning is the first process step. The next step is a series of chemical and metal additions designed to mildly acid-clean and activate the base metal. Copper powder is added to apply a thin, uniform "strike-like" coverage. The copper provides a clean, receptive surface for succeeding finishes. The next step adds chemistry (called

"accelerator" or "promoter" agents), producing a chemical environment that directs the rate of deposition and the bonding of the plating metals. To reach commercial plating thickness of 0.0002 to 0.0005 in. requires two or three additions of metal. Greater thickness (3 mils) used for galvanizing can require eight or more metal additions. The heavy galvanized coatings can be applied in approximately the same time as thinner commercial coatings, because thickness is somewhat independent of cycle time and is mostly controlled by the plating metal additions. Approximately 92 percent of the plating metal added is actually placed onto the parts.

Post Treatments

The chromating conversion treatments are similar (clear, blue, yellow, olive drab and black can be applied) to the ones used in electroplating. Chromates from the mechanical process are slightly different in color, luster and iridescence than those realized from electroplating. Extensive salt spray testing has established that the corrosion resistance of mechanical galvanized parts is comparable to that of hot-dip galvanized parts. Heavy coatings of zincaluminum can reach 5,000 hours to red rust.

Conclusions

Mechanical plating has a niche market for smaller parts with Rockwell hardness 42C or higher and coldheaded parts, or any part for which structural integrity is highly critical. As the automation and quality factors continue to improve, however, mechanical plating will challenge electroplating's market share for parts needing a thickness equal to or greater than 0.5 mils.

References

- A. Satow, "Mechanical Plating," ASM International Handbook, Vol. 5, Surface Engineering (Dec. 1994).
- 2. A. Brooks, "Mechanical Plating Update," *Metal Finishing Guidebook and Directory*, Vol. 52 (1984).
- 3. L. Coch, "Plating Fasteners: Avoiding Embrittlement," *Prod*ucts Finishing (1987).

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