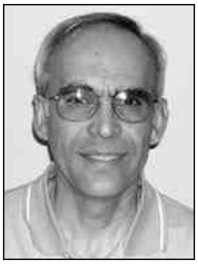

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Mechanical Plating: A Beneficial Process to Consider

Mechanical plating is essentially a tumbling process, by which metallic dusts are deposited on to a metal substrate. The terms cold-welded and bonded are used to describe the mechanism. Normally, parts for conventional barrel plating can also be mechanically plated. Deposited metals may include zinc, copper, tin, precious metals (*e.g.*, gold and silver), aluminum and cadmium. Coated substrates include ferrous, castings, copper and stainless steel. Each step in the cycle differs in varying degrees compared to conventional surface preparation, plating and post-finishing. The biggest and most critical difference is using one single process vessel for most mechanical plating cycles. The vessel is similar to an oblique tumbling barrel, and is the primary process "tank".

A typical cycle

1. ***Parts cleaning.*** This step is usually accomplished in bulk, off-line. Traditional hot alkaline cleaning, mechanical washer or solvent cleaning are employed as to effectiveness, availability, economic feasibility, etc. Alternatively, the parts can be tumble-cleaned in the mechanical plating barrel. Satisfactory cleaning proceeds to the next step.

2. ***Surface conditioning I.*** This critical step utilizes the action of a special chemical additive and media. The balanced chemical and mechanical action develops a part surface free of rust and scales. The chemical additive consists of surfactants, inhibitors and inorganic acids. Media is a glass bead type, primarily composed of silica, carbonate and limestone. It offers a relatively long service life, contributing very little friction to the operating process.

3. ***Surface conditioning II.*** This step completes the critical treatment, by depositing a thin, tightly adherent copper film. Deposition of copper promotes a uniform surface metal profile. It also forms a mechanical barrier between the basis metal and hydrogen. (Time, 2 - 7 min)

4. ***Promoter or accelerator.*** This solution consists of a proprietary additive. It standardizes conditions for deposition of the metal of choice. The promoter controls agglomeration of the yet-to-be-deposited metal powder and maintains surface cleanliness. (Time, 2 - 3 min)

5. ***Flash coat.*** This is the first addition of metal powder to be deposited. Typically, the powder is zinc, as zinc is the most common mechanically-deposited metal. The flash coat rapidly covers the copper layer with active sites of zinc, readily accepting additional layers of this metal deposit. (Time, 4 - 7 min)

6. ***Deposition build-up.*** Based on the thickness requirement, sufficient additions of metal powder are added. Usually, 2 - 4 min are allowed between additions. This promotes uniformity of metal thickness on parts, with accompanying deposit smoothness across the entire barrel load.

7. ***Rinse.***

8. ***Retrieve.*** Parts are separated from the media and collected for post-plate finishing.

9. ***Post-finishing.*** Chromate, sealer, lacquer, waxes.

10. ***Dry.***

The operating cycle uses a fresh make-up solution for each step, eliminating carry over or re-use of contaminated solution. Segregating parts in the same barrel eliminates their loss, because nothing is transferred until the cycle is complete. The solution for steps 2 thru 6 is preferred at 65 - 85°F (18 - 29°C). Some process development is required to determine the optimum conditions for steps 2 thru 6. Metal powder requirements for deposit thickness are measured on the basis of metal powder weight / deposit thickness / surface area of parts. Important considerations are parts loading, ratio of parts to impact media, volume of water, barrel rotation (speed and angle) and desired deposit thickness. The majority of finishing cycles offer approximate cycle parameters, requiring minimal fine-tuning. Because the solutions are acidic, rubber or plastic-lined stainless steel barrels are preferred. Barrels vary greatly in handling volume, from one to 50 ft^3. Glass impact media size and the ratio of parts to media is very critical. Requirements for media include cushioning the load, preventing scratching and abrasion, and reaching into tight recesses and geometric areas. Optimum conditions permit the media to transfer mechanical energy efficiently from the rotating barrel to peen metal dust particles on the substrate. Thickness continually builds over previously bonded metal layers. Size and diameter of the media is important to prevent it from being lodged and trapped in the parts. Media diameters may range from below 0.001 in. to above 0.25 in. Experienced operators develop reference points that offer good confirmation of preferred load performance. These include color of the foam or solution, and color and appearance of the parts.

Features and benefits

By using mechanical plating:

- Hydrogen embrittlement is eliminated,.
- Post plate baking is not required;
- Uniformity of deposit thickness is consistent.
- "Dog bone" thickness distribution is eliminated,.
- Excellent deposit adhesion is obtained.
- Up to 1 mil deposit thickness is deposited without harmful stress.
- Flat parts are compatible (no sticking, nesting or masking), thanks to the media.
- The process readily plates hardened steels, powdered metals, fasteners, nuts, bolts, washers, clips and screws.
- It allows excellent chromating of plated parts.

Compared to conventional electroplating, the mechanical plating cycle is much simpler. Most steps are completed in the same barrel. Conventional polypropylene plating barrels are not eliminated. This greatly reduces allocated space requirements. Rectifiers are not required, as mechanical plating does not use current. Rinsing uses sufficient water for each step. The plating solution does require any maintenance, since it is replaced after every process run. By determining optimum conditions, over 95% efficiency is achievable.

Mechanical plating uses non-complexing and non-chelating chemistries. Under proper operating conditions, discharged effluents are low in metals and do not contain any chemicals that would affect standard waste treatment systems. Post finishing, such as chromating, requires the same treatment as for an electroplating line effluent for treatment. Aside from the powder metal additives, surface conditioners and promoters are primarily liquid concentrates. Therefore sludging is not a post-treatment problem.

Related costs

Based on the described equipment for mechanical plating, the cost savings may range from 65 to 75% compared to traditional electroplating. Other economic benefits include:

- Less manual labor step-to-step.
- Able to complete an entire cycle within 60 minutes.
- No heating required after cleaning.
- Filtration and purification not required.
- No anodes, consumable or inert.
- Post-plate baking eliminated.

Corrosion protection

Unlike the electroplating application, up to 1 mil or 0.001-inch deposit thickness (zinc) is routinely obtained. Depending on finishing requirements or specifications, any thickness and post-finishing can be obtained.

Mechanically Zinc Plated with Chromates ASTM B-117

Zinc Thickness (in.)	Blue (hr)	Yellow (hr)
0.0003	90-95	150-175
0.0005	100-125	200-225
0.001	200-225	285-310
0.002	295-310	390-410

Application of a chromate and post seal can provide over 1,000 hours of salt spray corrosion protection.

The major international automotive companies specify mechanical plating for certain finishes. ASTM and MIL specifications describe cycles and finishing parameters. State and Federal highway and transportation agencies specify mechanical zinc finishes. On an industrial scale, many finishes require mechanical zinc for thickness and corrosion protection. P&SF

Answers to I.Q. Quiz #463
From page 29.

1. cast iron, high carbon steel and carbo-nitrided steels
2. b, d, e
3. Higher conductivity
4. Highly corrosive; lower throwing power; brittle, less pure deposit; sensitive to iron contamination; requires close pH control.
5. True.