Direct electroless deposition may find a niche.

Die casting is one of the most important fabrication processes for accurately producing articles of complex shape with small dimensional tolerances. Zinc die castings cost less than other metal and alloy castings and can also be readily electroplated or otherwise finished.

Zinc castings are commonly plated with successive layers of copper, nickel, and chromium to provide corrosion protection and a decorative appearance. However, they are porous and susceptible to attack by acid and alkaline solutions. Furthermore, the need for waste treatment of cyanide-containing baths and the difficulty of achieving uniform deposits in recessed areas are drawbacks that give impetus to alternative coating systems for certain applications.

For example, there has been increasing interest in producing electrical connectors from zinc die castings, but these parts can be difficult to plate by conventional techniques. Carburetors and fuel pumps are among the other devices that feature recesses or similar tough-to-plate areas but that can benefit from a hard, wear-resistant, corrosion-resisting coating.

A new method of depositing electroless nickel directly on zinc die castings offers excellent adhesion, appearance, corrosion resistance, and shielding properties. A review of current practices and a comparison with the electroless approach are provided here.

Surface Preparation

Die-cast surfaces with fissures caused by "cold shut" or other forms of porosity tend to corrode prematurely, even when good cleaning and plating procedures are used. Some, but not all, surface defects can be removed by abrasive polishing, but preplate finishing costs increase in proportion to the amount of polishing required to remove the defects.

Fortunately, manufacturing techniques adopted in recent years have reduced the cost of finishing. For instance, some castings are now being made in super-finished dies with a surface roughness of less than 0.25 um (10 pin.) to eliminate the cost of mechanical finishing or buffing.

Porosity of the zinc material nevertheless accounts for the primary difficulties in providing sound plating with good corrosion resistance. The nature of the zinc itself, being very vulnerable to attack by both acid and alkaline solutions, limits the kind of cleaning and preparation materials that can be used prior to plating. Initial cleaning to remove soils is done in very mild alkaline solutions and is sometimes preceded by solvent (often vapor) degreasing, which has its shortcomings. First, it is very efficient in removing oils and oily substances but frequently leaves behind colloidal materials. And without the oils, it is practically impossible for mildly alkaline cleaners and surfactants to remove them. Second, chlorinated solvents, which are popular for degreasing, are toxic and many are or will be tightly regulated or even banned by EPA.

Therefore, mild alkaline soak cleaning seems an appropriate first step. If heavy oils or soils are on the part, power-washing with alkaline cleaners is the preferred method. Table 1 shows some typical formulations for various types of alkaline cleaners. The cleaning stage is followed by thorough rinsing and a dip in a very mild acid (e.g., 0.5 percent by vol sulfuric) for a short time (20 to 30 sec).

Conventional Plating

The next step in the traditional electroplating cycle is to apply a cyanide copper strike, then plate with cyanide or acid copper. The coating thickness should be sufficient to seal the pores and prevent extensive zinc and copper diffusion, which results in the formation of weak alloys and blistered deposits. (Diffusion is greatly accelerated by operating any copper-plated device at service temperatures higher than room.)

The cyanide copper strike is required to promote good adhesion to the zinc. Without it, immersion deposits of copper would form and there would be no adhesion at all. Properly formulated copper cyanide and acid copper baths provide macrothrowing power that permits penetration of pores and imperfections in properly prepared zinc die castings. As a result, the level of porosity is reduced and a basis for reasonable corrosion protection is provided. Electroless nickel processes inherently fill these pores without difficulty, again assuming proper surface preparation, resulting in even greater corrosion protection without using a cyanide copper strike and copper plate.

Cyanide copper plating has become very expensive because of its environmental impact. The cost of cyanide waste treatment is higher than that of the sodium cyanide or potassium cyanide materials used in the process. Furthermore, cyanides are highly toxic materials and have been restricted or banned from a great many
Electroless nickel could be applied over the electrolytic nickel, but this is really unnecessary because the former can now be coated directly on properly prepared zinc die castings.

Electroless nickel plating usually does not require racking. Parts can be processed in bulk, baskets, and, in some cases, barrels. Where racking is required to prevent damage of the parts or for some other reason, both the work and the racks can be placed very close together in the tank, so long as mild solution circulation is provided.

Electroless Nickel

Electroless nickel provides a number of outstanding benefits. A wide variety of deposit characteristics are available, and process selection can be made to enhance the properties most desirable for the components under consideration. In general, the coatings are very hard and have excellent corrosion resistance. Furthermore, by topcoating with electroless nickel-boron, which is easily soldered and brazed, post-plating operations can be performed on zinc-die-cast housings.

Due to its relatively high electrical conductance, the shielding properties of zinc are excellent at frequencies up to and even exceeding 1000 MHz. Electroless nickel does not detract from these shielding properties. Thus, the use of electroless nickel on zinc-die-cast connectors can provide a means of producing a very cost-effective, yet high-quality product.

It has generally been considered difficult, if not impossible, to electroless nickel plate directly on zinc die castings. To obtain satisfactory deposits of electrolytic or electroless nickel, an intermediate copper plating step has been necessary. However, a new process allows successful electroless nickel plating directly on zinc without the problems associated with electroplating.

Nickel is a very hard and dense metal, meaning that it is soluble in acid and alkaline solutions and is therefore readily attacked by both. To adequately prepare zinc die castings for plating, careful attention must be paid to the selection of process materials used in every step of the cycle.

The first step is to condition the surface for the final electroless step. A rinse follows.

The next step is to treat the casting in an acid-type solution that chemically cleans and smooths the part, removing all impurities and surface imperfections of the casting. Generally, the pores are opened slightly in this step. The commercially available liquid product is used at 10 percent by weight and 140-150°F for 5 to 10 min. Once again, thorough rinsing follows.

A second acid treatment removes any smut that may have formed in the prior step and conditions the surface for electroless plating. This is a proprietary organic acid at 4 oz/gal and 90 to 110°F for 60-90 sec.

The first plating step is an electroless nickel strike. The bath consists of materials that do not attack the zinc die castings but that do allow the application of a very thin coating in the pores and on the surface. The product is used at 125 to 135°F, the pH ranges from 8.5 to 10, and the plating time is 3 to 5 min. It is not necessary to rinse after the strike and prior to immersion in the second solution—another mildly alkaline electroless nickel bath—which is operated at about 170°F and pH 8-10. This deposit, which contains from 2 to 4 percent by weight of phosphorus, provides the foundation for good corrosion resistance. Whereas the initial strike starts plating in the pores, the second has the effect of sealing porosity and otherwise conditioning the surface for the final electroless step. A rinse follows.

The last bath is a standard acid-type electroless nickel that gives a deposit containing 8 to 10 percent (or even more) phosphorus and that can be bright. The combination of the higher-phosphorus finish with the low-phosphorus foundation improves corrosion resistance. The final bath is operated at approximately 190°F to plate a deposit about 1 mil thick.

If enhanced properties for brazing, soldering, wire bonding, beam-lead attachment, or laser welding are required, a thin overplate of electroless nickel-boron may be advisable. This deposit is usually on the order of 100 pin. thick and is relatively simple to apply over the electroless nickel-phosphorus.

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