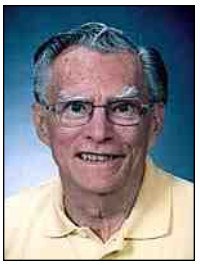

Do's & Don'ts

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Do's & Don'ts of Pitting: The Most Frequent Cause of Plating Failures

Introduction

Looking back in my years of consulting, I have found that pitting was the most frequent cause of plating failure. Indeed, the most frequent problem platers and their customers have reported, is "pitting" and the many manifestations of pitting. Pitting is often the root cause when quality control inspection sees surface discoloration, blisters and/or overall roughness. The ultimate outcome will be corrosion failures.

When unexpected results are discovered in plated deposits, failure analysis should be done to determine the causes. If corrections are to be effective, all possible causes for failure should be considered.

It is essential to select the correct coating and thickness for the applications. It is important to know the properties and characteristics of the plated deposit in order to properly select the best coating for the application. Corrosion protection (sacrificial or chemical resistance of the plated coating); electrical properties, including specific resistivity, magnetic characteristics, etc.; mechanical characteristics such as tensile strength, ductility, smoothness, hardness, abrasion resistance, etc. are all important considerations. The influence of the basis metal plays a very large role in the cause of pitting. And finally, environmental factors also play a critical part in the selection.

What causes pitting?

Pits in the basis metal.

The basis material is one of the most frequent causes of pitting of the plated deposit. Obviously, if there is visible pitting on the surface of the object to be plated, there is a chance of pitted plated deposits. More subtly, slight tears from machining that are barely visible, as well as small surface imperfections, can cause pitting in the deposit. How so, you ask? It happens because the voids are likely to contain (and retain) machining oils that cannot be removed in the cleaning operations. Why? Because the slight tears provide capillary inclusion of the contaminants that tend to stay put. Unless the cleaners are of the high temperature variety, and sometimes even above normal operating temperatures, the materials cannot be removed, nor can they be rinsed out. The bleed-out often occurs in the plating solution, particularly if it is an electroless nickel process operated at 85-90°C (185-194°F) where the thermal expansion of the metal releases the contaminants, resulting in pits.

This can also occur in plating solutions that use surfactants or are of naturally low surface tension. What is the remedy? One is to use alternating hot then cold rinsing after the cleaner tank. The more obvious remedy is to improve the machining operation by using sharp tools and follow good practices such as controlling the depth per pass, using water soluble (not water dispersible) cutting lubricants where possible.

Duncan has listed several surface defects in the basis metal which can result in pitting in electroless nickel plating.[1]

- Voids resulting from forming
- Surface separations resulting from forming
- Deformation due to machining or grinding
- Secondary phases inherent in the metal
- Foreign phases transferred to the substrate
- Dissimilar metal combinations.

Pits induced by the preparation process

The most frequent process cause of pitting when plating onto aluminum is the pretreatment. The use of etch-cleaners, while being very efficient in removing soils can over-etch aluminum. Non-etch alkaline

DO'S	DON'TS
Select the right plating and thickness for the application.	Try to plate poorly machined items.
Inspect the surface before plating for pits and pores.	Try to plate over obviously pitted surfaces.
Use the proper cleaner for the application.	Neglect the cleaner concentration, or age of the cleaner.
Use short etch cycles, lower temperature, time, and short times in the zincates for aluminum processing.	Use silicon containing lubricants.
Seal porous casting of steel and/or aluminum before plating.	Allow the plating solution to accumulate impurities.
Maintain the plating solution at its highest efficiency to minimize hydrogen gassing.	

cleaners often contain silicates, which are difficult to rinse and may leave residues. One remedy is to use a mildly alkaline first rinse, which can help remove the silicates. Another remedy is to use a mild acid cleaner or a mildly etching alkaline cleaner that will not be left for long times in the cleaner solution.

Over-etching aluminum alloys in the pre-plating process often results in a pitted deposit. Alkaline etches became popular for some alloys of aluminum to aid cleaning. Alkaline etching of aluminum alloys is corrosive to the aluminum and does not have an effect on most of the alloying constituents. Pits can be easily induced, leaving traces of the alkali in the resulting pits. Acids attack the aluminum as well as attacking some of the alloying constituents. This is good if it is not overdone. Silicon-containing aluminum alloys are vulnerable to over-etching even in short time cycles because aluminum is etched around the silicon inclusion. There can be enough etching of the aluminum to leave small capillary holes around the silicon, entrapping acid in the voids. When the zincate solution is introduced the acid is neutralized, and then the alkaline nature of the zincate solution etches further around the silicon particle, increasing the size of the hole. The second zincate solution can etch a little more. By the time the item reaches the plating solution, there are enough voids, with foreign chemicals entrapped, to cause severe pitting of the plating solution.

Pits induced by the plating process

Plating processes that generate hydrogen can cause hydrogen pitting. This is often overcome by increasing the agitation around the surfaces being plated. There is a tendency to blame natural hydrogen evolution for pitting caused by other sources. The plating solution can be contaminated or out of balance chemically. Gas pitting is the usual result. In a sense, most pitting involves hydrogen evolution whether or not it is normal for the particular plating solution.

Overstabilization of electroless nickel plating solutions can also be a possible cause. P&SF

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Fact or Fiction?

Continued from page 12.

per million of fluoride, dentists recommend the use of a fluoride supplement, in tablets or liquid, from birth until the late teen-age years.[4]

When researchers in Ohio sampled more than 50 brands of bottled water for fluoride content, they found that 90% of them had levels below the recommended range for dental health.[5] In South Australia, a study found a 71% rise in tooth decay in children, attributed to the lack of enamel strengthening fluoride in the bottled water that has become so popular.[6] P&SF

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