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Do's & Don'ts

Pitting: The Most frequent Cause of plating failures:

Introduction

Looking back in my years of consulting, I found that pitting was the most often cause of plating failure.

When expected results are not realized from plated deposits, failure analysis should be done to determine causes. If corrections are to be effective, all the 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 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 important considerations.

The influence of the basis metal plays a very large roll in the cause of pitting. Environmental factors also play a part in the selection.

In my years of consulting the most frequent problem platers and their customers have reported, is "pitting" and the many manifestations of pitting.

What causes Pitting?

Pits in the basis metal.

The basis material is one of the most often 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 visible small surface imperfections can cause pitting in the deposit. How so? you ask. Because the voids are likely to contain 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 high temperature, and sometimes even at higher than normal operating temperature the materials cannot be removed, nor can they be rinsed out. The bleed out often occurs in the plating solution, particularly if it is electroless nickel operated at 85-90C (185-194F) where the thermal expansion of the metal releases the bad stuff resulting in pits. And in plating solutions that use surfactants or are naturally low surface tension. What is the remedy? One is to use alternate 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.

Pits induced by the preparation process

Plating process that generates 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. In a sense most pitting involves hydrogen evolution whether or not it is normal for the particular plating solution.

The most frequent process cause of pitting when plating onto aluminum is the pre-treatment

The use of etch-cleaners, while being very efficient in removing soils can over etch aluminum. Non-etch alkaline cleaners often contain silicates that are difficult to rinse and may leave residues. One remedy is to use a mildly alkaline first rinse that 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.

The plating solution can be contaminated or out of balance chemically. Gas pitting is the usual result.

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 induced easily 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 over done. Silicon containing aluminum alloys are venerable 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 then the alkaline nature of the zincate solution further etched 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 is enough voids, with foreign chemicals entrapped, to cause severe pitting of the plating solution.

Over stabilization of Electroless nickel plating solutions is a possible cause.

Pitting is often the root cause when Q.C. inspection sees surface discoloration, blisters, rough, and spots on the surface, overall roughness, Corrosion failures,

Ron Duncan listed several surface defects. (2)

- 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.

Do's

Select the right Plating and thickness for the application.

Inspect the surface before plating for pits surfaces.

Use the proper cleaner for the application.

Use short etch cycles, lower temperature,

time, and short times in the zincates for aluminum processing.

Seal porous casting of steel and/or aluminum before plating.

Maintain the plating solution at its highest efficiency to minimize hydrogen gassing.

Don'ts

Try to plate poorly machined items.

Try to plate over obviously pitted or pores.

Neglect the cleaner concentration, or age of the cleaner.

Use silicon containing lubricants.

Allow the plating solution to accumulate impurities.

Reference: