## Do's & Don'ts

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# Corrosion! Oh No! Not Again #*!#!*!#*

Corrosion is defined as the destructive alteration of a metal by reaction with its environment. It is in keeping with the second law of thermodynamics that would have us believe that entropy is increasing in the universe. In other words everything we build wants to fall apart. This column deals with corrosion as it relates to plating and plated objects.

There are numerous possible causes for the corrosion of plated components. Many are the result of the surface condition of the basis material to be plated. Pitted, rough or cracked surfaces can be the sole cause. Ron Duncan[1] enumerates many of the problems with the basis material.

Corrosion can take place whenever there are two dissimilar (See the electromotive table) metals are in contact, and there is moisture and a conductive media. This is called electrochemical corrosion. Corrosion can also occur where there is oxide in contact with low or no oxide and an ionic medium. This type is often called crevice corrosion (concentration cell) or in paints or organic finishes it is called filiform corrosion.

### Detecting poor corrosion protection resistance

Detection is usually visual or by specific accelerated tests, including salt spray, ASTM B117; CASS tests, ASTM B368 & B117; Corrodkote, ASTM B380; flowing mixed gas test of Battelle Memorial Institute; humidity tests; various porosity tests, such as the "Ferroxyl test;" electrochemical anodic polarization tests, etc.

### Causes that lead to corrosion due to plating processes

- Improper selection of the plated coating for the application.
- Contaminated plating solution
- Poor control of the plating bath.
- Rough or porous basis material.
- Insufficient plate thickness.
- Porosity.
- Diffusion of plated layers or from the basis metal cause alloys to form that may be more prone to corrosion or staining.

The list continues:

***Lack of adhesion*:**
Detection is visual, such as observation of peeling and blisters, microscopic analysis or through failure of specific adhesion tests. Testing is done by various means: ASTM bend tests, saw test, smash, etc. Among quantitative tests are the "ring-shear test" and the "conical pull test."Among causes are:

- Poor cleaning or poor activation of the basis material
- Improper activation of the basis material. Different materials require different activation procedures. For example, stainless steel requires acid activation and a special low pH nickel strike such as a Woods nickel strike or a low pH sulfamate nickel strike.
- Hydrogen entrapment can cause blisters or peeling when the item is heat-treated.

***Roughness*:**
Detection is visual, by feel or by using a microscope. Among causes are:

- Plating solution in need of filtering.
- Magnetic particles on the basis material.
- Poor cleaning.
- Rough basis metal.

***Pitted deposits (causes)*:**

- Porous surface onto which plating takes place.
- Inadequate cleaning prior to plating.
- Contaminated plating solution.
- Low surfactant concentration where applicable.
- Hydrogen gas evolution.

***Skip plating (causes)*:**

- Contaminated surface.
- Contaminated plating solution.
- Poor rinsing.
- Oil on rinse tank
- For electroless nickel: excessive stabilizer content; excessive agitation; solution out of balance.

***Poor coverage (causes)*:**

- Item to be plated is not designed for plating.
- Current/thickness distribution poor because of recessed areas, sharp edges or protrusions.
- Insufficient anode area.
- Need for current robbers or masks.
- See any MFSA shop guide for suggested design criteria.

***Tarnish (causes)*:**

- Poor rinsing.
- Contaminated rinse water.
- Bleed out from porous basis material.
- Plating solution chemistry out of balance or lack of organic addition agents such as levelers or brighteners.
- Excessive brightener.
- Impurities in the solution.
- Poor cleaning of the parts.

Sources of organic impurities are:

- Tank linings that contain plasticizers, oils, colorants, fillers, biocides, impact modifiers, cadmium, mold release aids and/or stearates.
- New linings must be leached prior to filling with plating solutions.
- All these plastic additives are detrimental to plating solutions. I do not recommend linings for plating solutions.

Masking materials contain solvents and plasticizers that can contaminate plating solutions. Proper curing can help prevent contamination. Drag-in from rinse waters, or from cracks in the rack coatings that entrap preparation solutions will introduce impurities. Removal of impurities is usually by carbon-peroxide treatments, electrolytic purification (dummy plating at

low current density), high pH treatments or permanganate carbon treatment

## Do's and Don'ts

**Do**

- Plate with sufficient thickness to provide a pore-free surface and with sufficient thickness to minimize diffusion of the basis metal to the surface.
- Filter the plating and processing solutions well enough to keep particles from depositing on the work pieces.
- Consider sealing the plated deposit when the basis metal is rough or porous. Use silicon gels, sol-gel, epoxy, polyurethane or other clear coating if the application allows.
- Keep the plating shop clean, free from dust and free from airborne particles that can enter the plating or processing solutions.
- Maintain the process and plating solutions by frequent or automatic additions and change cleaners and acids on a schedule that assures optimum performance.

**Don't**

- Neglect rinsing. Good rinsing is critical to good results. Proper rinsing using flow meters and counter-flow rinse systems save money, water resources and assure good plating that is corrosion protective.
- Assume the plated deposit will be corrosion resistant without testing.
- Use plastic liners that contain additives to make them flexible, such as flexible PVC. P&SF

## Reference

1. Ronald N. Duncan. *Journal of Applied Surface Finishing*, 1 (2), 127 (2006).