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# Electroplating:

## What Engineers Should Know About Designing Electronic Components and Packages to Improve Quality and Lower Cost

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Most electronic components, such as microelectronic packages and microwave assemblies, are electroplated or have electroplated sub-assemblies. Decisions made by the design engineer regarding part configuration, base metals, and specification can significantly affect the quality and processing costs associated with plating.

The two major types of electroplating methods used to process electronic components are rack and batch.

## Rack plating

A wide variety of electronic components such as microelectronic packages, lids, bases, and machined modules are rack plated. Rack plating is used for larger or delicate parts that would be damaged using batch processing. The parts are mounted on fixtures and these fixtures are lowered into the plating solution and contacted to an electrical power source.

## Design for rack plating

To provide current for plating, each part has to be firmly contacted by a pin or wire. Some parts, such as glass sealed or metallized ceramic components, have multiple electrically isolated areas. Each of these areas needs to be contacted. Electroplaters will design racks and pins to have the smallest contact point possible; however, unless the part is moved during the plating process, the contact point will leave an unplated area. The designer should note on the component drawing any locations where unplated areas would be acceptable, as this will reduce labor costs.

Part geometry determines the uniformity of the plating thickness that can be attained. Basic laws of electrochemistry create low and high current density areas resulting in high and low plating thickness in those areas. Recesses, cavities and holes receive less current than outside corners, edges, and seal rings. This results in lower thickness in these areas. When full plating thickness is required in deep cavities, several times that amount can be expected in other areas. The plater can tighten this spread by slowing the plating rate and plating fewer parts on a fixture, but this will add cost. The design engineer should take this into account when specifying the plating thickness range, and allow as large a spread as possible.

Deep cavities and blind holes create other challenges for the plater. Air can be trapped on entry into the plating solution. This results in areas void of plating. Holes and cavities also trap cleaning and plating solutions, making them very difficult to rinse between operations and dry stain free. Where hole diameters are small, and complete plating coverage is required, solutions and water have to be introduced into each hole manually. This will increase costs considerably. Therefore, when possible, the designer should include bleed holes to better allow air to release and solution to enter.

## Batch plating

Many smaller components such as heat sinks, mounting pads, package lids, surface mounts, and robust glass sealed parts can be batch plated. The two most common methods of batch plating are barrel and vibratory. In barrel plating, parts are loaded into a cylinder that rotates at varying RPMs and electrical contact is made to the load by various methods determined by part geometry. During vibratory plating, the parts are loaded into a tray which vibrates at high frequency, enabling the parts to be shaken rather than tumbled during plate.

## Design for batch plating

Because parts are tumbled or vibrated during batch plating, there is less variation in plating thickness from part to part. Cavities and blind holes present some of the same issues as with rack plating. Where possible, the designer should include bleed holes to improve the quality of the finished parts.

Small flat parts such as mounting pads and heat sinks will tend to stick together during plating and therefore, if possible, should be designed with ridges or dimples. When these features cannot be added, the parts should be designed to be as thick as possible. Thin parts (<.010") have a strong tendency to stick. This is exacerbated when matte finishes are specified due to the roughness of deposit. Such parts must be plated in small quantities with large amounts of conductive media to keep them separated during processing. Running media with parts, especially when plating precious metal, will drive up the plating costs substantially.

Glass sealed components that are sturdy enough to withstand the tumbling in a plating barrel can be batch plated successfully. The design engineer should be aware, however, that thickness could vary substantially between areas of the parts that are isolated by the glass seals. Depending on the part configuration and the metal being plated, variation between the plating thickness on the main body of the part and isolated leads can also be very high. Therefore, use of temporary weld bars to connect multiple isolated leads should be considered whenever possible.

Ceramic bases with isolated metallized areas present the same type of issues as glass seal components. Larger areas plate faster than smaller areas, resulting in a wide plating thickness distribution. Measures that the plater takes to improve distribution - such as the use of conductive media, slower plating, and smaller lot sizes - all add to both material and labor costs. If the designer can allow isolated areas to be connected by thin lines of metallization that are later removed, the plater can use standard plating parameters.

## Base materials

All components must be cleaned and activated prior to plating. There are different processes used for different base metals. Parts made from components of multiple base metals can be difficult or nearly impossible to activate properly. The engineer should be aware of this when designing packages. Preplating each or some of the components is recommended to allow the plater to use simpler cleaning and activating steps.

Refractory metals and refractory metal matrix composites are often used as bases on electronic packages and are generally brazed to other materials. These materials always need to be pre-plated before brazing. This is because most plating processes include sintering at temperatures above the melting point of most brazes used on electronic packages.

Machined aluminum and aluminum metal matrix composites present challenges for the plater because of their softness and reactivity. When rack plating aluminum, the pins and wires used to hold the part may leave bare spots and could cause damage. Designing edges of holes with a radius also helps with subsequent final rinsing and drying. Some engineers have designed modules with threaded holes specifically for the purpose of attaching screws to which the plater can make electrical contact. This enables the processing company to never make contact to a critical area of the component.

Electroless nickel is the preferred first coating for aluminum. Although electrolytic copper and nickel strikes can be used, they are generally less reliable for achieving good plating adhesion. If subsequent layers of electrolytic plating are required over the electroless nickel, the thicker the initial layer of electroless nickel allowed, the better, in order to prevent attack of the aluminum during the activation and plating steps (.000200” is preferred).

## Choosing the specification

There are usually several specifications available for each type of finish, such as ASTM, SAE, and Military. Each specification will outline requirements for adhesion, thickness, corrosion resistance, etc., along with the testing requirements. The design engineer will select from one of these.

Over the last several years numerous Military specifications have been cancelled and have been replaced with ASTM or SAE specifications. Because many of these specifications were not written specifically for electronic package, some have default testing requirements that do not apply to the product being plated. The engineer should be aware of this when specifying as this testing can add unnecessary cost.

Decisions made at the design stage can significantly affect the electroplating process. The optimum design and specification will allow the electroplater to supply a component with a plating finish of better quality at the lowest cost.