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Better by Design: Guidelines for Designing the Perfect Plated Piece

Suggestions, tips and design considerations for enhancing plated part appearance, improving performance and facilitating racking and plating ease

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The success of any metal plated piece begins with design. The design must accommodate molding, plating and part performance. Easy-to-plate contours will invariably provide a more uniform distribution of the electro-deposited metal and will provide a finish having better performance at a reduced processing cost.

Component design can be considered in three different ways: Design considerations that will 1) enhance the appearance of the plated piece, 2) improve the performance or functionality of the piece, or 3) facilitate the ease of racking and plating parts.

1. Design Considerations: Enhancing Plated Part Appearance

Since appearance is a key factor in decorative plated parts, it's important to incorporate proper design practices from the start.

Surface defects are more pronounced on a highly reflective surface than on bare plastic metal, so the following practical design considerations will help optimize the surface appearance once the piece is plated.

Integral parts: Whenever possible, ABS components should be designed as one piece since good plating appearance is difficult to achieve over welded or cemented joints. Parts are sometimes plated and then assembled via screws, hot staking, snap fits, etc.

Planes: Large planes should be crowned with a curvature of about 0.015 in./in. Crowning tends to camouflage minor surface irregularities because the eye is not capable of focusing on a wide expanse or curvature as it is on a flat surface. As an alternative, shallow, well radiused texturing can be used to effectively break up flat areas and mask minor molding, thermoforming, handling or plating imperfections.

Gates: Gates should be located on non-critical appearance surfaces, as gate and trimming marks, too, are exaggerated by the metal plate. If this is not practical, a feature can be made of the gate area. For instance, on a small plated knob, with a slightly peaked convex top surface, the gate cold be placed at the apex, where it may be noticeable but not objectionable.

Ribs and bosses: Care should be taken in locating ribs, bosses or other heavy sections on the reverse side of appearance areas. Unless properly designed, they will cause sink marks which are more noticeable after plating.

Edges and corners: Sharp edges and corners will cause high current density areas which can result in undesirable plating build-up.

Parting lines: Molding part lines leave visible marks on bare plastic, which will also be greatly magnified by the bright metal plate. If possible, locate them in nin-critical appearance areas.

2. Design Considerations: Improving Plated Part Performance

Performance of the electroplated piece can be improved by controlling wall thickness and plate deposition; i.e. thickness and uniformity.

Adequate wall thickness should be specified by the designer to obtain good moldability, sufficient rigidity for racking and maximum adhesion between the metal plate and the plastic substrate. The part should be designed to facilitate uniform deposition of the plate for the express purpose of achieving maximum tip plate corrosion resistance and thermal cycle resistance.

Because of its intrinsic nature, plastic never corrodes as metal does, however both plated metal and plated plastic parts are subject to corrosive surface attack due to galvanic action between the plate components. Additionally, plate thickness is important in designing parts having close tolerance fits; for example, threads, snaps fits and interference fits.

Wall thickness: The wall thickness is generally dependent upon part size and shape and is further governed by its strength and rigidity requirements.

An ideally designed part is one with a uniform wall thickness. Wall thickness variations can result in more performance problems than overall thin wall sections. For this reason, we suggest using a wall thickness in the range of 90 to 150 mils for ABS parts whenever possible. Gradual transitions from one wall section to another via tapers, radii or fillets should be specified. This will minimize local flow variations and surface stresses that can cause poor plate adhesion.

At a given injection speed and stock temperature, plate adhesion increases with part thickness. For a given part thickness and stock temperature, plate adhesion increases with slower injection speed. Plate adhesion increases also with higher stock temperature (within the acceptable range) for a given fill time and part thickness. Therefore, to achieve optimum plate adhesion and thermocycling performance, it is necessary to consider injection speed, stock temperature, part thickness as well as part design, appearance and cycle time.

Thermal cycling performance can be improved if excess bulk is removed from thick cross-sections.

In this way, a more uniform wall thickness is obtained, and the plastic has less tendency to expand and overcome the strength of the metal plate.

Plate uniformity: Uniformity of electroplate thickness is improved by designing parts with gently curving convex surfaces. Non-uniformity of thickness is caused by an unequal distribution of current density on the part. Technically, this problem arises because the recessed areas of a part (slots, grooves, blind holes, etc.) are normally now current density areas. These areas are starved of their share of the electroplate, while the current density areas (corners, edges, ribs, fins and other protuberances) are apt to have plate build-up out of proportion. Low current density areas may have less than one-fourth the amount of electroplate generally deposited on the part's surface.

These thinly plated areas are commonly the site of first failure from abrasion, corrosion or wear.

Auxiliary anodes can be used in low current density areas to improve plate uniformity, but the designer must be aware that this technique may be more expensive than standard plating practices.

Angles: All angles should be as large as possible. Minimum inside and outside radii of 1/16" and 1/32" respectively are suggested. Sharp angles increase plating time and costs for plate uniformity and reduce the durability of the plated part.

Edges: Sharp edges are undesirable. Beading will occur which may destroy the design concept. They should be rounded to a radius of at least 1/64", or preferably 1/32".

Recesses: Round flat-bottomed groves or indentations and limit their depth to 50% of their width. Edges, both internal and external, should be chamfered or rounded. If chamfered, the minimum angle designed by the chamfer should be 100 degrees.

Reduce the depth of concave recesses as much as possible and avoid scoops with a depth greater than 50% of the width.

Deep, v-shaped grooves are extremely difficult to plate because of low current density factor at the bottom on the groove. Shallow, rounded grooves are better.

If blind holes are functionally necessary, design depth to less than 50% of the width. Whenever possible, provide drainage holes so that solutions are not carried from bath to bath.

Slots, as well as indentations, should be at least twice as wide as they are deep. Rounded corners will reduce plate buildup in the high current density areas and plate starvation in adjacent areas.

Protuberances: Ribs are frequently chosen to provide additional strength. When ribs are used, their thickness should not be greater than ½ of the adjacent wall thickness, nor should the height exceed 1 ½ times the wall thickness.

Bosses are heavy areas usually provided around holes for reinforcement, while studs are more frequently used for mounting purposes. Both bosses and studs should be as short as possible. Better plating results will be obtained if their height does not exceed twice their diameter. Inside and base angles should be rounded generously. Tips must be similarly rounded and tapered or the inevitable thick metal deposits will occur, increasing dimensions beyond acceptability.

Draft angles of at least 1 degree are normally needed to facilitate removal of parts from mold cavities without the use of mold releases.

3. Design Considerations: Accommodating Racking and Handling

At this point, the designer should consult with the plater because, quite often, properly located gates can be used as efficient cathode points and, in some cases, the runners can be left attached to the parts to accommodate racking.

The best and most efficient electroplating results can be realized if plating racks are specifically made for each part design. There are many reasons for this; part size, of course, is the major one. Part design is another, because each rack has to be made so that the rack tips will contact the part in an area where the lack of plate will not affect final appearance or performance. Also, the racks should be designed to hold the part in such a way as to prevent the loss of electrical contact.

Racking: For economic reasons, the rack design should take full advantage of the plating bath size, yet no plastic component should be too close to the tank bottom or surface of the solution. The uppermost component on a rack should always be immersed to a depth of at least 1 ½” to 2” below the solution surface and the lowest component should be about 6” above the tank bottom.

Other considerations include variations in tank size as well as differences in heights that the work rod may be placed above the solution. Otherwise, parts to be plated may fail to be submerged in one or more of the plating baths.

Rack splines and hooks constructed of copper, bronze, or brass and vinyl coated for protection against acids used in the cleaning and etching solutions are recommended.

Rack tips of 316 stainless steel are recommended. They can be chemically stripped without damaging the points.

Rack splines, tips and hooks must be of ample size to allow current to pass without overheating. A safe figure for copper 1,000 amperes per square inch of cross section, however this can be extended to 2,000 amperes if the plating cycle is short, the solution cool and good contact is made between the tips and the parts.

Finally, the part should be sufficiently rigid to be held on the rack in agitated solutions at electroplating temperatures (up to 155 degrees F) without warpage. Generous wall thickness will provide the necessary rigidity, or ribs can be used as an alternative.

Handling: Anything less than clean and careful handling of molded ABS parts is aft to result in inferior and, perhaps, unacceptable parts.

Attention should be focused on the fact that the slightest blemish on a part surface will stand out after a bright metal finish has been applied. Therefore, caution should be taken when removing the runners not to leave surface defects too large for plating success.

Gates and parting lines located in prime appearance areas may necessitate buffing the part.

Cotton gloves should be worn when removing parts from the mold in order to prevent excessive fingerprinting. Fingerprints may leave an oily film which, when imbedded in the hot plastic surface, will prevent strong plate adhesion if the plating system does not include a cleaning bath as its first step.

Parts also can be soiled by grease or other such contaminants in and around the molding equipment, particularly in the mold cavities themselves, making the parts more difficult to plate. Molds must be free from all preservatives and lubricants.

The production parts should be kept out of any area where mold lubricants are being used. Mold releases, especially silicone sprays, can contaminate the air and be attracted to the parts by static charge, not to be noticed until the parts prove difficult to wet in the plating process.

When removed from the mold, the ABS parts should be adequately protected in shipping containers to prevent scuffing and scratching. Parts to be packaged in polyethylene bags must be cooled to below 100 degrees F before packaging.