Troubleshooting On Plating on Plastics Revisited

Donald W. Baudrand, Consultant
621 NE Harrison St.
Poulsbo, Washington 98370-8453
E-mail: donwb@tscnet.com

For this paper, it is assumed that the reader is experienced in plating on ABS plastics, the products plated require good adhesion, and the products have corrosion resistance and/or other functional requirements.

Early plated plastics were mostly for decorative purposes such as baby shoes, plants and flowers, toys, art objects and home decorative objects. I serviced a company in Los Angeles in the 1950s whose only business was plating onto plastics. The parts were cleaned in alkaline cleaners and mechanically roughened. Then they were transferred to a basket where they were metallized using either the standard silvering method used to silver mirrors to make them electrically conductive, then transferred to a barrel where they were copper plated. Then they were bronze, brass or nickel and gold plated using barrels. When required, they were then lacquered to preserve the finish. The adhesion was minimal, but since the items were totally encapsulated and the end use did not require mechanical deformation, the results were satisfactory.

Today much of the plated plastics are for functional uses in addition to decorative, thus requiring good adhesion of the plating layer to the plastic and corrosion resistance. For that reason ABS (acrylonitrile-butadiene-styrene) was developed. During molding, the butadiene portion separates into the form of small spherical globules. These spheres are easily attacked by the etching solution, leaving holes in the surface. The ideal hole has an opening somewhat smaller than the inside diameter. These holes absorb the catalyst that initiates the plating. The plated deposit fills the holes and becomes a part of the surface plating, thus forming an interlocking system. In addition, there is some chemical bonding taking place, such as covalent bonding, valence bonds and electrostatic forces. The etching has been and is being done in a sulfuric acid-chromic acid solution.

There are some modified ABS plastics that act similarly. Newer modified ABS systems can use non-chromium-containing etchants. Polyamide-containing ABS is one plastic blend that can be etched without using chromium-containing etchants. These are polymer alloys of number 6 polyamide and ABS where the ABS is uniformly dispersed in the polyamide matrix and is available as "plating grade." Etching is done in a hydrochloric acid process with no chromium present, followed by a post treatment.[1]

Another new process uses polyamide alone. Etching is done using an organic "swellant" followed by a non-chromium "conditioning" step.[2]

The three systems are shown below.

PA/ABS	ABS	PA
Etch: Hydrochloric acid	Etch: Chromic-sulfuric acid	Organic swellant
Neutralize (Cr reduction)	Post etch	Conditioning
Catalyst I (Pd type)	Palladium/tin	Catalyst
Catalyst II (Pd type)	Activator	Activator
Conducting Layer	Electroless Cu or Ni	"Cu-Link"
Acid Cu plating	Acid copper plating	
Electroplated Ni/Cr	Electroplated Ni/Cr	Electroplating

Do's & Don'ts

Do use good quality molds. Test for stresses and strains using glacial acetic acid that makes them visible.

Do maintain the chemical balance of each processing solution to optimum concentrations. Analyze frequently.

Do use low ripple rectifiers - 5% or less even at low loads.

Do rinse very well between steps. Process chemicals are not compatible with each other.

Do use automatic chemical feed pumps for frequent or continuous additions.

Do keep racks very clean and in good repair. Strip after each cycle. Watch for and repair any breaks in the coating.

Do use plating grade ABS or ABS/PA

Do filter continuously.

Don't allow particles to enter any processing solution.

Don't use silicone mold release. They are nearly impossible to remove. Preferably **Don't** use any mold release compounds.

Don't skimp on the copper thickness for ABS. Copper provides thermal stability and ductility to the system.

Don't expect non-plating grades of ABS to plate properly or with adhesion.

Don't accept inferior molds that have pits, stresses, sink areas, scratches, dents or other visible defects. Many plating defects are the result of poor molds or molding practices.

Don't expect other plastics to plate using the ABS system. Other plastics require separate individual preparation steps, particularly different etchants.

References

1. T. Nagao, *et al.*, *J. Applied Surface Finishing*, **2** (1), 72 (2007)
2. M. Brandes, *Metal Finishing*, **105** (3), 35 (2007).
3. N.V. Mandich & D. Baudrand, *Plating & Surface Finishing*, **88** (9), 84 (2001).

Troubleshooting Chart[3]

Problem	Possible cause	Remedy
Blistering after electroless deposition	1. Poor etching	Test cleaner efficiency. Increase etch treatment time. Increase etch temperature. Agitate etch solution or work. Analyze H_2SO_4 and adjust.
	2. Greasy surface	Check cleaner. Replace etch solution. Increase cleaning time or temperature.
	3. Electroless solution is too fast.	Lower the reducer concentration or temperature.
	4. Entrapped moisture in the plastic substrate; or strains and stresses present.	Contact molder for remedial action.
Roughness	1. Activating solution too old.	Replace solution.
	2. Excessive time in activator solution.	Reduce treatment time.
	3. Overetching.	Reduce etch time.
	4. Excessive H_2SO_4 in etch solution.	Analyze and correct by dilution, add CrO_3.
	5. Contamination of electroless plating solution.	Filter solution and clean (strip) tank.
	Deposition on plating racks.	Strip racks thoroughly. Reduce temperature or time in catalyst.
Blistering after electroplating step	1. Overheating at rack contact points, due to poor electrical contact at these points or neighboring areas of the parts.	Redesign the rack contacts.
No electroless deposition	1. Wrong polymer.	Check the grade and type of polymer for platability.
	2. Low reducer in electroless bath.	Analyze and correct.
	3. Low etch temperature.	Check thermostat and heaters.
	4. Insufficient activation.	Increase temperature in the activator or decrease time in accelerator.
	5. Insufficient acceleration.	Increase acceleration time. Analyze and correct concentration.
Slow electroless deposition	1. Catalyst and/or activating solution too dilute.	Strengthen sensitizing and/or activating solution.
	2. Sensitizing and/or activating solution too cold.	Warm-up sensitizing and/or activating solution.
	3. Electroless plating solution too dilute.	Regenerate electroless solution according to operating instructions.
	4. Electroless deposit too cold.	Warm up electroless solution.
	5. pH of electroless solution too low.	Adjust pH.
Conducting layer burns during electroplating	1. Electroless deposit too thin.	Prolong the plating time.
	2. Current density too high.	Reduce current density to 3.0 to 5.0 A/ft^2.

	3. Contact points too small.	Increase contact area or size of contacts.
	4. Contact points worn through work movement.	Repair racks.
	5. Bipolar effect - anodic dissolution.	Better space racked parts.
Poor adhesion between electroless and electroplated metals.	1. Plastic surface contaminated with mold release compound.	Do not use mold release compound.
	2. Etch time too short.	Lengthen etch time.
	3. Etch time too long.	Reduce etch time.
	4. Etch solution too concentrated or too hot.	Dilute etching solution or work at lower temperature.
	5. All other conditions being satisfactory, molding characteristics such as stresses or strains in the molded parts are present.	Contact molder. Use full strength Watts nickel bath for a strike; or use a Wood's nickel; or use sulfamate nickel. Use copper pyrophosphate bath before bright copper or nickel.
	6. Electroless nickel has become passive.	Use live entry going into bright copper and nickel or nickel activator. Shorten transfer time from electroless nickel to the first plating tank.
Poor adhesion between electroless metal and plastic	1. Etching solution out of balance.	Analyze for Cr(VI), Cr(III) and total acidity.
	2. Stresses and strains in molded plastic part.	Contact molder for remedial action, after checking for strains and stresses using glacial acetic test.
	3. High pH and/or too low concentration in the catalyst solution.	Analyze and adjust.
	4. Too long post-catalyst treatment time.	Reduce treatment time.
	5. Electroless solution plates too fast.	Reduce temperature in electroless bath or reduce concentration.
Incomplete (skip) deposition or complete absence of plating.	1. Work contaminated with silicone.	Avoid use of silicone mold release compounds. Replace cleaner or increase its concentration.
	2. Inadequate etching.	Extend treatment time in etching bath and increase temperature.
	3. Work racked too close.	Improve the racking of the parts. Increase contact area or size of contacts.
	4. Neutralizer exhausted.	Replace neutralizer. Increase time.
	5. pH or temperature of electroless solution too low.	Adjust pH Warm up electroless solution.
	6. Excessive etch solution run-out from blind holes, recesses, etc.	Improve rinsing and agitation.
	7. Low catalyst metal concentration ; low temperature; low pH.	Analyze and correct catalyst bath Adjust the temperature and pH.
	8. Etch time and temperature too low for certain ABS plastics and highly stressed surfaces.	Stressed surfaces and certain plastics may require highest obtainable temperatures and/or longer times.

	9. Contaminated etch.	Increase time in neutralizer.
	10. Electroless deposit dissolving in acid copper solution.	Strike deposit in Woods Ni- strike. Strike in Cu-pyrophosphate before transferring to acid copper bath.
No electroplated deposit.	1. Bad racking.	Improve racking, so that contact points are in medium to high current density areas. Eliminate air pockets.
	2. Initial current density too high, causing "burn-off" of thin electroless deposit.	Start electroplating step at low current density, ramping to full current within 2 min.
	3. Electroless deposit dissolving in acid copper solution.	Strike deposit in Woods Ni- strike or in Cu-pyrophosphate strike before transferring to acid copper bath.
	4. Passive electroless nickel.	Electroplate immediately, or activate in activating dip.
Sandpaper effect	1. Electroless bath out of balance, giving solid particles precipitation.	Analyze and filter electroless bath.
	2. Plastic surface overetched.	Lower the time and the temperature in the etch tank.
	3. Dirty electroless solution.	Filter bath.
Plating on plating racks	1. Poor rack maintenance.	Strip racks regularly.
	2. Too high pH and catalyst solution concentration.	Lower the concentration of catalyst and/ or pH.
	3. Too high temperature in the catalyst solution.	Lower the temperature of the catalyst solution.
	4. Too high concentration and/ or time in the catalyst solution.	Lower the concentration and the time in the catalyst solution.
	5. Too long time in the post-catalyst (accelerator) solution.	Lower the time in the accelerator solution.
	6. Build-up of the catalytic metal or metallic dust in rack stripper solution.	Replace the rack striper solution.
	7. Contaminated accelerator solution via build up of metallic dust.	Replace the accelerator solution.
Voids or air pockets	1. Poor cleaning.	Analyze or replace cleaner.
	2. Insufficient agitation.	Increase agitation.
	3. Low total acidity in etch tank.	Analyze for total acidity in the etch solution.
	4. Poor rinsing of etch solution or inefficient post conditioner solution.	Improve rinsing, or replace post-conditioner solution.
Dull electroless plating	1. Electroless bath out of balance.	Analyze and correct the bath.
	2. Overetching.	Lower the temperature and/or time in the etch tank.
High drag-in	1. Poorly engineered rinse tanks	Change rinse tank design to counter-current flow and add spray rinses, especially after etch and catalyst tanks.
Overall poor appearance of the plated part	1. Sink marks, pits, splay marks, etc.	Contact molder.