TRouble ShootinG Plating on abs Plastics revisited

For this paper, it is assumed that the reader is experienced in plating on ABS plastics, and that the products plated require good adhesion, and has 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 1950’s 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 bronze, brass or nickel and gold plated using barrels, then when required, 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-styrine) 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 adsorb 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 co-valent bonding, valence bonds, and electrostatic forces. The etching has been and is being done in a sulfuric acid-chromate solution.

There are some modified ABS plastics that act similarly. Newer modified ABS systems can use non-chrome 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 non chrome "conditioning" step.(2)

The three systems are shown below.

**PA/ABS ABS PA**

<table>
<thead>
<tr>
<th>Etch—Hydrochloric acid</th>
<th>Chromesulfuric acid</th>
<th>Organic swellant</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Neutralize&quot; (chrome reduction)</td>
<td>Post etch Conditioning</td>
<td></td>
</tr>
<tr>
<td>Catalyst I (palladium type)</td>
<td>Palladium/tin Catalyst</td>
<td></td>
</tr>
<tr>
<td>Catalyst II (Palladium type)</td>
<td>Activator Activator</td>
<td></td>
</tr>
<tr>
<td>Conducting Layer Electroless copper or &quot;Cu-Link&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electroless nickel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acid copper plating</td>
<td>Acid copper plating</td>
<td></td>
</tr>
<tr>
<td>Electroplating Nickel/chrome</td>
<td>Nickel/chrome plating Electroplating</td>
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</tbody>
</table>

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

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

Use low ripple rectifiers 5% or less even at low loads.

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

Use automatic chemical feed pumps for frequent or continuous additions.

Keep racks very clean and in good repair. Strip after each cycle. Watch for and repair any breaks in the coating.
Use plating grade of ABS or ABS/PA
Filter continuously.

Do not allow particles to enter any processing solution.

Do not use silicone mold release. They are nearly impossible to remove. Preferably don’t use any mold release compounds.

Do not skimp on the copper thickness for ABS. Copper provides thermal stability and ductility to the system.

Do not expect non-plating grades of ABS to plate properly or with a 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.

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

Trouble Shooting (3)

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blistering after Electroless deposition</strong></td>
<td></td>
</tr>
<tr>
<td>1. Poor etching</td>
<td>Increase etching treatment time.</td>
</tr>
<tr>
<td>2. Greasy surface</td>
<td>Increase etch temperature.</td>
</tr>
<tr>
<td>4. Electroless solution is too fast.</td>
<td>Agitate etching solution or work.</td>
</tr>
<tr>
<td>5. Entrapped moisture in the plastic substrate; or strains and stresses present.</td>
<td>Analyze H$_2$SO$_4$ and adjust</td>
</tr>
<tr>
<td>Test cleaner efficiency</td>
<td>Check cleaner</td>
</tr>
<tr>
<td>Increase etching treatment time.</td>
<td>Replace etching solution. Increase cleaning time or</td>
</tr>
<tr>
<td>Increase etch temperature.</td>
<td>Temperature</td>
</tr>
<tr>
<td>Agitate etching solution or work.</td>
<td>Lower the reducer’s concentration or temperature</td>
</tr>
<tr>
<td>Analyze H$_2$SO$_4$ and adjust</td>
<td>Contact molder for remedial action.</td>
</tr>
<tr>
<td>Check cleaner</td>
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<td></td>
</tr>
<tr>
<td><strong>Roughness</strong></td>
<td></td>
</tr>
<tr>
<td>1. Activating solution too old.</td>
<td>Replace solution.</td>
</tr>
<tr>
<td>2. Excessive time in Activator solution.</td>
<td>Reduce treatment time.</td>
</tr>
<tr>
<td></td>
<td>Reduce etch time.</td>
</tr>
<tr>
<td>3. Over etching.</td>
<td>Analyze and correct by dilution, add CrO$_3$</td>
</tr>
<tr>
<td>4. Excessive H$_2$SO$_4$ in Etch solution.</td>
<td>Filter solution and clean (strip) tank.</td>
</tr>
<tr>
<td>5. Contamination of Electroless plating solution</td>
<td>Strip racks thoroughly</td>
</tr>
<tr>
<td>6. Deposition on plating racks.</td>
<td>Reduce temperature or time in catalyst</td>
</tr>
<tr>
<td><strong>Blistering after Electroplating step.</strong></td>
<td></td>
</tr>
</tbody>
</table>
1. Overheating at rack contact points, due to the poor electrical contact, at these points or neighboring areas of the pars.

Redesign the rack contacts.

**No Electroless deposition.**

1. Wrong polymer.
2. Low reducer in Electroless bath.
3. Low Etch temperature.
4. Insufficient Activation.
5. Insufficient Acceleration

*Check the grade and type of polymer for platability.

Analyze and correct.

Check thermostat and heaters.

Increase temperature in the activator, or decrease time in accelerator. Increase acceleration time. Analyze and correct concentration.

**Slow Electroless deposition.**

1. Catalyzing and/or Activating solution too dilute.
2. Sensitizing and/or activating solution too cold.
3. Electroless plating solution too dilute.
4. Electroless deposit too cold.
5. pH of electroless solution too low

*Strengthen sensitizing and/or activating solution.

Warm-up sensitizing and/or activating solution.

Regenerate electroless solution according to operating instructions.

Warm-up solution.

Adjust pH

**Conducting layer burns during electroplating**

1. Electroless deposit too thin.
2. Current density too high.
3. Contact points too small.
4. Contact points worn through work movement.
5. Bipolar effect-anodic dissolution.

Prolong the plating time.

Reduce current density to 3-5 ASF.

Increase contact area or size of contacts.

Repair racks.

a. Better space racked parts.

**Poor adhesion between electroless and electroplated metals.**

1. Plastic surface contaminated with mold release compound.
2. Etching time too short.
3. Etching time too long.
4. Etching solution too concentrated or too hot.
5. All other conditions being satisfactory, molding characteristics such as stresses, strains, in the molded parts are present.
6. Electroless Nickel has become passive.

Do not use mold release compound.

- Prolong etching time.
- Reduce etching time.
- Dilute etching solution or work at lower temperature.
- Contact molder.

Use full strength Watts nickel bath for a strike; or use a Wood’s nickel; or use sulfamate nickel.

Use Cu-pyrophosphate bath before bright copper or nickel.

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.
2. Stresses and strains in molded plastic part.
3. High pH and to low concentration in the catalyst solution.
5. Electroless solution plates too fast.

Analyze for Cr(VI), Cr(III) and total acidity.

- Contact molder for remedial action, after checking for strains and stresses using glacial acetic test.
- Analyze.

- Lower treatment time.
- Lower temperature in electroless bath or its reducer concentration.

**Incomplete (skip) deposition, or complete absence of plating.**

1. Work contaminated with silicone.
2. Inadequate etching.
3. Work racked too close.
5. pH or temperature of Electroless solution too low.
6. Excessive Etch solution run-out from blind holes, recesses, etc.
7. Concentration of catalyst metal too low, and too low temperature at too low pH.
8. Etch time and temperature too low for certain ABS plastics and highly stressed surfaces.
10. Electroless deposit dissolving in Acid copper solution.

- Avoid use of silicone mold release compounds.
- Replace cleaner or increase its concentration.
- Extend treatment time in etching bath and increase temperature.
- Improve the racking of the parts.
Increase contact area or size of contacts.
Replace Neutralizer.
Increase time.
Adjust pH
Warm-up Electroless solution.
Improve rinsing and agitation.
Analyze and correct Catalyst bath
Adjust the temperature and pH.
Stressed surfaces and certain plastics may require highest obtainable temperatures and/or longer times.
Increase time in Neutralizer.
a. Strike deposit in Woods Ni-strike.
Strike in Cu-pyrophosphate before transferring to Acid copper bath.

**No Electroplated deposit.**

1. Bad racking.
2. Initial current density (CD) too high, causing “burning-off” of thin electroless deposit.
3. Electroless deposit dissolving in Acid copper solution.

Improve racking, so that contact points are in medium to high CD areas. Eliminate air pockets.
Start electroplating step at low CD, ramping to full current within 2 minutes.
Strike deposit in Woods Ni-strike or in Cu-pyrophosphate strike before transferring to acid copper bath.
Electroplate immediately, or activate in activating dip.

**Sand-paper Effect**

1. Electroless bath out of balance, giving solid particles precipitation.
2. Plastic surface over etched
3. Dirty electroless solution.

Analyze and filter electroless bath.
Lower the time and the temperature in the etch tank.
Filter bath

**Plating on plating Racks**

1. Poor racks maintenance.
2. Too High pH and Concentration of the Catalyst solution.
3. Too high temperature in the Catalyst solution.
4. Too high concentration and/or time in the Catalyst solution.
5. Too long time in the post-catalyst (Accelerator) solution.
6. Build-up of the catalytic metal or metallic dust in rack striper solution.
7. Contaminated Accelerator solution due to the build up of metallic dust.
a. Strip racks regularly.
Lower the concentration of catalyst and/or pH.
Lower the temperature of the catalyst solution.
Lower the concentration and the time in the Catalyst solution.
0. Lower the time in the Accelerator solution.
Replace the rack striper solution.
Replace the Accelerator solution.

**Voids or Air Pockets**
1. Poor cleaning.
2. Insufficient agitation.
3. Low total acidity in etch tank.
4. Poor rinsing of etch solution or inefficient post conditioner solution.
Analyze or replace cleaner.
Increase agitation.
0. Analyze for total acidity in the Etch solution.
Improve rinsing; or replace post-conditioner solution.

**Dull Electroless Plating**
1. Electroless bath out of balance.
2. Over etching.
a. Analyze and correct the bath.
Lower the temperature and/or time in the etch tank.

<table>
<thead>
<tr>
<th><strong>High Drag-in</strong></th>
<th>1. Poorly engineered rinse tanks</th>
<th>. Change rinse tank design to counter current flow and add spray rinses, especially after Etch and Catalyst tanks.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall poor appearance of the plated part</strong></td>
<td>1. Sink marks, pits, splay marks, etc</td>
<td>Contact molder.</td>
</tr>
</tbody>
</table>

**References**

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