Best Operating Practices for Pollution Prevention in Electroplating

By:
Frank Altmayer, MSF, Consultant and Technical Education Director, AESF Foundation/NASF
Pollution Prevention in Electroplating

Focus Areas:

• Masking
• Racking
• Process Solutions
• Rinse Systems
• Maintenance and Housekeeping
BOP of Process Solutions

Focus on Maintenance

- Accurate and frequent solution analyses
  Use of statistical process control (SPC)
- Removal of dropped parts
- Deionized water use
- Bus bar maintenance
- Control of operating parameters
- Filtration
- Use of inert anodes
- Contamination removal
BOP of Process Solutions

Analytical Control of Process Solutions:

Constituent Concentration

± 10%

Time

±2% Optimum Level
Selecting Masking Materials

Factors to Consider:

- The amount of labor/skill required
- Part geometry and size/weight
- The chemical resistance of maskant
- The chemical resistance of adhesive
- The temperature limitations of maskant
- Cleaning requirements
- Physical resilience of maskant
- Ability to seal complex surfaces
- Spec Requirements
- Ease of maskant removal
- Cost to purchase and disposal of residuals
UV Curable Masks

Potential Applications:

- Acid Based Stripping
- Anodizing
- Plating (including EN and Hard Chromium)
- Chemical Milling
- HVOF/Plasma Spray
- Painting/Powdercoating
- Blasting/Shot Peening/Vibratory Finishing

Photo courtesy of Dymax Adhesives & Light Curing Systems Inc.
UV Curable Masks

Burn-Off Masking Resins
- Best surface adhesion
- Greatest resistance to heat/aggressive chemical solutions
- Secondary heat curing capability
- 900°F to 1400°F (~15 minutes)
- Maskant is incinerated leaving no residue

Peel-able Masking Resins
- Good adhesion
- Resilient enough for grit blasting, shot peening, acid cleaning, plating and anodizing
- Removed through by peeling
- Cured in a few seconds with UV light
- Can be used in multiple process steps
- Maskant waste is non-hazardous

Water Soluble Masking Resins
- Used in "dry" finishing processes such as grit blasting, grinding, shot peening, and plasma spraying
- Maskant dissolves in hot water (140° - 180° F) and a spray wash or agitated/ultrasonic bath
- Maskant completely dissolves in the water leaving no residue
- 20% maskant in water has a pH of 7
UV Curable Masks

UV Curing Systems

System Factors
- Spectral output of the lamp
- Lamp intensity
- Size/shape of part
- Production rate

Spot Lamps
- Generate high intensity UV energy that is directed through a fiber or liquid filled light guide, typically 5-8 mm in diameter
- Ideal for curing UV Masking Resins in cooling holes or sealing off core cavities

Flood Lamps
- For larger surfaces like airfoils and housings
- Footprints up to 8" square.

Note: When cured, the resin changes color (blue to pink for example) to indicate a complete cure.
Reducing Mask Usage in Hard Chromium Plating

Plating tank has no anodes

Anode fixture for plating hydraulic part shown

Solution may be pumped into Anode/cathode compartment during plating

Anode Assembly
Out-of-Tank Plating

Features:

• May Eliminate Masking
• Small solution volume required
• High agitation velocities
  - Higher CCE
  - Less pitting
• Very High Plating Speeds
• Uniform Thickness

Hydraulic Cylinder, With No Drain Holes
Parts Lost in Processing

Chief Causes of Dropped/Lost Parts:

- Poor Rack Maintenance
- Poor Barrel Door Maintenance
- Poor Operator Practices

Prevention:

- Preventative Maintenance
- Inspection Program
- Scheduled Removal Program
Good Rack Maintenance Practices

**Damaged Coatings:**
- Ruptured coatings at the corners or the bottom of a rack or at rack tips can cross-contaminate all process solutions and will corrode the splines.
- Remove damaged racks from service.

**Broken Tips:**
- If 1 of 10 tips is broken = 10% loss in productivity.
- Do not strip tips with pliers.

**Heavy Plating Buildup on Tips:**
- Inspect for build-up on tips and chemically strip excess.
- Strip rack tips frequently.
Good Rack Maintenance Practices

Proper Rack Handling/Storage:

- **Hooks/Tank Bus:**
  - Inspect/clean inside of hooks frequently for better conductivity.

- **Suspended racks from hooks to protect the PVC**

- **Do not store racks on the floor**
Proper Rinse Practices

Opportunities for Improvement:

- Rinse agitation
- Countercurrent rinsing
- Air knives/sprays
- Reactive rinsing
- Proprietary plating barrels

How Water Can Be Wasted
Proper Rinse Practices

Single vs. Counterflow Rinses:

- Single rinses may be suitable for lines in sporadic use
- Counterflow rinses dramatically reduce water usage in high volume production

DI vs. Tap-water:

- Use DI water for process solution make-up and replenishment
- DI is not always the best choice

<table>
<thead>
<tr>
<th></th>
<th>D.I. Water*</th>
<th>Tap*</th>
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<tbody>
<tr>
<td>Calcium</td>
<td>&lt;0.05</td>
<td>10-75</td>
</tr>
<tr>
<td>Magnesium</td>
<td>&lt;0.05</td>
<td>5-20</td>
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<tr>
<td>Sodium</td>
<td>&lt;0.05</td>
<td>1-20</td>
</tr>
<tr>
<td>Iron</td>
<td>&lt;0.05</td>
<td>&lt;0.01-1</td>
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<tr>
<td>Chlorides</td>
<td>&lt;0.10</td>
<td>10-250</td>
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<tr>
<td>Sulfates</td>
<td>&lt;0.10</td>
<td>20-250</td>
</tr>
<tr>
<td>Conductivity</td>
<td>1µmS</td>
<td>500-5000µS</td>
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</table>

*mg/L
Multiple Use Rinsing

Clean Rinse -> Acid Rinse

To Waste Treatment

Exit of Acid Rinse must be 3” higher than Clean Rinse
Reactive Rinsing

Clean

Clean Rinse

To Waste Treatment

Acid

Exit of Acid Rinse must be 3” higher than Clean Rinse

Acid Rinse
Spray Rinses/Air Knives

- Match spray pattern to part shape
- Mix air with water to reduce consumption
- Make spray nozzles easy to service
- Spray over hot process tanks when possible
- Use Low Pressure Blower Air, 15 psi
- Air Should Be Highly Humidified
- Use De-Ionized Water to Avoid Nozzle Clogging
- Design Nozzles for Optimum Coverage
Controlling Water Usage

- Turn back main valve
- Install flow restrictors
- Timer
- Conductivity Controllers with inductive loop probe(s)
- Flow Meters
- Monitor using rotameters
Process Ventilation

**Downdraft:**
- Collects Condensation
- Collects Mists
- Creates Nice View
- Ineffective for Very Hot Processes

**Updraft:**
- Condensation/Mist Returned to Process
- More Effective on Very Hot Tanks

**Part-time Updraft**
- Major reduction in exhausted air
Proper Ventilation Practice

Eliminate ventilation system obstructions:

Bus bar blocks ventilation and is corroded by mist.

Bus bar blocks push air.

Hard Chromium Plating Tank
Tank Liner Design/Maintenance

- **Most Common Hard Chrome Liners:**
  - Standard Rigid PVC (Koroseal®)
  - High performance PVC (HP Koroseal®)

- **Conductive:**
  - Lead alloy
  - Titanium

- **Non-Conductive:**
  - CPVC
  - Rigid PVC + HP Koroseal®
  - Halar fluorocarbon
  - PVDF (Kynar®)
  - Polypropylene
  - High density polyethylene
  - Acid brick

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<table>
<thead>
<tr>
<th>Liner</th>
<th>Skirt</th>
<th>Life (yrs)</th>
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<tbody>
<tr>
<td>3/16” Koroseal®</td>
<td>None</td>
<td>2-3</td>
</tr>
<tr>
<td>3/16” Koroseal®</td>
<td>1/8” PVC</td>
<td>4-5</td>
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<tr>
<td>3/16” Koroseal®</td>
<td>1/8” PTFE</td>
<td>5-7</td>
</tr>
<tr>
<td>3/16” Koroseal®</td>
<td>1/8” PVDF</td>
<td>7+</td>
</tr>
</tbody>
</table>

**Note:** annual spark test is highly recommended
Tank Insulation

- Heavily used tanks:
  - Insulation may prevent efficient cooling of solution

- Infrequently used tanks:
  - Insulation conserves energy
Installation of Polyurethane Insulation

- Use “C” Clamp To Hold Outer Shield In Place During Foaming
- Caulk Between Tank Lip & Outer Shield Lip
- Solidified Foam Holds Shield In Place
- 1” of Polyurethane Foam
- Injection Hole In PVC Outer Shield. Cover After Injection
- Wood or Plastic Spacer

Insulated Hard Chrome Tank

Partial View Of Tank Wall
Control Operating Parameters

**Higher Operating Temperature**
- Lowers viscosity
- Increases evaporation
- May increases plating efficiency

**Eductor Agitation**
- May increase plating efficiency
- May improve plating distribution
- Reduces air emissions
- Increases anode efficiency

**Higher Current Density**
- May increases plating efficiency
In-Tank and Out of Tank Filtration

In-Tank Filter

Out of Tank Filter

Notes: Install Out of Tank Filters in Trays
Use Re-usable Filtration Media
Anode Bags

- Improper bags and bags in poor condition generate waste
- Inspect frequently
- Replace annually or every 2 years
- Use the correct material and weave

Example, for bright nickel plating:
- Cast, Rolled Carbon, Electrolytic Anodes
  - Cotton (96 warp x 64 weft) 8 oz/yd^2
- Cast, Rolled Carbon, Electrolytic, S Rounds
  - Cotton Flannel (64 x 40) 12 oz/yd^2

Double Bagging:
- Inside: One of the above,
- Outside:
  - Dynel (38 x 29) 6.25 oz/yd^2 or
  - Dacron (67 x 47) 4.75 oz/yd^2
ToRemove Contamination from Plating Solutions

Metallic:

- Low current density electrolysis
- Chemical Treatments
  - Hydrogen peroxide
  - pH adjustment
  - Polysulfides
- Ion Exchange/Membrane Technologies

Organic:

- Activated carbon adsorption
- Hydrogen peroxide treatment
- Prevention is better than treatment

Carbonates:

- Chilling
- Chemical precipitation
BOP of Process Solutions

Dragout Reduction:

- Use of dragout tanks
- Installation of drain boards / hang bars
- Increase dwell time
- Reduce removal rate
- Optimum racking & part geometry
- Use of wetting agents
- Reduce viscosity of solution
- Installation of air knives
- Proper rack / barrel maintenance
Proper Use of a Drag-out Rinse

Hot Processes:
Optimum Sequence:
1. Drag-in
2. Plate
3. Drag-out
4. Rinse

Cold Processes:
Use DI/DO System

Drag-in / Drag-out System

For Room Temperature Processes:

Typical Drag-out recovery = 40-50% of Normal Losses
Reducing Drag-out

Options:

• Optimize part withdrawal rate:
  – 15 - 25 ft/min

• Optimize dwell time before rinsing:
  – 15-20 seconds
  – Exceptions: Nickel Plating, Chromates

• Reduce surface tension of the solution

• Increase the operating temperature of the solution

• Decrease the concentration of solution ingredients
More BOP on Barrels

- Holes should be tapered (bigger on outside)
- Holes should be as large as possible but less than 30% of wall area
- Eliminate Plugged holes
- Maintain Dangler Cable Insulation
- Dangler Sleeve May Be Feasible in Some Cases
- Maintain Doors/Clips
- Minimize Dangler Metal Build-up
- Avoid Oscillating Equipment on Cup-Shaped Parts
- Replace old style holes with slots
Proper Design/Use of Drip Trays

Best Design Returns 100% of Drippage Back to Process Tank

Other Designs May Direct Some Drippage to Rinse Instead!

Good Drip Tray Usage/Design?
Practice Good Housekeeping

Inspection/maintenance of:

- Floors
- Secondary containment
- Overflow protection
- Tank construction/liners
- Storage tanks
- Ventilation systems
- Pits
- Pipes/pumps
- Heat exchanger/cooling coils
- Controller/pump calibration

Grating and collection tray routes drippage to collection system for return to process or treatment
Additional Good Housekeeping Recommendations

Chemical Purchasing/Handling

- Waste management
- Dead man switches on water hoses
- Sample returns
- Inventory control
- Storage segregation
The End

Thank You!