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# Modern Trivalent Chrome Plating Technology Comparison

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# Technology Comparison

- Sulfate
  - Sulfate base and Iridium Mixed Metal Oxide anodes
- Chloride
  - Chloride salts and graphite anodes
- Hexavalent
  - Chromic acid and lead anodes

# CHROME APPEARANCE

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | Blue-bright chrome color. Can get close to hex chrome blue-bright appearance. Not exact! |
| Chloride-based Trivalent | Not blue-bright, darker in color. |
| Hex Chrome Plate | Beautiful blue-bright. |

# EASE OF CONTROL

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | Very easy and routine, wider operating parameters. |
| Chloride-based Trivalent | Very easy and routine, wider operating parameters. |
| Hex Chrome Plate | Difficult due to very tight operating parameters. |

# INCREASED PRODUCTIVITY

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | Averaging 33% - 50% increase in pieces per rack. |
| Chloride-based Trivalent | Averaging 33% - 50% increase in pieces per rack. |
| Hex Chrome Plate | Limiting factor. |

# REJECT RATES

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | Low due to ease of operation, no tendency for white wash, and no threat of burning. |
| Chloride-based Trivalent | Low due to ease of operation, no tendency for white wash, and no threat of burning. |
| Hex Chrome Plate | Up to 15% due to tight operating parameters, potential white wash, and potential burning. |

# Comparison



## IMPURITIES

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | High tolerance – Metallics can be plated out. |
| Chloride-based Trivalent | Low tolerance - Ion exchange filtration is required. |
| Hex Chrome Plate | Extremely high tolerance with the exception of chlorides. |

# Tolerance Comparison

| Contaminant | SULFATE | CHLORIDE | HEX |
|---|---|---|---|
| Copper | 10 ppm | 0 ppm | 10,800 ppm |
| Nickel | 50 ppm | 20 ppm | 5,100 ppm |
| Iron | 30 ppm | 100-150 ppm | 1,600 ppm |
| Zinc | 30 ppm | 20 ppm | 2,700 ppm |

# TEMPERATURE

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | 50 - 58° C.<br>No solution growth. |
| Chloride-based Trivalent | 25C. solution growth can be an issue |
| Hex Chrome Plate | 30-50C |

# Comparison



## BURNING

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | No burning. |
| Chloride-based Trivalent | No burning. |
| Hex Chrome Plate | Susceptible to burning. |

# WHITE WASH

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | Not susceptible to current interruption. Not dull @ 0.8 um |
| Chloride-based Trivalent | At times blue-wash like white wash on edges of parts. (High Thickness) |
| Hex Chrome Plate | Current interruption of all types causes white wash. |

# POST TREATMENTS

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | Required on un-plated steel. Ex: Tubular. |
| Chloride-based Trivalent | Required on un-plated steel. Ex: Tubular. |
| Hex Chrome Plate | None required. |

# COATING HARDNESS

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | Slightly softer than hex chrome. |
| Chloride-based Trivalent | Slightly softer than hex chrome. |
| Hex Chrome Plate | Hardest, so can be polished in the aftermarket without fear of wearing down the coating. |

# ANODES

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | Special anodes are required. Approved sources are critical |
| Chloride-based Trivalent | Graphite |
| Hex Chrome Plate | Lead |

# WASTE COSTS/TOXITY

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | Lowest waste costs and safer to operate. On a dry basis 1/10 the sludge is generated per volume of treated solution. |
| Chloride-based Trivalent | Low waste cost (exception of ammonia restriction in some municipalities) and safer to operate. |
| Hex Chrome Plate | High waste costs and safety hazard to employees. |

# COST OF CHEMISTRY

| Advantage Indication | Disadvantage Indication |
|---|---|
| Sulfate-based Trivalent | $0.04 USD/ sq. ft. |
| Chloride-based Trivalent | Can cost more than sulfate $0.06/sq. ft. |
| Hex Chrome Plate | $0.02 USD/ sq. ft. |

# Bright Trivalent Chrome Evolution

## Recent Improvements

# New vs. Old

- Conducted studies to improve process for high thickness applications.
  - Hex chrome
  - Metals
  - Temperature
  - Chrome
  - Brightener

# Improved Sulfate System



## Improved Plating Rate

- Modified additives to reduce hex formation
- Chrome Levels 8-15 g/l vs. 6-8 g/l
- Increase Operating Temperature

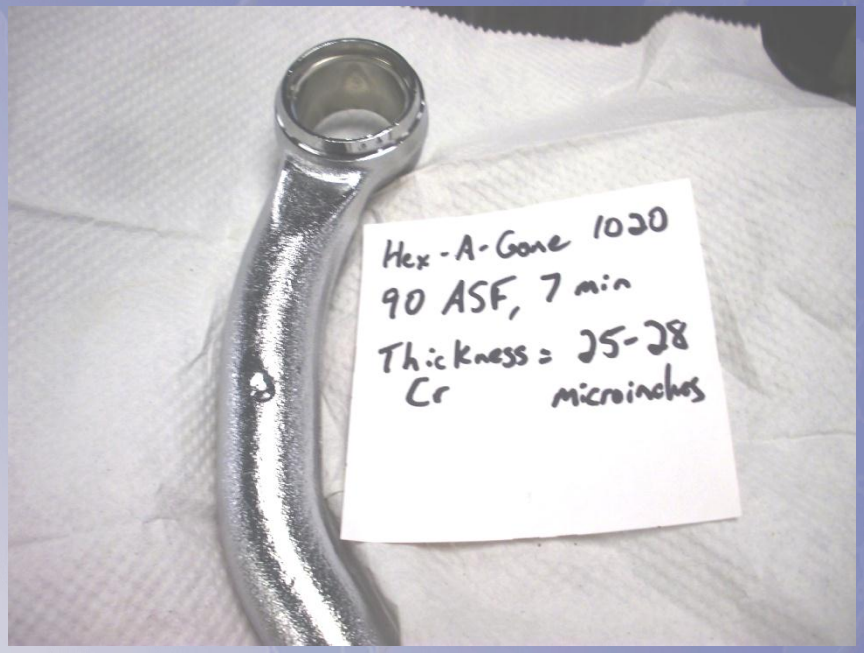
# Plating Rate – 10 Minutes

| Standard | New |
| --- | --- |
| 0.25-0.4 microns /10 minutes | 0.5-0.8 microns/ 10 minutes |

# Operating Conditions

| | Range | Optimum |
|---|---|---|
| Temperature | 52-60° C | 57° C |
| pH | 3.3-3.8 | 3.5 |
| Cathode Current Density | 4-10 ASD | 7 ASD |

# Improved Plating Rate





0.7 microns – 7 minutes

# Metallic Contamination

- Metal contamination of iron, nickel, and zinc have high impact on efficiency and appearance
- 200 ppm Nickel – Plated deposit is 90% nickel, 10% chrome
- 150 ppm Zinc – Plated deposit is 100% Zinc
- 100 ppm Iron – Plated deposit is 60% iron
- Deposit color with metals is Poor
- Need for service tool to remove metallics

# Metallic Contamination



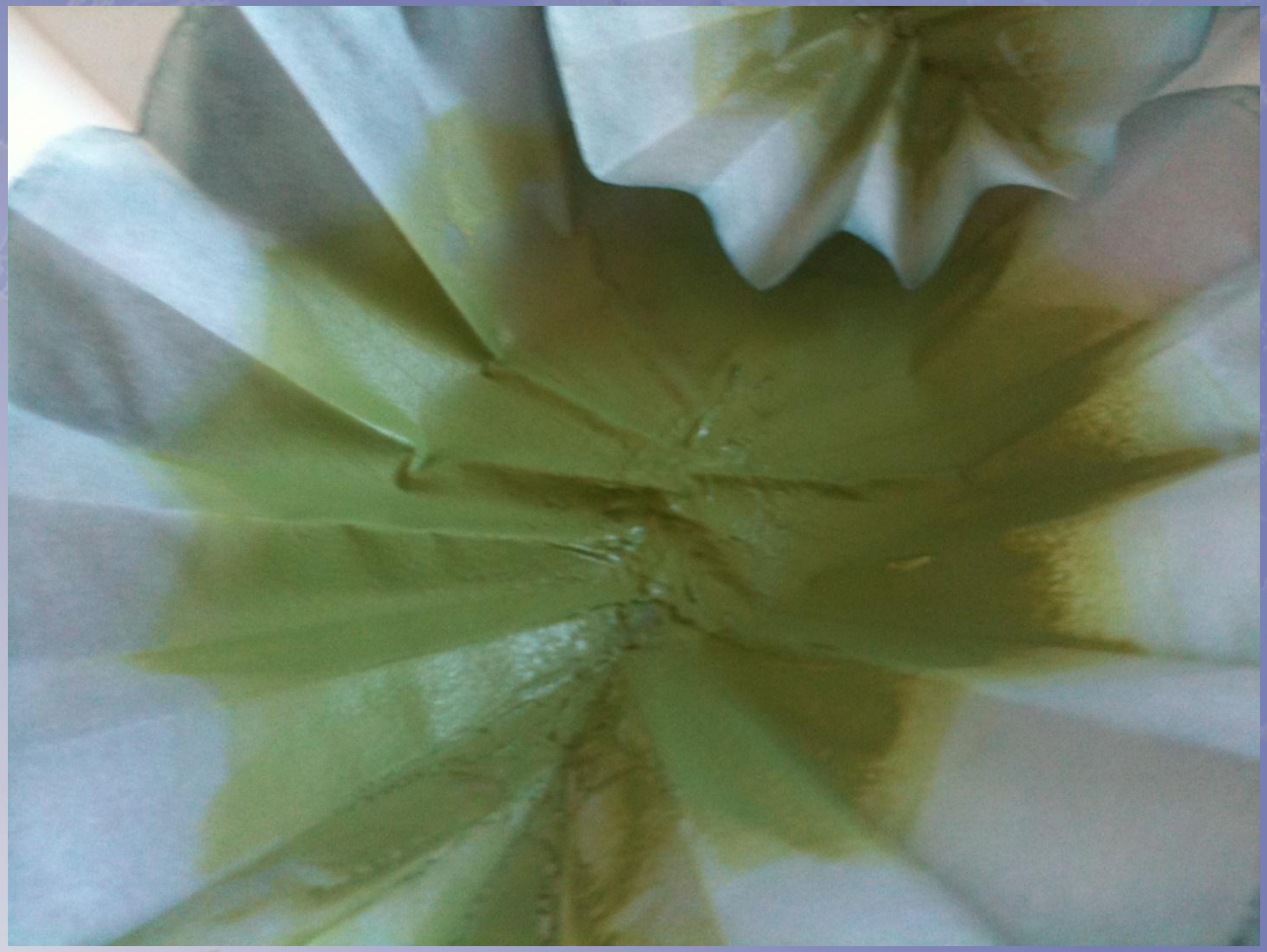
## Service Tools are Available to Remove Metallic Contamination

- Metal precipitant, binds and precipitates nickel and iron
- Keep plating, no down time
- Consistent Plating Rate
- Consistent Color

# Metallic Contamination



## 200 ppm Nickel treated with 0.25% Purifier



# Control Issues

1. Hex Chrome formation
2. Efficiency
3. Analytical Technical Support
4. Metal contamination

# Cr+6 Formation

Serious issue with Cr+3 baths. Cr+6 causes thin deposit and skip plating.

Issues causing High Hex chrome:

- **Specific Low Additive.** Specific additives must be analyzed to insure correct solution concentrations.
- **Incorrect Additive Addition Rate** – Platers must make regular and correct additive additions based on amp hours.
- **Anode Quality** – Poor anode quality will cause Cr+6 formation.
  - NO Mesh – inconsistent coating thickness, poor conductivity
  - High quality anodes must be used. Pavco has approved anode sources.
- **Chloride-** Test bath samples for chloride in. Excess chloride due to poor nickel rinsing can be a problem for anode coating and for additive consumption.

# Thickness Testing

**Knowing plating rate and total thickness is critical to maintain proper operation of modern sulfate based Cr+3 plating solutions.**

# Metal Contamination

It is important to understand the effect of metal contaminants.

- Nickel reduces efficiency and gives poor color.
- Iron improves LCD but causes bad darkening of the deposit.
- Zinc ties up additives and slows the plating rate down. Extra additives must be added to help maintain the plating speed and thickness in the presence of zinc.
- Platers will better understand this with the availability of thickness data.

# How to get Blue color

- No hex chrome
- Good plating rate, total thickness over 0.2 microns
- Keep nickel and iron low
- Purify by dummy plate or ion exchange routinely
- Use Purifier if not dummy plating
- Must dummy or ion exchange for zinc

# Measuring Color – LAB

L= light intesity
A= red/green
b= blue/yellow

Blue = (-) b
Yellow = (+)  b

Hex chrome = -1.5 to -1.9
Trichrome sulfate = -0.5 to -1.0
Trichrome chloride = +0.5 to +2.0
Nickel = +4

# Summary

- Modern Cr+3 plating is a viable alternative to Cr+6 plating for most applications.
- Overall cost of modern Cr+3 plating is less than Cr+6 plating.

# Summary

- Color and hardness of modern Cr+3 plating is comparable to Cr+6 plating.
- Understanding metallic contamination, plate thickness, plating rate and additives are important for successful operation of modern Cr+3 plating baths.

# Thank You!

Thanks for your attention!

Questions?