HE CHROME

HIGH SPEED MIXED CATALYST HARD CHROME SYSTEM

INTRODUCTION

HE Chrome is a high speed, etch-free, mixed catalyst hard chromium plating process. The process is maintained by the addition of a secondary catalyst to the chromic and sulfuric acid. The higher efficiency provides numerous benefits as compared to conventional hard chromium plating baths. The system is designed to run at a lower chromic acid/sulfate ratio resulting in a maximum uniform micro-cracked pattern providing extremely high hardness for enhanced part longevity due to high wear and corrosion resistance.

BENEFITS

- Non-etching (fluoride-free)
- Improved thickness distribution
- High cathode efficiency – up to 2x conventional
- Maximum micro crack pattern (>2,500 cracks / linear inch) for enhanced wear and corrosion protection
- Reduced porosity in high builds
- Less build up on sharp corners and cylinder ends
- High hardness (1,050 – 1,100 KHN^{100} Vickers or 69 – 70 Rockwell R_C)
- Increased wear resistance – 2x conventional chrome
- Reduces time to plate and electricity consumption – up to half less
- Reduces total amp-hours for air quality management permits

SOLUTION MAKE-UP*

Chromic Acid Flake	275 g/L (36.7 oz/gal)
Sulfuric Acid (see Op Data)	2.75 g/L (0.37 oz/gal)
HE Chrome	2.8% v/v (28 ml/L)
DHC Mist Suppressant	2 – 3 ml/L

*Make-up for maximum efficiency. Other combinations will see enhanced performance over conventional chrome plating.

OPERATING DATA

Chromic Acid	270 – 285 g/L (36.0 – 38.0 oz/gal)
Sulfuric Acid 100:1	2.70 – 2.85 g/L (0.36 – 0.38 oz/gal) = 1.0% w/w with chromic acid
Sulfuric Acid 90:1 (maximum micro-cracks)	3.00 – 3.14 g/L (0.40 – 0.42 oz/gal) = 1.1% w/w with chromic acid
HE Chrome	1.4 – 2.8% (14 – 28 ml/L) (See Maintenance and Control)
Density*	23 – 24 Bé @ 68°F
Current Density	2 – 4 ASI (280 – 560 ASF)
Plating Rate @ 2.6 ASI (370 ASF)	1.8 mils/hr
Plating Rate @ 3.1 ASI (450 ASF)	2.4 mils/hr
Temperature	130 – 140°F
Voltage	6 – 12 volts
Maximum Cathode Efficiency	23 – 24%
Surface Tension	≤30 dynes/cm (with suppressant)

*With no contaminants

EQUIPMENT

Tanks	Steel, lined with PVC or polypropylene
Heaters	PTFE, lead alloy or tantalum immersion with thermostatic control
Ventilation	Recommended, in conjunction with Spray Suppressant
Agitation	Solution agitation is necessary to ensure uniform temperature and avoid layering
Rectifier	12 – 15 volt units with maximum 5% ripple
Anodes	4 – 7 % tin/lead or antimony alloyed lead

INSTALLATION

It is essential that the tanks to be used for HE Chrome are thoroughly cleaned and TSP leached before any product is introduced. For new tanks or linings extended leaching at slightly elevated temperatures is required.

If there is any doubt as to the cleaning procedure please contact Automated Chemical Solutions.

1. Remove anodes and ancillary equipment (coils, thermostats, etc.) to allow thorough cleaning of tank by scrubbing walls and bottom.
2. Rinse thoroughly with water.
3. Fill the tank to approximately 70% of required final volume with water and heat to 120°F.
4. Add the calculated quantity of chromic acid and stir to dissolve.
5. Add the HE Chrome and mix thoroughly.
6. Analyze for sulfate and add sulfuric acid accordingly (0.54 ml/L 93% = 1 g/L)
7. Add DHC Spray Suppressant.
8. Replace anodes and electrolyze using dummy cathodes at 6-12 volts for 3-4 hours at required plating temperature.

MAINTENANCE AND CONTROL

HE Chrome:
HE Chrome affects the bath efficiency and can be determined using an efficiency test in the lab. Average consumption of HE Chrome is 15 mls per lb of chromic acid (4 gals per 1000 lbs) OR 5 mls HE Chrome + 158 grams chromic acid every 1000 amp-hrs. NOTE: Any amount of HE Chrome will result in improved performance. Excessive HE Chrome will not affect the finish nor will it increase the maximum efficiency. HE Chrome without replenishment will be completely depleted through electrolysis.

Chromic Acid:
The chromic acid concentration can be estimated from the specific gravity of the solution, using Table 1 below.

The specific gravities shown in the table are for new solutions. As contaminants build up in the solution the specific gravity will not be a true measure of the chromic acid concentration and periodic chemical analysis is recommended.

Table 1

SPECIFIC GRAVITY OF HE CHROME SOLUTION*		
Chromic Acid g/L	**Specific Gravity**	**Degrees Bé**
250	1.175	21.60
260	1.182	22.30
270	1.190	23.15
280	1.196	23.80
290	1.202	24.20
310	1.215	25.66

*Measured at 60ºF

MAINTENANCE AND CONTROL (con't)

Anodes:
It may be necessary to remove insulating scale from some anodes. This can be done by scrubbing while wet. If the solution is left idle for an extended period (over shut-down, etc.) the anodes should be removed and left suspended in air. When plating begins again they should be electrolyzed to re-form the brown film.

Sulfuric Acid:
Regular analysis for sulfuric acid is recommended and a ratio of 1.1% w/w to chromic acid content should be maintained.

Sulfates:
To reduce sulfate, add barium carbonate as per Table 2.

Table 2

BARIUM CARBONATE ADDITIONS TO REDUCE SULFATE LEVEL				
g/L Sulfate To be removed	**Grams Barium Carbonate Required**			
	66 gal	132 gal	198 gal	264 gal
0.1	50	100	150	200
0.2	100	200	300	400
0.3	150	300	450	600
0.4	200	400	600	800
0.5	250	500	750	1000

Contaminants:
Built up metal contaminates should be maintained below maximum levels summarized in Table 3.

Table 3

Contaminate	Maximum Level
Trivalent chromium	1 – 2%
Chloride	22.5 ppm (0.003 oz/gal)
Total metallic contamination (Fe, Cu, Zn, Pb, Ni)	7.5 g/L (1 oz/gal)

When combined contaminate (including trivalent chromium) levels exceed 1 – 2 oz/gal (7.5 – 15 g/L), poor quality deposits will result. The solution conductivity will be reduced and increasing voltage will be required.

Various methods are available to reduce metallic contamination including setting up a porous pot (cation-selective membrane technology), ion-exchange resin system, or diluting the bath.

Metallic contamination effects can be also minimized with increased chromic acid (up to 0.5 oz/gal contamination maximum recommended). Rule-of-thumb: increase chromic acid 20-25% for 0.5 oz/gal maximum.

MAINTENANCE AND CONTROL (con't)

While a small amount of trivalent chromium is necessary for proper operation (1% maximum), too much will reduce brightness and will build up when using reduced anode area (ie., ID plating with auxiliary anodes).

Trivalent chromium can be oxidized by electrolyzing the solution using high anode area and low cathode area. Theoretically, an anode-to-cathode ratio of 27:1 is optimum. A 10:1 ratio is minimum and electrolyze the bath at 6 volts. If the 27:1 ratio can be obtained, 1 ounce per gallon (7.5 g/L) of trivalent chromium can be electrolyzed to trace amounts in about 12 hours at 130°F. At 10:1 ratio and 130°F, it will take about 24 hours to reduce the trivalent chromium to a trace. An anion/cation exchange system also reduces trivalent chromium.

NOTES ON SURFACE ACTIVATION: When using the plating bath for activation/etch, increase chromic/sulfuric acid ratio to 100:1 to overcome metal (iron) oxides. Run parts for 3 – 4 minutes for uniform grey color (if non-uniform, add more time; if black, the carbon formed will need physical removal). An alternative etch method is to install a separate chromic or sulfuric acid reverse etch tank.

ANALYSIS METHODS

1. Hexavalent chrome

Reagents

Ammonium bifluoride
Concentrated hydrochloric acid
Potassium iodide
Starch indicator
0.1N Sodium thiosulfate

Method

1. Pipette a 10 mls sample of the plating solution into a 500 ml volumetric flask and fill to the mark with DI water.
2. Mix thoroughly.
3. Pipette 10 mls of above dilution into a 250 ml Erlenmeyer flask.
4. Add 100 mls of DI water and 2 g of ammonium bifluoride and stir to dissolve.
5. Add 10 mls of concentrated hydrochloric acid and mix.
6. Add one spatula of potassium iodide and stir to dissolve.
7. Place in the dark to react for 5 minutes.
8. Titrate with 0.1N sodium thiosulfate to a pale straw color, add starch indicator and continue titration to a light green color.

Calculation

Chromic acid (g/L) = mls of 0.1N sodium thiosulfate X 16.67

Replenishment

For every 1 g/L required: add 1 g/L chromic acid and 0.033 mls/L HE Chrome

ANALYSIS METHODS (Cont.)

2. Sulfates (sulfuric acid)

Reagents

Concentrated hydrochloric acid
Hydrogen peroxide solution
30% w/v barium chloride solution
5% v/v hydrochloric acid

Method

1. Filter a sample of the working solution.
2. Pipette a 10 mls sample of the filtered solution into a 500 ml beaker.
3. Add 20 mls DI water and 20 mls concentrated hydrochloric acid.
4. Add hydrogen peroxide drop by drop until no further effervescence is seen and the solution is a blue-green color.
5. Heat to boiling and add 2 mls of 30% barium chloride solution.
6. Continue boiling for 2 minutes.
7. Add 200 mls boiling DI water and continue boiling for 2 hours.
8. Allow to stand overnight.
9. Filter into a Whatman 542 filter paper.
10. Rinse the beaker into filter with hot DI water.
11. Rinse beaker into filter paper with hot 5 % hydrochloric acid.
12. Rinse filter with hot DI water until paper is clean.
13. Weigh a dried crucible and record weight as ‘A’ in grams.
14. Transfer paper to the crucible and burn off in furnace for 1 hour at 1472°F (800°C).
15. Ensure no carbon residues remain in the crucible.
16. Transfer crucible to a desiccator and allow to cool.
17. Weigh the crucible and record weight as ‘B’ in grams.

Calculation

Sulfuric acid (sulfate) (g/L) = (weight B – weight A) X 42.02

Replenishment

For every 1 g/L required add 0.54 mls/L sulfuric acid (93%)

STORAGE

Store in original containers above 40°F

SAFETY

CAUTION! HE Chrome concentrate and working solutions contain acidic and chrome components. Avoid contact with eyes, skin and clothing. Wear chemical handler's gloves, goggles and protective clothing when handling. Read and understand Material Safety Data Sheet before using this product.

PRODUCT GROUPS

The following products are referred to in this data sheet.

PRODUCT NAME	PRODUCT NUMBER
HE Chrome	417004
DHC Mist Suppressant	411010

NOTICE

The information and recommendations of PMD (UK), Ltd. and Automated Chemical Solutions, Inc., and its representatives, regarding this product are, to the best of our knowledge, true and accurate. We make no guarantee of results because the conditions of actual use are beyond our control. We assume no liability for damages or penalties resulting from the use of this product or following our recommendations. Our recommendations and suggestions for use of this product are not intended to grant license to operate under or infringe any patent.