Decorative Trivalent Chromium Deposits Applied by Barrel Electroplating

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TOPICS

History

Chromium Barrel Plating Overview & Approach

Review of Parameters and Analysis

Conclusion & Next Steps

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History of Trivalent Chromium Plating

- In 1939 the U.S. Bureau of Mines began research and developed a electrowinning process in the 1940s.
- Union Carbide also began research on trivalent chromium at this time.
- Together they broke down many obstacles in the art of trivalent chromium plating.

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History of Trivalent Chromium Plating

- In the early 1970's Albright Wilson further developed the process, their big contributions were additives to prevent the formation of hexavalent chromium and a method to precipitate metallic impurities.
- The Albright Wilson chemistry was a mixed sulfate/chloride electrolyte.
- There were other developments that were sulfate only electrolytes.

History of Trivalent Chromium Plating

Trivalent Chromium plating has proven to be a viable alternative to hexavalent chromium in both cost and performance in decorative rack plating for over 20 years.

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Chromium Barrel Plating

Until recently, chromium was never successfully applied in a decorative barrel process simply due to the limitations of hexavalent chromium electrolytes.

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Chromium Barrel Plating - Hexavalent

Hexavalent Chromium is prone to burning in the HCD areas.

Hexavalent Chromium does not tolerate current interruption.

Therefore it is nearly impossible to plate Hexavalent Chromium in a Barrel.

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Trivalent Chromium Barrel Plating

Trivalent chromium does not burn.

Trivalent chromium tolerates current interruption.

Therefore it is theoretically possible to plate trivalent chromium in a barrel.

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Trivalent Chromium Barrel Plating - Key Advantage

For small parts such as bolts, screws, sockets and fittings, trivalent chromium barrel plating can provide dramatic labor savings.

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Trivalent Chromium Barrel Plating - Challenges

Coverage of deposit is less than nickel.

Conductivity of solution is less than nickel.

Approach to Problem

Evaluate current electrolyte used for rack plating then modify to meet barrel plating needs.

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Evaluate current electrolyte used for rack plating for use in barrel plating

80 ASF - 5 minutes		
	Cr Thickness Screw Head (nm)	Cr Thickness Screw Thread (nm)
Average	**228.26**	**7.94**
Standard Deviation	**150.90**	**5.63**

>95% REJECTS

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Evaluate current electrolyte used for rack plating for use in barrel plating

125 ASF - 5 minutes		
	Cr Thickness Screw Head (nm)	Cr Thickness Screw Thread (nm)
Average	**216.74**	**32.84**
Standard Deviation	**130.74**	**18.78**

>95% REJECTS

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Evaluate current rack electrolyte for use in barrel plating

Conclusion: Electrolyte needs modified to improve coverage.

Electrolyte Modification

Electrolyte was then modified to improve coverage.

Modify Electrolyte to Optimize Coverage

70 ASF - 5 minutes		
	Cr Thickness Screw Head (nm)	Cr Thickness Screw Thread (nm)
Average	**259.02**	**94.06**
Standard Deviation	**124.14**	**94.79**

33% REJECTS

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Electrolyte & Contact Modification

Contact area was also modified to further optimize coverage.

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Modify Electrolyte and Contact Area

50 ASF - 5 minutes		
	Cr Thickness Screw Head (nm)	Cr Thickness Screw Thread (nm)
Average	**217.69**	**83.20**
Standard Deviation	**107.95**	**63.34**

15% REJECTS

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Modify Electrolyte and Contact Area

80 ASF - 5 minutes		
	Cr Thickness Screw Head (nm)	Cr Thickness Screw Thread (nm)
Average	**356.63**	**93.87**
Standard Deviation	**143.22**	**56.96**

5-10% REJECTS

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Electrolyte, Contact Area and Load Modification

Mixed Load to further
test different part geometries.

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Modify Electrolyte and Contact Area - Mixed Load

70 ASF - 5 minutes		
	Cr Thickness Screw Head (nm)	Cr Thickness Screw Thread (nm)
Average	**181.41**	**104.29**
Standard Deviation	**63.38**	**60.52**

NO REJECTS

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Conclusion

By modifying the electrolyte and optimizing the cathode contact area - barrel trivalent chromium is a commercially viable process

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Future Work

Identify additional trial sites

Evaluate in larger barrel sizes

Evaluate on other part geometries

Complete field testing and analysis