

Selectively Plated Trivalent Chrome

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Background

- Developed 10 years ago by Dr. Zoltan Mathe at Liquid Development Corporation (LDC).
- Process is fully developed, but main customer interest has been for smaller, limited applications such as touch-up of existing chrome.
- Referred to as LDC-HTC³

Properties of LDC-HTC³

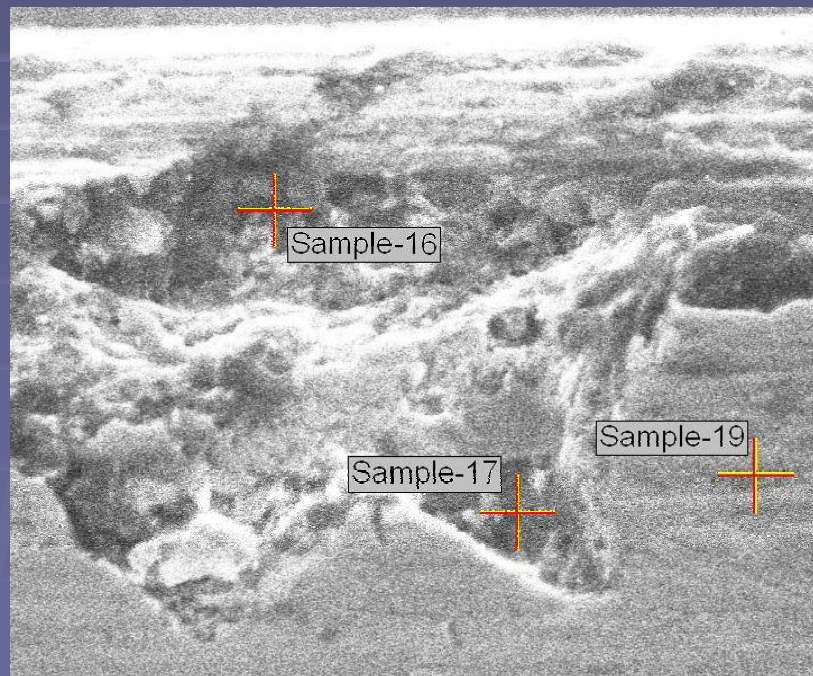
- Hardness (HV) 900-1200
 - As good or better than Electrolytic Hard Chrome (EHC)
- Taber Wear Index of 0.7 mg/1000 cycles
 - 3 times better than EHC
- Coefficient of friction equal to EHC
- Can build deposits 3 times faster than EHC
- Application of a nickel flash prior to LDC-HTC³ eliminates need for post bake. No hydrogen embrittlement.
- Line of sight NOT required

Repair of Existing Chrome

- LDC-HTC³ can build new chrome on existing chrome.
- No need to strip existing chrome if remaining coating is acceptable.

Coating Thickness

- Can plate to thicknesses in excess of 10-mils.
 - Cause of pitting seen at thicker coatings isolated and identified at Tinker AFB.

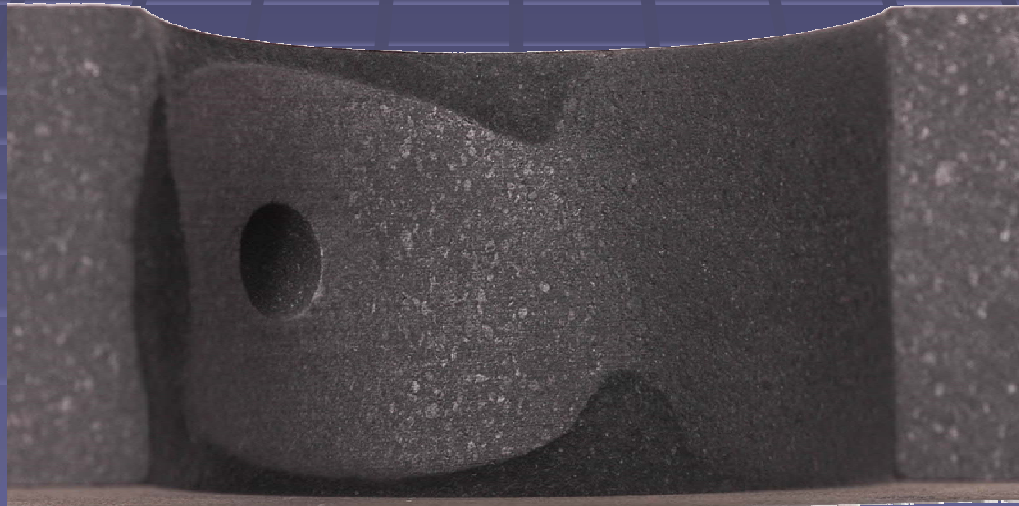


Sample-19
0.0% Carbon

Sample-16
48.7% Carbon

Sample-17
62.5% Carbon

- Carbon contamination caused by corrosion of graphite anode used in the process.



- Replacement of graphite anode with platinum niobium mesh eliminates graphite contamination.

Coating Thickness

- Coating thickness can very accurately be predicted by measuring amp-hrs during the process.
 - Thickness predictions +/- 0.00001 inches possible with selective plating.
- “Plate To Tolerance”

Coating Finish

- Surface finishes as good as 10 Ra have been measured at Tinker.
 - Surface finishes better than 16 Ra generally called for after grinding and polishing.
- “Plate To Finish”

Post Machining

- “Plate to Tolerance, Plate to Finish”
- Post grinding and polishing may be completely eliminated

Micro/Macro Cracking of Coating

- To date, no micro or macro cracking has been observed in LDC-HTC³ coated samples
 - EHC has large tensile stresses associated with it, resulting in microcracking “spider webs”.
- The lack of cracking in LDC-HTC³ could mean:
 - Large residual stresses could remain in the coating and are not being relieved by microcracking as in EHC.
 - Coating does not crack during cutting and grinding of metallurgical samples.
 - Residual stresses in LDC-HTC³ could be less than those in EHC.
 - Selectively plated coatings in general are less porous and more dense when compared to tank plated coatings.
- Lack of cracking could mean a dramatic improvement in corrosion resistance of LDC-HTC³ as compared to EHC.

Environmental/Safety Hazards

- LDC-HTC³ is
 - Non-oxidizing
 - Non-toxic
 - Non-carcinogenic
 - Non-corrosive
 - pH of 7.0
- Process is carried out in a “closed system”.
 - 6 gallons of solution contained in a closed heater/pump system.
 - Solution is passed through anode over part and returned to heater/pump.
 - No chrome rinse water is generated.
 - Solutions used to prepare parts (~65 mL per part) are segregated and collected.
 - A finding of “CATEX” is anticipated at Tinker
 - “No significant individual or cumulative effect on the human environment”

Lean Cell Applicable

- LDC-HTC³ is ideally suited to the Lean Cell concept.
 - Equipment is low cost
 - Less than \$30,000 per station.
 - Small footprint needed
 - Equipment fits on a workbench
 - Very little masking of part is required
 - Taping of boundaries using plating tape
 - Cleaning and preparatory steps carried out using selective plating equipment
 - Parts can be completely processed in as little as 4 hours
 - Ready to be reinstalled

Cost Comparison for Trivalent Brush Plated Chrome vs. Electrolytic Chrome Technologies			
	Trivalent Brush Plated Chrome		Hexavalent Chrome Plating
Capital and Installation (Per Trichrome Lean Cell)	\$30,000		N/A
Operational Costs:			
Consumables Cost (25 square inch area, 1500 parts annually)	\$121,247		\$109,875
Gas	\$0		\$0
Labor (Including "Shipping & Handling" and Post-Plate Machining and Polishing for HVOF and Hexchrome)	\$29,580		\$318,750
Rinsewater treatment	\$0		\$500
Disposal	\$0		\$1,000
Annual Total (w/o capital)	\$150,827		\$430,125
Economic Analysis Summary:			
Annual Savings for Trivalent Brush Plated Chrome:			\$279,298
Capital Cost for Diversion Equipment/Process:			\$30,000
Payback Period for Investment in Equipment/Process:	Years		0.11
	Months		1.29

Current Status

- Submission of project to ESTCP complete.
 - Submitted with contributors from
 - Tinker Air Force Base
 - Oklahoma City ALC
 - Army Research Labs
 - Naval Research Labs
 - NAVAIR
 - Naval Air Systems
 - PEWG
 - HCAT
 - Boeing
 - Pratt & Whitney
- Supplementary funding obtained at Tinker AFB
 - Testing will continue during ESTCP review process.

Summary

- Metallurgical properties measured to date “as good or better” than EHC
- Process does not require line of sight
- Could eliminate stripping of existing chrome
- Could eliminate post grinding and polishing
- Environmental and health concerns greatly reduced or eliminated