

Selectively Plated Trivalent Chrome

Presented by
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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

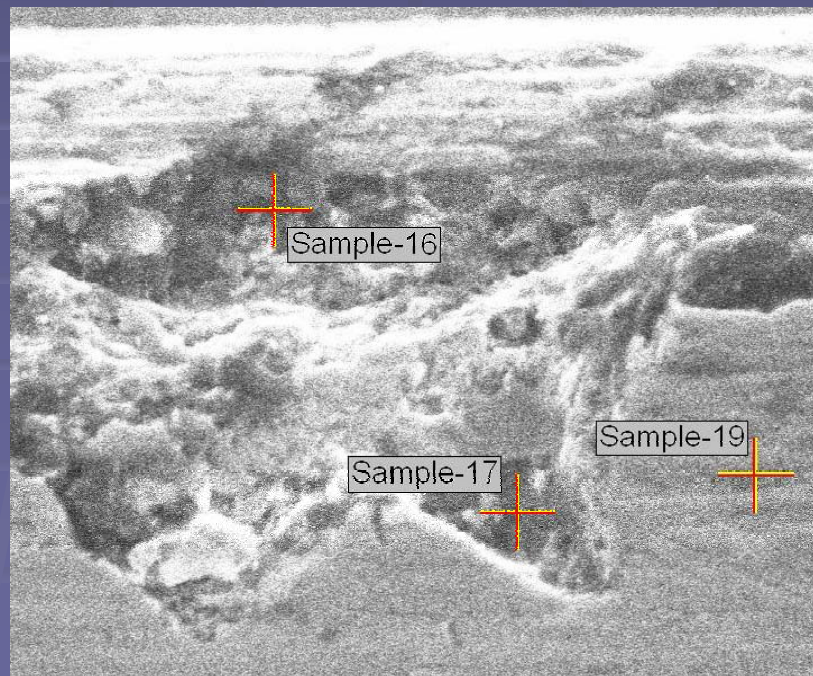
- Hardness (HV) 900-1200
 - As good or better than Electrolytic Hard Chrome (EHC)
- Taber Wear Index of 0.7 mg/1000 cycles
 - 3 times better than EHC
- Coefficient of friction equal to EHC
- Can build deposits 3 times faster than EHC
- Application of a nickel flash prior to LDC-HTC³ eliminates need for 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.

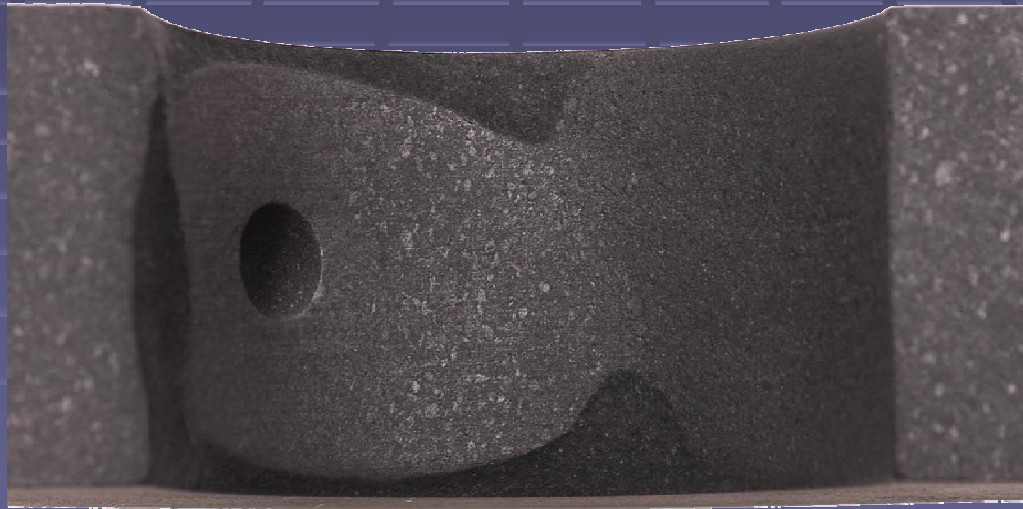


Sample-19
0.0% Carbon

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	Electrolytic Hexavalent 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