

DoD Metal Finishing Workshop May 16-17, 2007



Chrome Alternatives for Metal Protection By William Wittke, Matthew Clark

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Collective Goals

- Processes that ensure increased reliability with low life cycle costs.
- Processes that avoid exposure to toxic/hazardous substances during manufacturing/maintenance.
- Processes that eliminate pollution sources, monitoring and compliance reporting.
- Processes that can be used globally.



Possible Replacement for Powdered Hexavalent Chrome Conversion Coatings

Reasons: Exposure concerns

Elimination of chrome/lead/zinc in paint system

Substitute: Liquid Hexavalent chromate products

Performance: Develops corrosion resistance and paint adhesion per Mil-DTL-81706B (QPL)/Mil-DTL-5541F Type I, Class A & B

Alodine® 1600



Alodine® 1600



Possible Replacement for Hexavalent Chrome Conversion Coatings

Reasons: Environmental/Exposure/Corrosion Concerns

Elimination of chrome/lead/zinc in paints

New platform material restrictions

Substitute: Trivalent chrome conversion coating for Aluminum, Titanium, and Magnesium

Anodize seal for Aluminum

Performance: Meets Mil-DTL-81706B (QPL)/Mil-DTL-5541F Type II, Class A & B.

No hexavalent chrome in product or coating.

Alodine® T 5900, Alodine® T 5900RTU



Alodine® T 5900, Alodine® T 5900 RTU



Possible Dry-In-Place Touch-Up – Trivalent Chrome Conversion Coatings

Reasons: Environmental/Exposure/Corrosion Concerns
Where no pre-treatment equipment is available.

Substitute: Dry-In-Place Trivalent chrome treatment

Performance: Develops corrosion resistance and paint adhesion. No hexavalent chrome in product or coating

Currently being tested to Mil-DTL-81706B

Alodine® 871 Touch-N-Prep® Coatings



Possible Non-Chrome Replacement for Chromate Conversion Coatings Promoting Paint Adhesion

Reasons: Environmental considerations
Exposure concerns

Substitute: Non-chrome, non-phosphate conversion coating for Aluminum, Titanium, and Magnesium.

Performance: Pre-paint conversion coating permitted for TT-C-490E use on 5000 or 6000 aluminum alloys, passing 120 cycles of GM9540P. Chemistry greatly improves paint adhesion and significantly reduces all forms of under paint corrosion on aluminum.

Alodine® 5200, Alodine® 5700



Alodine® 5200, Alodine® 5700



Alodine® 6000 SG

- Based upon Sol-Gel technology licensed from the Boeing Company.
- Alodine® 6000 SG is a two part solution. It consists of Alodine® 6000 SG part A and Alodine® 6000 part B.
- Qualification testing is in process with Boeing.



Aluminum/Titanium Painting and Bonding

Reasons: Environmental/Exposure Concerns

Substitute: Sol-Gel Technology

Performance: Conversion coating allows for superior adhesion of paint and adhesives to aluminum/titanium surfaces. Surface preparation can be either mechanical or chemical. Can be air cured or heat cured.

Alodine® 6000 SG



Possible Non-Chrome Replacement for Chrome Conversion Coatings on Aluminum Castings

Reasons: Corrosion Problems/Environmental/Exposure Concerns

Substitute: Titanium Electrodeposited Oxide Coating (5-7 microns)

Performance: Coating offers superior corrosion protection for aluminum castings in corrosive environments (marine, engine exhaust gasses, temperature, etc.).

Alodine® EC2™



Alodine® EC²™
SEM images of coating on aluminum

- Surface contains closed cell random pores and ripples/wrinkles Visible at 65,000X

Alodine® EC²™
TEM Images on aluminum

Platinum*
EC² Coating
Substrate

*Platinum Present for imaging preparation

- Sample is cut through inter-hole region using FIB
- The nominal size of the sample:
Length: 15 um; Depth: 10 um; Thickness: 100 nm

Alodine® EC²™

- **Surface Properties**
 - Hardness = 600-800 Vickers (Nano-indentation)
 - Flexibility = 1-2 "T" Bend
 - Chemical Resistance = Acids & Alkali
 - Thermal Cycle = 5°C to 600°C
 - Unaffected by boiling ethylene glycol water mixtures
- **Corrosion Resistance**
 - 3000-6000 hrs Most Wrought Aluminum Alloys (unsealed)
 - 1000-3000 hrs Cast Aluminum Alloys (unsealed)
- **Bonding Compatibility**
 - Most paints/adhesives
 - Thermal Spray Coatings

Alodine® EC²™

Possible Replacement for Cadmium and Zinc Plating

Reasons: Corrosion Problems/Environmental/Exposure Concerns

Substitute: Titanium Electrodeposited Oxide Coating (5-7 microns)

Performance: Coating protects aluminum, aluminized steels, hardened aluminized steels, and titanium. Stops mixed metal galvanic couples. Heat resistant to 600° C. No regulated heavy metals. Flexible. Paintable.

Alodine® EC²™

Alodine® EC²™

Flexibility - Crosshatch followed by impact (metal fractured)

Aluminized Steel Bolts after Salt Spray

Titanium Fasteners