**Enhanced Trivalent Chromium Pretreatment Coatings for Light Metals**

**Introduction**
- Current primer substrates for aluminum alloys contain hazardous chromium, a known carcinogen and environmental pollutant.
- Alteration to materials that are hazardous does not provide the obvious color change seen with hazardous chromium (silver to gold).
- This leads to difficulty identifying the presence of coating for quality control purposes (silver to aluminum appearance).
- **New enhanced trivalent chromium pretreatment coating (eTCP) provides obvious color change (silver to blue in purple) along with excellent corrosion resistance, low electrical resistance, and paint adhesion.**

**What is conversion coating?**
- Underlying and base for primer.
- Improves corrosion resistance and primer adhesion.
- Commercially available (COTs) color additions.
- Navy and industry goal of 90% on uniform/defect free MIL-DTL-81706 MIL-DTL-81706 MIL-DTL-81706 QPL Pass.
- Reduces/eliminates Cr6+ at Fleet Readiness Centers (FRCs).
- Savings: $3M in labor/materials for HM cleaning at FRCs/year.
- 12,000 gallons of Cr6+ solution representing 22% of all Cr6+ usage across all FRCs.
- Microscopic visual color changes are seen on various aluminum alloys (e.g., 2024-T3, 2024-T3, and eTCP-Violet as an anodized seal per MIL-A-8625F and eTCP-Blue).
- Wide application as a conversion coating on various light metals.

**Technical Progress – FY18 (CRADA)**
- Pre-activated TCP and dyes.
- 10+ new dyes tested in laboratory.
- 31 produced acceptable color.
- 2 produced unacceptable corrosion resistance.
- Poor corrosion resistance.
- Uneven color change.
- **Color Changes**
  - Color change with eTCP compared to bare metal.
- **Technical Progress – FY18 (CRADA)**
  - Testing TCP at NASL, April 2018.
  - Objective: Evaluate 8 primer colors with TCP-Melac.
  - Test: Exposure testing of painted panels.
- Paint Adhesion
  - Testing paint adhesion on eTCP-Blue per MIL-O-21366 and FED-STD-141D via external testing at Altair Testing Laboratories.

**Performance Criteria**
- Salt Fog Corrosion
  - Two colors: blue and violet.
  - 2 produced acceptable corrosion resistance.
- **Technical Progress – FY18 (CRADA)**
  - Paint adhesion risk.
- Color Change
  - Color change with eTCP compared to bare metal.
- Low Electrical Resistance (LER) results (In Progress)
  - Average before salt spray for TCP-Violet = 125 ± 3 5 µΩ/in.
  - Average before salt spray for TCP-Blue = 125 ± 3 2 µΩ/in.
  - ALU-2024, 5052 and 6061 Ti 17 cell open circuit potentials (OCP) - 1,200,000 µΩ.
  - Two orders of magnitude below specification limit.

**Contact**

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**Technical Overview**
- **E TCP Anodized Aluminum Seal**
  - Type II and Type IIB anodized aluminum sealed with eTCP-Violet.
  - Requires MIL-A-84227 requirements of 328 hours.
  - Converts standard COTS color coatings to eTCP-Violet as an anodized seal per MIL-A-84227 and FED-STD-141D.

**Background**
- Chronic Pretreatments
  - Industry standard for over 60 years.
- Hazardous chromium, Cr6+ 90%.
- Non-hazardous chromium, Cr3+ 10%.
- **Trivalent Chromium Pretreatment**
  - Developed by NAVAIR in 2005.
  - **Background**
  - Multiple pass change (MPG).
  - **Enhanced Trivalent Chromium Pretreatment (eTCP)**
  - Goal: to provide obvious color change.
  - **Performance**
  - Color change with eTCP compared to bare metal.
  - **Technical Progress – FY18 (CRADA)**
  - Testing TCP at NASL, April 2018.
  - Objective: Evaluate 8 primer colors with TCP-Melac.
  - Test: Exposure testing of painted panels.
- **Technical Progress – FY18 (CRADA)**
  - Paint adhesion risk.
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**Conclusions**
- Enhanced TCP (eTCP) provides superior corrosion resistance (>1000hr) and paint adhesion.
- Other Aerospace Applications
  - Spray application to aircraft.
  - Post treatment for Cadmium.
  - Post treatment for Zinc-Nickel.
  - Post treatment for Class III IVD Aluminum.
  - Conversion coating on other light metals.
  - Magnesium, zinc.
  - Stainless galvanic anodes.

**Enhanced Trivalent Chromium Pretreatment**
- New formulation of eTCP
  - Two colors available and color.
  - eTCP-5052 (5052-T6) salt fog on AA2024 (ongoing external validation at Altair Testing Facility).
  - eTCP-Blue (5052-T6) salt fog on AA2024 (externally validated at Altair Testing Facility).

**Performance Criteria**
- Salt Fog Corrosion
  - Two colors: blue and violet.
  - 30 new dyes tested in laboratory.
  - Poor corrosion resistance.
  - Uneven color change.
  - **Color Changes**
  - Color change with eTCP compared to bare metal.
  - **Technical Progress – FY18 (CRADA)**
  - Testing TCP at NASL, April 2018.
  - Objective: Evaluate 8 primer colors with TCP-Melac.
  - Test: Exposure testing of painted panels.
  - Two orders of magnitude below specification limit.