



Non-Fatigue Protection Schemes

11 MARCH 2026

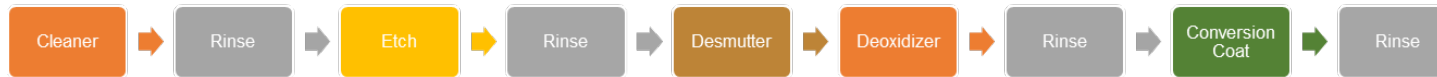
Presented to: AFCPCO 2026 NCTIM

Presented by: Joshua Walles

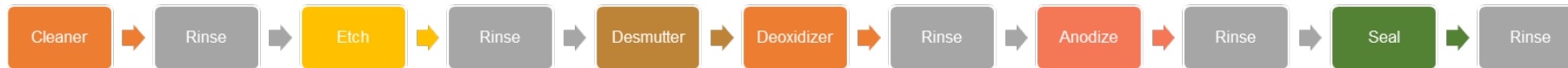


Electrolytic Conversion Coating (ECC)

Chemical Conversion Coating Process



Anodize Process



Electrolytic Conversion Coating Process



- ECC process improves performance and precision from chemical trivalent chromium pretreatment (TCP)
 - Cleaning, etching, and deoxidation chemistries
 - Compatible with aerospace products; primers, topcoats, fluids



Electrolytic Conversion Coating (ECC)



Conversion Coating

- Reduced fatigue debit
- Corrosion protection for about two weeks in ASTM B117 NSF
- Minimal coating resistance
- Coating weight is generally between 20-50 mg/ft²
- Sensitive to alloys
- Sensitive to upstream processes
- Reduced corrosion protection
- Easy touch up procedure

Electrolytic Conversion Coating

- Fatigue debit is less than that of Type IIB anodize
- Corrosion protection is similar to Type IIB
- Conductivity directly correlates to coating weight and can be targeted via coating weight
- Coating weight can be between 10-300 mg/ft²
- Improvement across alloy families
- Reduce sensitivity to upstream processes

Anodize (Types I, IC, II, and IIB)

- Fatigue debit between 5-50%
- Maximum corrosion protection – up to thousands of hours in B117
- Non-conductive coating
- Less sensitive to upstream processes
- Sensitive to alloys
- Coating weight is a minimum of 200mg/ft²
- Repair method is of a lower quality than the anodize



Patent and Licensees

• Electrolytic Process for Deposition of Chemical Conversion Coatings

• Co-exclusive Licensees

- Surtec International, GMBH
- Chemeon Surface Technology, LLC

(12) **United States Patent**
Matzdorf et al.

(10) **Patent No.:** US 11,155,928 B2
(45) **Date of Patent:** Oct. 26, 2021

(54) **ELECTROLYTIC PROCESS FOR DEPOSITION OF CHEMICAL CONVERSION COATINGS**

(71) **Applicants:** Craig Matzdorf, Hollywood, MD (US); Alan Grieve, Springfield, VA (US); Alexander Westbrook, Lexington Park, MD (US); Jeremy Mattison, California, MD (US)

(72) **Inventors:** Craig Matzdorf, Hollywood, MD (US); Alan Grieve, Springfield, VA (US); Alexander Westbrook, Lexington Park, MD (US); Jeremy Mattison, California, MD (US)

(73) **Assignee:** The United States of America as represented by the Secretary of the Navy, Washington, DC (US)

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 97 days.

(21) **Appl. No.:** 16/720,483

(22) **Filed:** Dec. 19, 2019

(65) **Prior Publication Data**
US 2021/0189580 A1 Jun. 24, 2021

(51) **Int. Cl.**
C25D 3/06 (2006.01)
C25D 7/06 (2006.01)

(52) **U.S. Cl.**
CPC C25D 3/06 (2013.01); C25D 7/0642 (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS

1,977,622 A	10/1934	Buzzard	
6,511,532 B2 *	1/2003	Matzdorf C09D 5/084 106/14.21
8,187,439 B2	5/2012	Wang et al.	
9,309,602 B2	4/2016	Wolpers et al.	
10,156,016 B2	12/2018	Kramer et al.	
10,274,468 B2	4/2019	Wolfgong et al.	
2006/0191599 A1	8/2006	Matzdorf et al.	
2019/0352791 A1	11/2019	Ozkaya et al.	

FOREIGN PATENT DOCUMENTS

WO	WO 1998/040542 A1	9/1998
WO	PCT/US20/18946	6/2021

* cited by examiner

Primary Examiner — Wojciech Haske
(74) **Attorney, Agent, or Firm** — Mark O. Glut; NAWCAD

(57) **ABSTRACT**
This invention is directed to a process of coating metal in a trivalent chromium conversion-electrolyte coating wherein the metal anode or cathode is subjected to a current density ranging up to about 3.0 amperes per square foot for a period ranging up to 60 minutes.

4 Claims, 8 Drawing Sheets





MIL Specification Revisions

- MIL-DTL-81706C

- Grade N – Non-electrolytic
 - Traditional chemical products/process
- Grade E – Electrolytic
 - New ECC process

- MIL-DTL-5541G

- Draft and comments to come following 81706C release

1.2.5 Grade. Chemical conversion coating and pretreatment materials are deposited according to the following grades (see 6.1.5 and 6.2):

Grade N - Non-electrolytic.

Grade E - Electrolytic with a maximum current density of 0.800A/ft² (0.086 A/dm²) with the working part acting as a cathode.

1.3 Part or identifying number (PIN). PINs to be used for the chemical conversion **and pretreatment** materials for coating aluminum and aluminum alloys acquired to this specification are created as follows:

<u>M81706</u>	-	<u>X</u>	-	<u>X</u>	-	<u>X</u>	-	<u>X</u>
Spec Code		Type Code		Class Code		Form Code		Method Code
		(1, 2, or 3)		(A, B, or C)		(1, 2, 3, 4, 5, or 6)		(A, B, C, D, E, F, or G)
								Grade Code (N or E)

ONR Future Naval Capability (FNC) Program



FNC Non-Fatigue Protection Schemes (Non-FAT)

Government Team



- Sponsor
- Programmatic and technical coordination and guidance
- Program Lead, Tech Warrant Holder
- Testing, Process Optimization
- Qualification, Transition



- Process Scale up, Field Testing
- Technology and Process Adoption

Program Partners



CHEMEON
SURFACE TECHNOLOGY



PennState
Applied Research Laboratory





Program Upcoming Activities

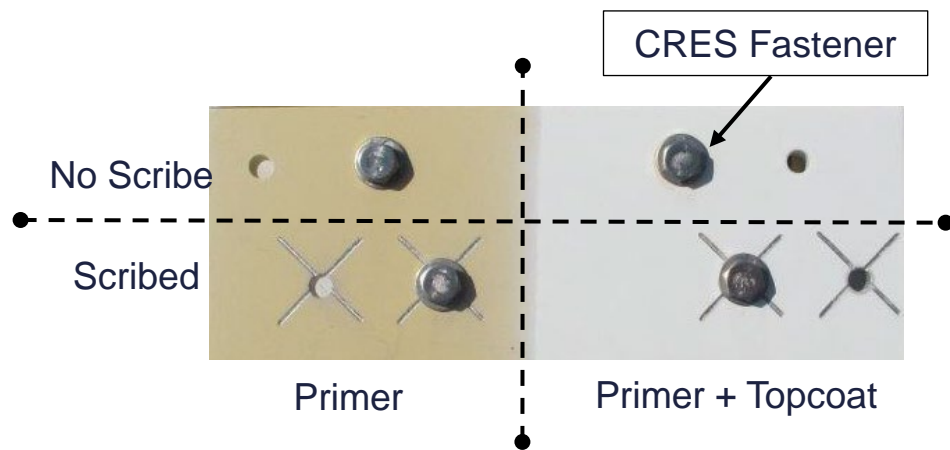
- Preliminary ECC study of Galvanic Corrosion
 - Outdoor exposure testing at NASA KSC
- Design of Experiments (DOE)
 - Determine Optimal ECC parameters
- Cleaning Steps Study
 - Impact of upstream processes on aluminum substrate
- Mechanistic study for ECC
 - Determine why/how ECC improves performance
- Formulation Improvements
 - Develop TCP formulations further enhanced by ECC process
- Stress Corrosion Cracking and Corrosion Testing
 - Study SCC risk and test methods for faster screening of aluminum
- Fatigue Characterization of ECC
- Component and Sub-System Level Testing
- Repair Techniques and Procedures
- Follow-On:
 - Aircraft Demonstrations and Transition



Preliminary ECC Study of Galvanic Corrosion

TEST DESIGN

- 60 Samples (12 Months Exposure)
- AA2024 Galvanic Sample with CRES Fasteners
- ECC and Control (Ty IIB Anodize) Sample Sets
- Primers
 - MIL-PRF-23377 - Class N
 - MIL-PRF-23377 - Class C2
 - MIL-PRF-85582 – Class C1
 - Al-Rich
- Topcoat MIL-PRF-85285, Ty IV (1/2 of Specimen)
- Scribe/Unscribed Locations

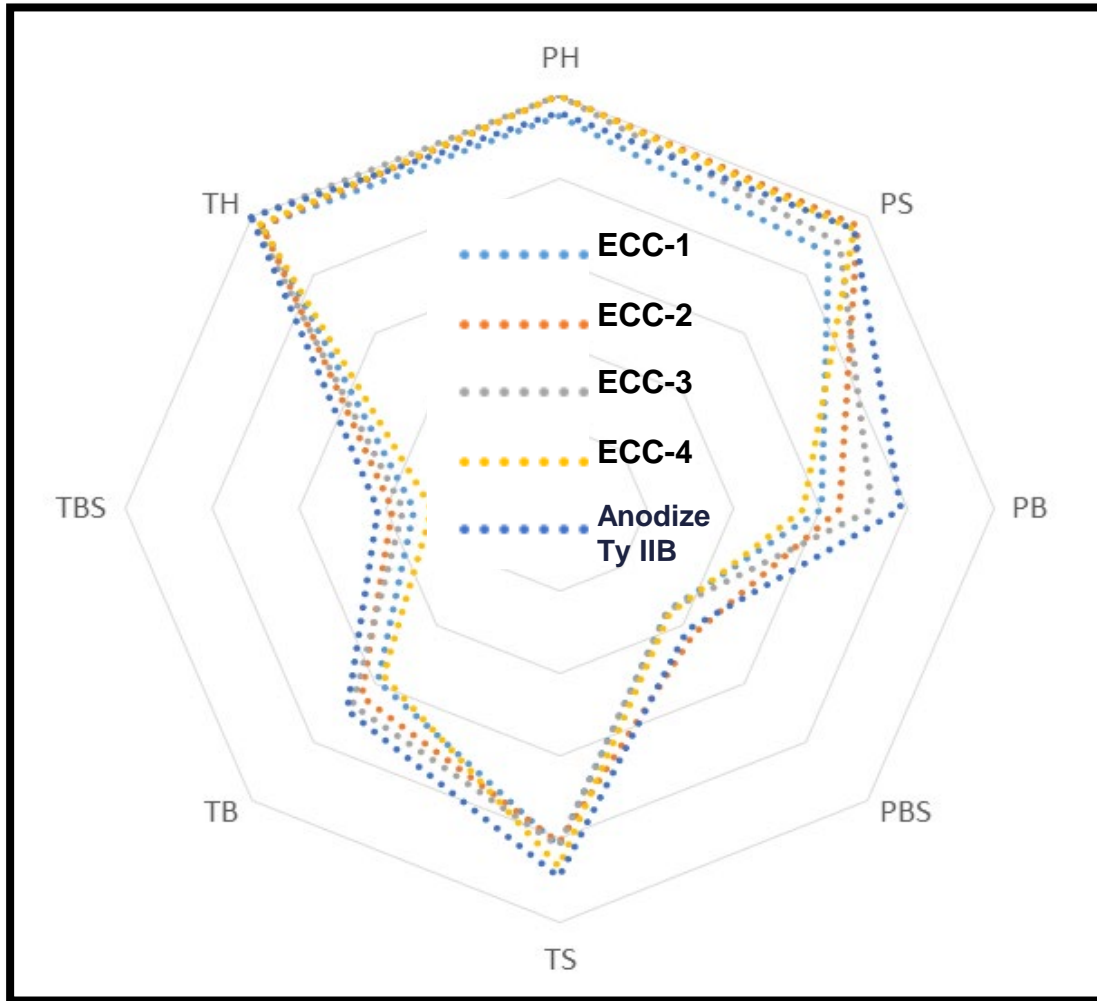


Zone	Description
PH	Primer Hole
PS	Primer, Scribed
PB	Primer Bolt
PBS	Primer, Bolt, Scribed
TH	Topcoat, Hole
TS	Topcoat, Scribed
TB	Topcoat, Bolt
TBS	Topcoat, Bolt, Scribed



Preliminary ECC Study of Galvanic Corrosion

RESULTS – Average Corrosion Rating (12 Months)



OBSERVATIONS

- Panel locations with CRES Fasteners presented greatest degree of degradation
- Panel locations with CRES Fasteners presented improved differentiation of process performance

Zone	Description
PH	Primer Hole
PS	Primer, Scribed
PB	Primer Bolt
PBS	Primer, Bolt, Scribed
TH	Topcoat, Hole
TS	Topcoat, Scribed
TB	Topcoat, Bolt
TBS	Topcoat, Bolt, Scribed



Design of Experiments (DoE)

- Process Optimization
 - NAWCAD investigating Solution Formulation, Concentration, pH, Application Time, and Current Density
 - Monitor performance in Corrosion Resistance, Coating Weight, Surface Conductivity, and Primer Wet-Tape Adhesion
- DoE Validation
 - Round robin optimized process at NAWCAD, FRC-E, FRC-SE, and FRC-SW for variance as a drop-in replacement with existing upstream procedures
 - Corrosion testing centralized at NAWCAD for consistency of B117 chambers



Academic Research Studies

- Impact of Upstream Processes
 - Cleaners, Etchants, and Deoxidizers
 - Comparison of Cr6+, Cr3+ (TCP), ECC, and Anodize on Aluminum
 - Surface studies
 - SEM, XPS, Raman, and tribology
 - Corrosion
 - EIS, OCP, B117
 - Fatigue comparison
 - Axial-round bars
- Mechanism of Electrolytic Deposition
 - Understand why performance increases with ECC process



Program Upcoming Activities

- Preliminary ECC study of Galvanic Corrosion
 - Outdoor exposure testing at NASA KSC
- Design of Experiments (DOE)
 - Determine Optimal ECC parameters
- Cleaning Steps Study
 - Impact of upstream processes on aluminum substrate
- Mechanistic study for ECC
 - Determine why/how ECC improves performance
- Formulation Improvements
 - Develop TCP formulations further enhanced by ECC process
- Stress Corrosion Cracking and Corrosion Testing
 - Study SCC risk and test methods for faster screening of aluminum
- Fatigue Characterization of ECC
- Component and Sub-System Level Testing
- Repair Techniques and Procedures
- Follow-On:
 - Aircraft Demonstrations and Transition



Help Requested

- FNC Program to be followed by Demonstration Project(s)
- On-aircraft dem/val and in-service monitoring
 - Looking for Collaborators across Services
 - Comparison to legacy systems
- Collaboration could include transition at multiple levels:
 - OEM Production
 - Depot Maintenance/Overhaul
 - Field Repairs

Contact Information

Joshua Walles
NAVAIR / NAWCAD
Coatings and Sealants Team Lead
(240) 256-4424
joshua.g.walles.civ@us.navy.mil