NAVAIR Progress in Assessing, Validating and Implementing Non-Chromate Primers

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NAVAIR Progress in Assessing, Validating and Implementing Non-Chromate Primers

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Overview

- Why?
- Application Areas: Status
- On-going efforts
- Implementation Strategy
- Comprehensive NC Primer Projects
- Where are we going?
Why?

To understand the balance between corrosion protection, environmental benefits, regulatory compliance and logistics for any new coating or coating system.
NAVAIR Application Areas for Hexavalent Chromium Alternatives: Status

- Alternatives Implemented/Niche Chromate Use Remains
- Limited Implementation/Near Term Validation
- No Implementation/Very Limited Implementation

Hexavalent chromium alternatives

- Aircraft & Components
- Support Equipment
- Bonding
- Painting
- Chrome Plating
- Aluminum Anodizing
- MIL-A-8625 Anodize
- Type IC Seal
- Type IIB Seal
- Type II Seal
- Aluminum Pretreatment
- Aluminum Bond Primer
- Aluminum Anodizing
- Type IC Seal
- Type IIB Seal
- Type II Seal
- Aluminum Bond Primer
- Aluminum Phosphating
- Aluminum Rinse (Steel)
- Aluminum Rinse (Aluminum)
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- aluminium bond primer
- aluminum coating
- aluminum plating
- aluminum anodizing
- aluminum phosphating
- zinc-nickel pretreatment
- cadmium plating
- type ii seal
- type iib seal
- type ic seal
# On-going Efforts

<table>
<thead>
<tr>
<th>Project/Primer</th>
<th>Goal</th>
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<tr>
<td>Mg-Rich Primer</td>
<td>Optimize primer for general use</td>
</tr>
<tr>
<td>Electrocoat Primer</td>
<td>Optimize, demonstrate and validate primer/process for aluminum component rework/repair</td>
</tr>
<tr>
<td>Non-Chromate, Zero VOC Coating System</td>
<td>Demonstrate and validate coating system for steel ground support equipment</td>
</tr>
<tr>
<td>Crosslink</td>
<td>Optimize and mature primer formulation for general use</td>
</tr>
</tbody>
</table>
Mg-Rich Primer

- Assessing MgRP003 formulation in testing:
  - P003 performs better than 1st and 2nd generation formulations (MgRP XP406/XP417)
- Modifications have greatly improved performance
- For use in Naval environment, self-corrosion failure mechanism in accelerated (NSS/SO$_2$) and beach environment must be understood and overcome
- NAVAIR pursuing cooperative research and development agreement (CRADA) with AkzoNobel to further improve performance to meet NAVAIR requirements
Electrocoat Primer

- Primer formula optimization in progress – NSS, SO₂, Galvanic assembly, Beach Exposure Testing
- Dem/Val location: FRC-Southwest (NAS NI)
  - Electrocoat tank installation
  - Demonstrate primer on aluminum components, such as wheel assemblies
Non-Chromate, Zero VOC Coating System

• Current coating process for steel: grit blast & paint direct to metal
• NC/ZVOC coating system to be demonstrated at FRC-East on Navy ground support equipment
• Laboratory Testing Complete – Humidity, RSL and WTA performed at NAS PAX, GM9540P & Pull-off Adhesion performed at ARL, Beach Exposure testing conducted at Cape Canaveral by Army.

<table>
<thead>
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<th>STEEL</th>
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<tr>
<td>Primed w/ Deft 02GN084 (23377N, Ty I)</td>
</tr>
<tr>
<td>Chemetall Oxsilan (NC Pretreatment)</td>
</tr>
<tr>
<td>Topcoated w/ Deft 55W002 (85285, Ty III)</td>
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</table>
Crosslink Primer

- Previously funded through ESTCP Project #WP-200904
- 3-component primer based on promising new NC pigment package
- Crosslink partnered with Hentzen Coatings, Inc. and Wayne Pigment Corporation to optimize and mature primer formulation
- In-house NSS/SO$_2$ testing in-progress
NC Primer Comprehensive Evaluation: (In-house Study)

- Evaluated coatings systems made up of 5 different pretreatments and 7 different primers.
- Scribed flat panels and galvanic assemblies tested in NSS, SO$_2$, and beach exposure
- Minitab - statistical analysis
Main Effects: All Coatings
Data Means

<table>
<thead>
<tr>
<th>Pretreatment</th>
<th>Primer</th>
<th>Topcoat</th>
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Mean

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<tr>
<th>Adhesion Promoter 1</th>
<th>Adhesion Promoter 2</th>
<th>Ty IC Anodize</th>
<th>23377N, Ty I</th>
<th>85582N, Ty I</th>
<th>23377C, Ty I</th>
<th>85582C, Ty I</th>
<th>Experimental Coating 1</th>
<th>Experimental Coating 2</th>
<th>no</th>
<th>yes</th>
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<tr>
<th>Fastener</th>
<th>Damage</th>
<th>Exposure Time (Months)</th>
</tr>
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<table>
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<th>1.0</th>
<th>1.5</th>
<th>2.0</th>
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</table>
Main Effects: Best Surface Treatments, All Primers

Data Means

Pretreatment

Primer

Topcoat

Mean

81706, Ty I
81706, Ty II
Ty IC Anodize
23377N, Ty I
23377C, Ty I
85582C, Ty I
85582N, Ty I
Experimental Coating 1
Experimental Coating 2
no
yes

Fastener

Damage

Exposure Time (Months)

CRES
Ti
none
sanded

0.5
1.0
1.5
2.0
2.5
3.0
4.0
5.0
6.0
7.0

Mean

8.0
8.5
9.0
9.5
10.0

Main Effects: Best Surface Treatments, All Primers

Data Means
Main Effects: Best Coatings
Data Means

Pretreatment

81706 Ty I
81706 Ty II
Ty IC Anodize
23377N Ty I
23377C Ty I
85582C Ty I
23377N Ty II
Experimental Coating 2
no
yes

Mean

9.0
9.5
10.0

9.0
9.5
10.0

9.0
9.5
10.0

Damage

none
scribed

Exposure Time (Months)

0.5
1.0
1.5
2.0
2.5
3.0
4.0
5.0
6.0
7.0

Fastener

CRES
Ti

9.0
9.5
10.0

9.0
9.5
10.0

9.0
9.5
10.0

Topcoat

Experimental Coating 2
no
yes

9.0
9.5
10.0

9.0
9.5
10.0

9.0
9.5
10.0

81706 Ty II
81706 Ty I
Ty IC Anodize
23377N Ty I
23377C Ty I
85582C Ty I
23377N Ty II

Pretreatment

Mean

Primer

Main Effects: Best Coatings

Topcoat

Experimental Coatings 2
no
yes

9.0
9.5
10.0

9.0
9.5
10.0

9.0
9.5
10.0

81706 Ty II
81706 Ty I
Ty IC Anodize
23377N Ty I
23377C Ty I
85582C Ty I
23377N Ty II

Pretreatment

Mean
Implementation Strategy

• Based on primer risk assessment

• Application Axis vs. Platform/Basing Axis

• Application Axis: Low-to-High Risk
  – 1 (L) – Composite/Fiberglass Surfaces
  – 2 (L) – Non-critical Metallic Surfaces – External Fuel Tanks, etc.
  – 3 (M) – Airframe Tie-Coat Applications
    • 3A – OML / 3B – IML – Topcoat or inspectable areas only
  – 4 (M-H) – Airframe Direct-to-Metal Applications
    • 4A – OML / 4B – IML
  – 5 (H) – Interior/Faying Surface/HS Components.
Implementation Strategy

• Platform Axis
  - 1 (L) – Trainer Aircraft – T-45, T-34, etc.
  - 2 (M) – Land based Aircraft – KC-135, C-40, etc.
  - 3 (M-H) – Special Land – P-8, H-53, etc.
  - 4 (H) – Ship-based Aircraft – E-2, H-60, etc.
  - 5 (H) – Ship-based Aircraft – *Specialty Coatings
    • F/A-18, EA-18G, F-35, etc.
Comprehensive Evaluation and Transition of NC Primers

- **GOAL:** Evaluation & dem/val of mature non-chromate primers for corrosion/environmental performance over a range of platforms and applications, starting with lower risk implementation strategies
- Focus on Navy-specific requirements:

<table>
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<tr>
<th>FRC-East</th>
<th>FRC-Southeast</th>
<th>FRC-Southwest</th>
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<tbody>
<tr>
<td><strong>V22:</strong> NC primer as tie coat with Type IV topcoat</td>
<td><strong>Ty I &amp; II NC coating systems, including Ty II conversion coating and NC anodize sealing</strong></td>
<td><strong>E-2/C-2:</strong> Leading Ty I NC Primer over CCC on outer moldline; if successful, implement coating system on interior/components</td>
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<tr>
<td><strong>H-46:</strong> Ty II conversion coating w/ mature Ty II, NC primer</td>
<td><strong>Dem/val NC primer on composite and avionics components</strong></td>
<td><strong>Transition E-2 coating system to F/A-18 Hornets</strong></td>
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<td><strong>Dem/val NC primer on composite components</strong></td>
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Comprehensive Evaluation and Transition of NC Primers

• **GOAL**
  - “Top down” assessment of current NC primer technology, including coating process MRL and coating TRL
  - Dem/val NC primers and processes with sufficient process and coating maturity and invest in development of promising newer technologies

• Test multiple substrates, surface conditions, exposure environments and coating combinations, comparing to CCC

• Joint service demonstration (Army, AF, USCG, USMC)
Where are we going?

- Use the NESDI and ESTCP efforts to address the DoD Cr\(^{6+}\) memos and anticipated new DFARS contract language and *accelerate* the transition of NC primers at DoD and OEM/Sub-contractors.

- Efforts will provide the data required to make authorization and implementation decisions, starting with low-risk applications and moving toward medium and high-risk applications as warranted by products.
Questions?