Progress in Implementing Non-Cr\textsuperscript{6+} Surface Finishes for U.S. Navy and Marine Corps Aircraft

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# Report Documentation Page

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<td>00-00-2012 to 00-00-2012</td>
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<td>Naval Air Warfare Center, Materials Engineering Division, 22347 Cedar Point Road, Patuxent River, MD, 20670-5304</td>
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*Standard Form 298 (Rev. 8-98)*

Prescribed by ANSI Std Z39-18
Agenda

→ Navy and Marine Corps Aircraft Applications

→ Progress in Implementing Alternatives

→ R&D Efforts
Applications

Conversion coatings for Aluminum: MIL-PRF-81706/5541 Type IA (general use)

- Type II excludes hexavalent chromium (8 qualified products from 4 companies)
- Includes products for immersion, spray, wipe and applicator pen methods
- Only qualified products to date for Class 1A are based on trivalent chromium
- **Key aspect overlooked:** qualified products provide passivation to aluminum which lowers corrosion current densities 10-1000 fold in galvanic interfaces
  - ability to suppress current and potential is a possible new requirement
  - galvanic test is being considered as a new requirement
  - technical boundaries will be established through ONR-supported work on DC polarization measurements of protective coatings, corrosion modeling, and verification

Conversion coatings for Aluminum: MIL-PRF-81706/5541 Type 3 (electrical applications/unpainted)

- Type II excludes hexavalent chromium (7 qualified products from 5 companies)
- Qualified products to date are based on trivalent chromium except one non-Cr
- Similar passivation issues/potential changes as Class 1A coatings
Applications

➤ Aluminum Anodizing: MIL-A-8625
  • Process Types IC (boric-surfuric acid), IIB (thin-film sulfuric acid), and II (sulfuric acid) and III (sulfuric acid) do not contain chromium
  • No discrimination in sealer chemistry per current specification language
  • Draft revision includes separate seals for non-chromate options including water, nickel, cobalt, trivalent chromium, and duplex

➤ Conversion coatings and Anodizing for Magnesium: SAE-AMS-M-3141
  • Specification needs to be revised to include a Type for non-chromium conversion coating (current Type VIII specifically calls out chromate conversion coating) and Types for new anodize processes like Tagnite and Keranite
  • More challenging to change due to control by commercial entity

➤ Conversion coatings for Titanium:
  • Conversion coating needed for paint adhesion
  • No current specification
  • Unknown/undefined role of conversion coating in passivating Ti- may be important for galvanic couples
Related/Linked Applications

➔ Priming:

➔ MIL-PRF-23377: high solids epoxy primers
   • Class N in place for Types I and II (low IR reflection)
   • Two products qualified to Type I, one to Type II
   • Galvanic protection generally better than MIL-PRF-85582, long re-coat times (up to 4 hrs)

➔ MIL-PRF-85582: water reducible epoxy primers
   • Class N in place for Types I and II (low IR reflection)
   • One product qualified to each type
   • Preferred to -23377 by users due to short (1hr) re-coat times

➔ TT-P-2760: high solids polyurethane primers
   • Class N in place for Types I and II (low IR reflection)
   • No qualified products
Progress in Implementing Alternatives

- **Inorganic Metal Finishing Coatings and Processes**
  - Alternatives authorized and used for
    - Aluminum and magnesium anodizing
    - Hard Chrome Plating
    - Type II conversion coating on aluminum alloys under chromated primer: Class 1A applications
    - Type II conversion coating on Alumiplate under chromated primer
    - Sealing of Type IC, IIB, II and III anodize using Type II conversion coatings (TCP)
  - Alternatives pending authorization and use
    - Conversion coating titanium (TCP and Alodine 5700)
    - Sealing of phosphate coatings (ChromiPhos)
  - Alternatives being assessed in demonstration and validation projects
    - Type II conversion coating on aluminum alloys with non-chromate primers per MIL-PRF-23377 Class N and MIL-PRF-85582 Class N
    - Conversion coating magnesium
    - Post treatment of IVD aluminum
    - Post treatment of IZ-C17+ ZnNi
    - Type II conversion coatings on aluminum: Class 3 applications
Featured Effort: Mg Conversion Coating Dem/Val

- OSD Corrosion IPT funded effort to complete FRC validation of coating process and performance on representative alloys and scrap parts

- FRC SE (Jacksonville) has 730-gallon process tank for Mg conversion coating
- Operates near 200F
- Change to trivalent chromium process offers multiple benefits:
  - Energy savings (75-90F vs 200F)
  - EOSH improvement- non Cr\(^{6+}\) process and coating
  - common product- same TCP as being planned for Al anodize sealer and conversion coating
  - Equal or better paint adhesion and corrosion protection
Progress in Implementing Alternatives

• **Organic Coatings and Processes**
  – Alternatives authorized for
    • Priming of support equipment (MIL-DTL-53022)
    • Sealing- various specifications
    • Priming aircraft/components: scuff sand and overcoat applications
  – Alternatives pending authorization
    • None currently
  – Alternatives being assessed in R&D
    • Primer in coating systems with chromated or non-chromated conversion coatings or anodize
    • Galvanic (metal rich) primers in total NC systems
Research & Development and Implementation Progress

• Ongoing
  – Type II conversion coating touch up pens- qualifications completed, not being implemented at FRCs for now
  – TCP passivation of IVD Aluminum- field testing underway
  – Conversion coating Magnesium and Titanium- FRC testing underway
  – Metal rich primer- lab development

• New in FY12 and continuing
  – NC Primer Field Validation– Supports implementation of qualified Type I and Type II Class N primers at NAVAIR user sites. **Includes Type I and II conversion coatings.**
  – Type II, Class 3 Conversion Coatings; electronics requirements- linked with NASA effort
  – IZ- C17+ zinc-nickel, with trivalent chromium passivation(s)- FRC demo underway
  – Type II conversion coating assessment of Surtec 650V- lab assessment underway

• Planned for FY13
  – TCP process variable optimization- pH and temperature of deox and TCP rinses; TCP concentration, pH, immersion time, temperature; multiple TCP products; multiple metal processes- acid & base etch, mild deox
Featured Effort: Surtec 650V Process Optimization

- NISE/219 funded effort to optimize performance of Surtec 650V
- Sensitivity to operating variables slowing implementation of Type IIIs
- Minitab interaction plots show:
  - large effect due to bath operating temperature
  - large effect due to bath concentration
  - minor effect due to immersion time
  - minor effect due to pH
Featured Effort: Surtec 650V Process Optimization

- Focused interactions at 104 F immersion temperature show:
  - large effect due to bath concentration
  - moderate effect due to immersion time
  - moderate effect due to pH

FY13: plan to look at alternate surface preps (acid and base etch), temps around 104 F and lower concentration (5%) in effort to optimize for both alloys and corrosion and powder formation- share information with Surtec and users

FY13: plan to expand to other TCP products
Summary

- Top level strategy in place to systematically address Cr6+ in metal finishing (and painting)
- Alternatives partially implemented by FRCs, fleet and OEMs based on business cases-
  - incremental transition planned to continue
  - each user/location has different drivers due to mix of local/state/federal regulations and laws
- Heavy focus on spray applied products and coatings removed during maintenance due to higher exposure risks from mists and dusts
- R&D ongoing and focused on improved coatings
  - Improved corrosion properties for all
  - Additional Class N, Type II primers
  - 1-hr re-coat for high solids primers