

Predictive Coating Condition Model for Advanced Asset Management

WP19-1168

Fritz Friedersdorf
Luna Labs USA, LLC

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14. ABSTRACT The technical objectives of this project are listed below: <ul style="list-style-type: none"> Coating prognostic model for predicting coating damage and inhibitor exhaustion <ul style="list-style-type: none"> Focus is on corrosion protection Implications for hexavalent chrome substitution Verified model predictions in laboratory tests, outdoor exposures, and with observations of aircraft coating conditions A test protocol / method for extending the model to other material systems and assets PCCM module designed for integration with Air Force CBM+ systems 					
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Project Team

Fritz Friedersdorf (PI), Luna Labs USA

James Dante, Southwest Research Institute

Ahmad I. Karayan, The Boeing Company

Andrew Keller, University of Dayton Research Institute

Austen Scruggs, Air Force Corrosion Prevention and Control Office

Yao Xie, Georgia Institute of Technology

Background

WPSON-19-C2 (2019)

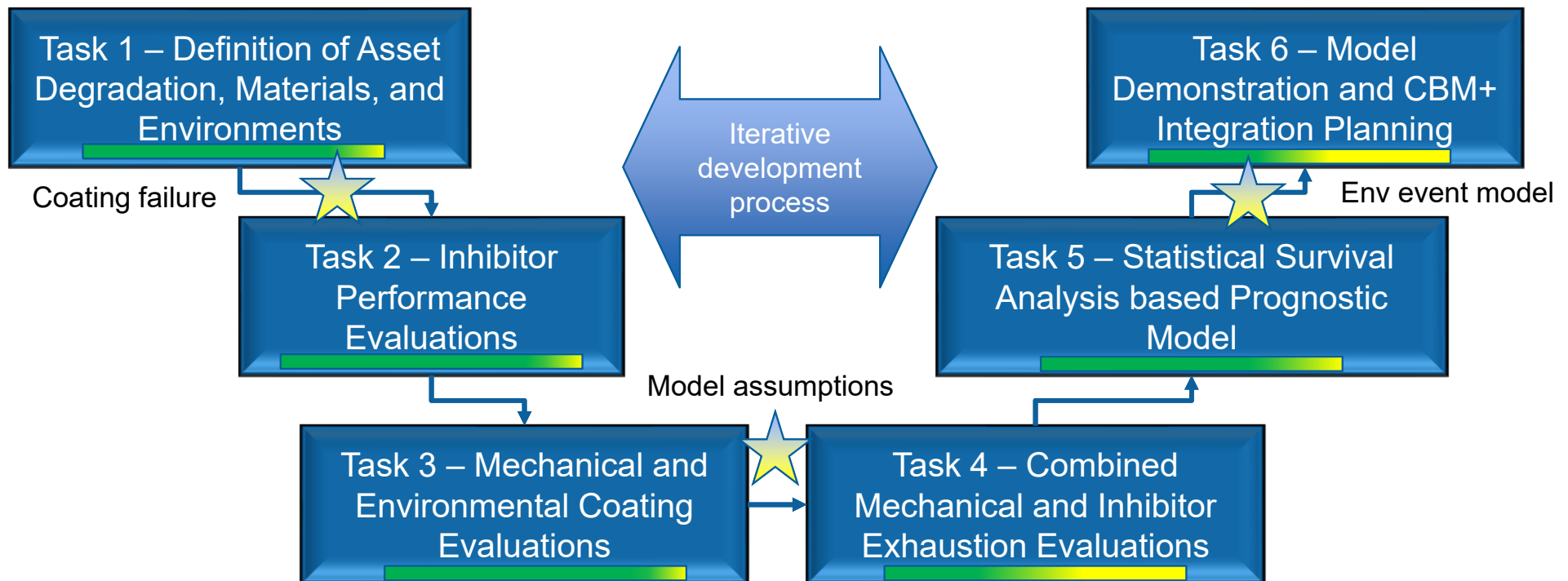
- Objective: A model that accurately characterizes and can predict the cumulative damage state of a coating system
 - ◆ Model should account for both static and dynamic influences on integrity
 - ◆ Inputs to the model should be readily available environmental and aircraft data
 - ◆ The model will provide an assessment of the condition of the coatings
- Project should leverage previous SERDP/DoD work on corrosion and environmental degradation of coatings
- The ideal model should predict the cumulative degradation of polyurethane and epoxy coating systems

Technical Objectives

- Coating prognostic model for predicting coating damage and inhibitor exhaustion
 - ◆ Focus is on corrosion protection
 - ◆ Implications for hexavalent chrome substitution
- Verified model predictions in laboratory tests, outdoor exposures, and with observations of aircraft coating conditions
- A test protocol / method for extending the model to other material systems and assets
- PCCM module designed for integration with Air Force CBM+ systems

Technical Approach

- The definition of materials and damage modes (Task 1) informed the experimental work (Tasks 2 – 4) that supported the model development (Task 5)
- The predictive coating condition model is structured to be compatible with CBM+ systems (Task 6)



Coating Failure

Original Perspective

Intact coating

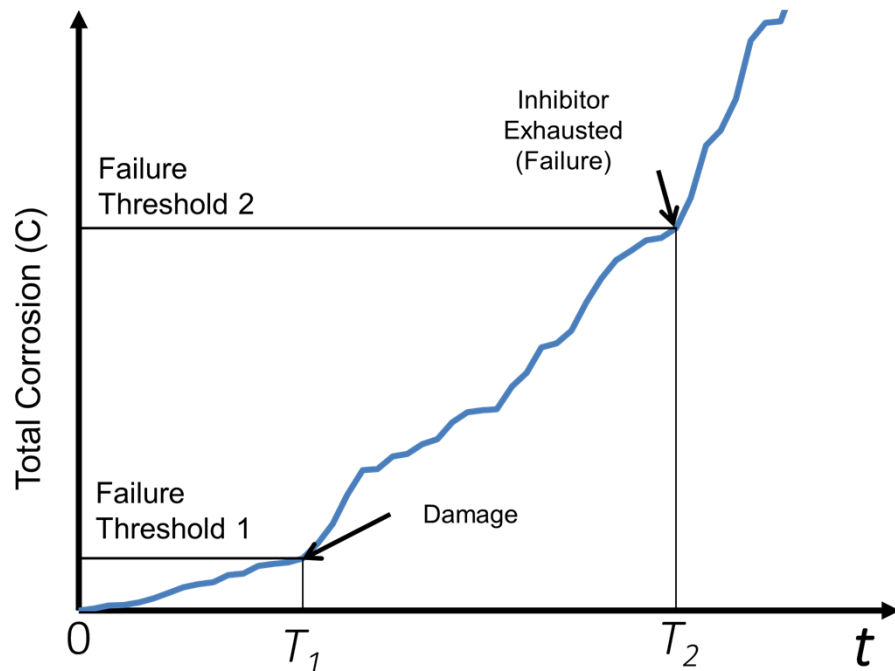
- no corrosion

Damaged or coating crack

- Protected above critical concentration inhibitor

Inhibitor exhaustion

- blistering and corrosion below inhibitor critical concentration



Current Perspective

Intact coating

- no corrosion

Damaged or coating crack

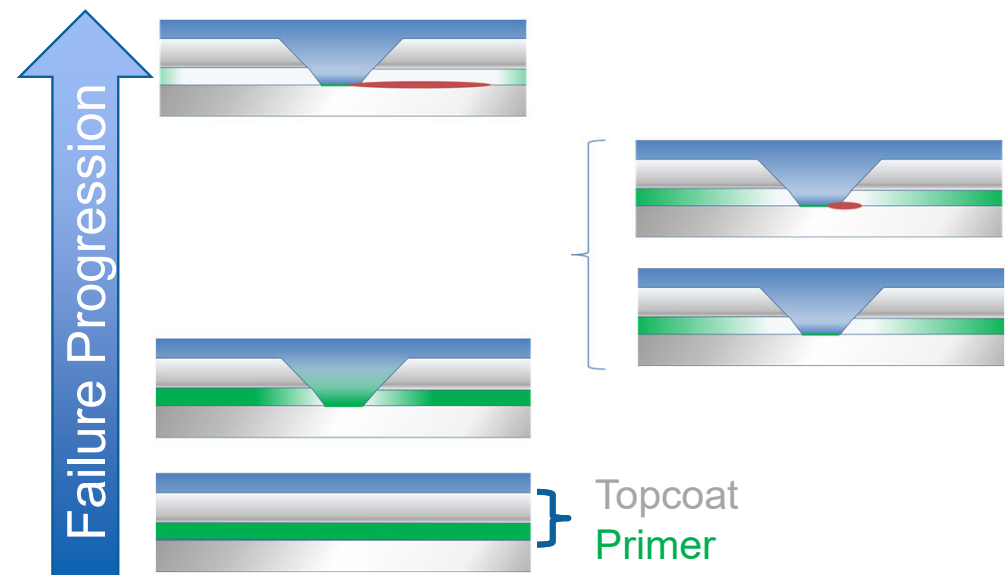
- Protection above critical concentration inhibitor

Persistent passive film

Blister initiation

Inhibitor exhaustion

- Blistering propagation



Topcoat
Primer

Key Points

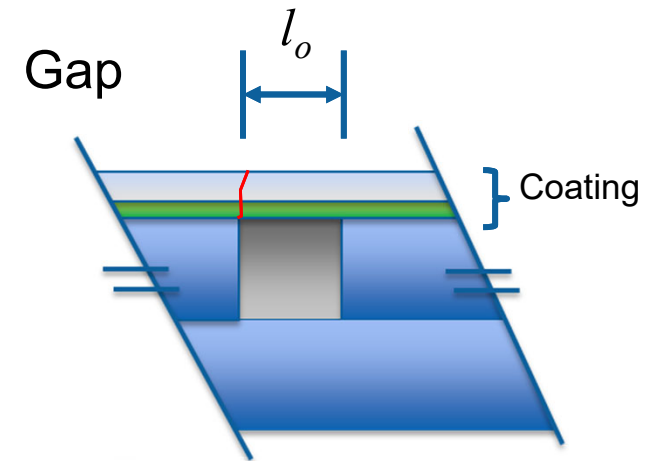
- Event (temporal point process) models were found to be more suitable for coating and corrosion modeling compared to direct modeling of cumulative corrosion
 - ◆ Maintenance may want to consider contribution of severe events
- Inhibition is dependent on leaching rate to achieve a critical concentration and formation of protective films that may be persistent over long time periods
 - ◆ Non-chrome coatings did not exhibit persistent protective films
- Non-chrome coatings were not as protective as chromate coatings in every lab and outdoor test in this study
 - ◆ Non-chrome coating implementation should consider increased inspection and preventative maintenance relative to structures protected with chromate coatings
- Coating cracking at structural discontinuities and protection of galvanic couples are appropriate assumptions and focus for aerospace coating protection testing and modeling
 - ◆ Free corrosion may not be a strong or relevant performance discriminator

RESULTS

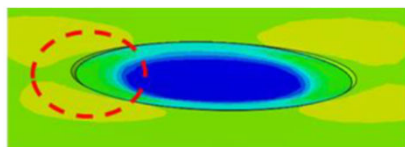
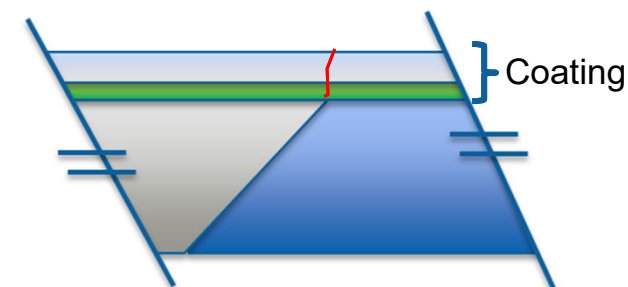
Definition of Asset Degradation, Materials, and Environments of Interest

- Generally, aircraft of interest included fixed wing transport and rotorcraft
- Loads analysis for airframes focused on structural elements
 - ◆ Fuselage skin detail subjected to hoop stress associated with pressurization
 - Similar to the notched gap panel that simulates a lap splice used in WP-2521
 - Maximum strains of structural alloys is 0.0009 (0.09%) well below the elastic limit (0.2%)
- Coating strains at structural discontinuities joints and fasteners are expected to be 3% to 10%

$$\epsilon = \frac{\Delta l}{l_o}$$

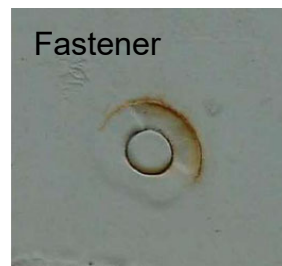


Counter sunk fastener

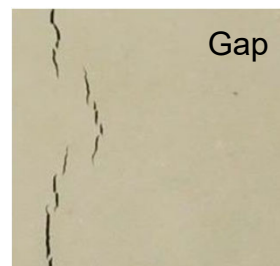


Landing Load Case

Policastro, WP19-1017



Fastener
Hunter,
ASETSDEFENSE
2014



Gap
Schultz, WP-2521

Definition of Asset Degradation, Materials, and Environments of Interest

- Relevant environmental conditions were determined from typical ambient environments and operating conditions
 - ◆ Marine corrosive conditions (laboratory tests or outdoor exposures)
 - Corrosives, relative humidity, temperature
 - Salt loading: 5 to 750 mg/m²/day (ISO 9223)
 - Temperature: -10 °C to 60 °C
 - RH: 5% to 100%
 - Solar and blackbody irradiance affect surface temperature and RH
 - ◆ Operation at altitude produces cold dry conditions
 - Aircraft monitoring has demonstrated no corrosion below -20 °C
 - Extreme low temperatures of -51 °C to -65 °C (MIL-STD-810)

NOAA Weather Station Data

Location	Air Temp (°C)			RH (%)			AH (g/m ³)			TW ISO (%)
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	
Daytona Beach FL	-2.8	22.4	37.8	11.9	74.8	100.0	1.7	15.3	24.9	45.7
El Segundo CA	6.1	17.7	38.3	7.0	66.7	100.0	1.8	10.2	19.5	29.4
Whidbey WA	-6.7	9.4	24.0	32.2	89.9	100.0	2.0	8.4	16.0	84.9

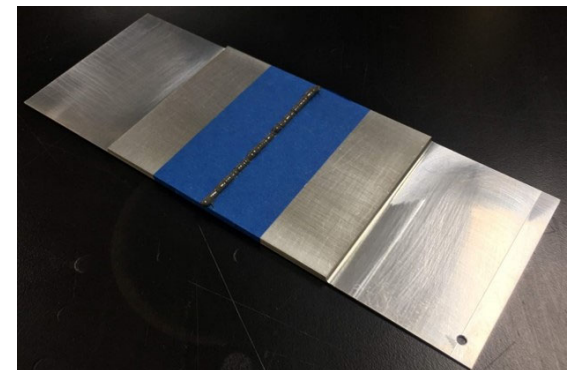
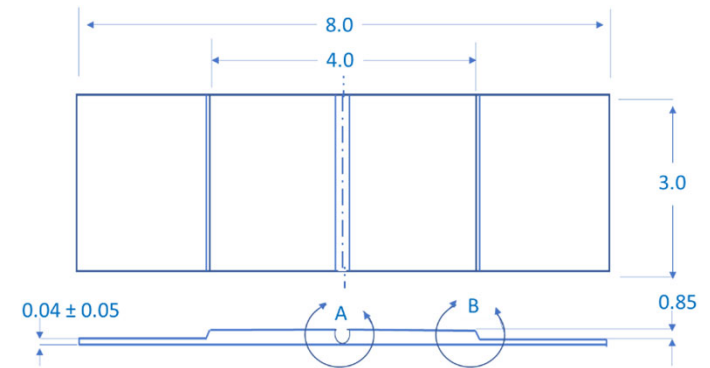
Definition of Asset Degradation, **Materials**, and Environments of Interest

	Chromate Solvent-Borne	Non-Chrome Solvent-Borne	Chromate Water-Borne	Non-Chrome Water-Borne
Substrate	AA7075-T6 coupled to SS316 / Ti 6-4 / CRES 286			
Deoxidation	Alumiprep 33			
Pretreatment	Pre-Kote			
Gap Sealant	PPG P/S 870 B-1/2 Gray (MIL-PRF-81733 Type IV Class 1 Grade A)			
Primer	PPG-Deft CA7233 (MIL-PRF-23377 Type I, Class C2) strontium chromate	PPG-Deft 02GN084 (MIL-PRF-23377, Type I Class N) dipraseodymium trioxide	PPG 44GN072 (MIL-PRF-85582 Type II, Class C2) strontium chromate	PPG-44GN098 (MIL-PRF-85582 Type II, Class N) dipraseodymium trioxide
Topcoat	PPG-Deft CA8202, F17925 Gloss White (MIL-PRF-85285 Type I)			

COATING CRACKING

Coating Cracking

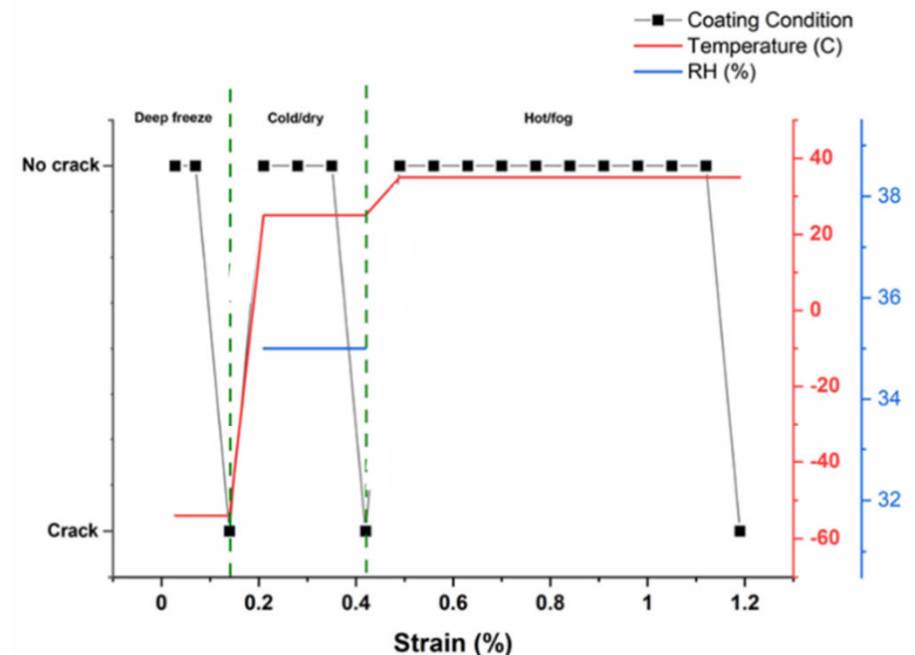
- Displacement testing was performed using a flex test system
- Specifically designed panels with machined gaps were used for flex testing (WP-2521)
- Flex tests were done using pristine and outdoor aged painted panels
 - ◆ Coating is applied over gap filler
 - ◆ Strain in the coating is estimated across the gap



Influence of Temperature and RH on Coating Cracking

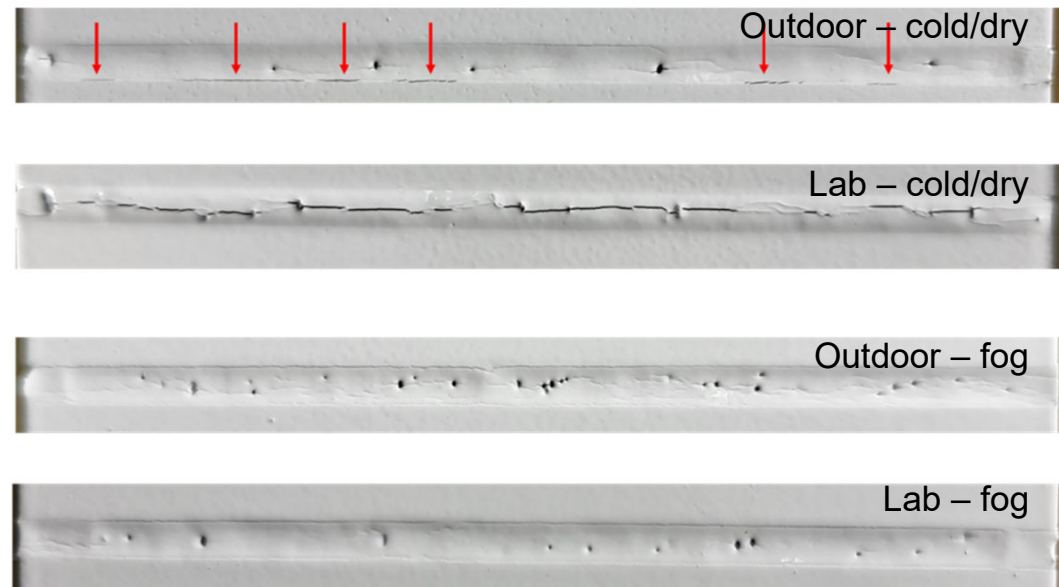
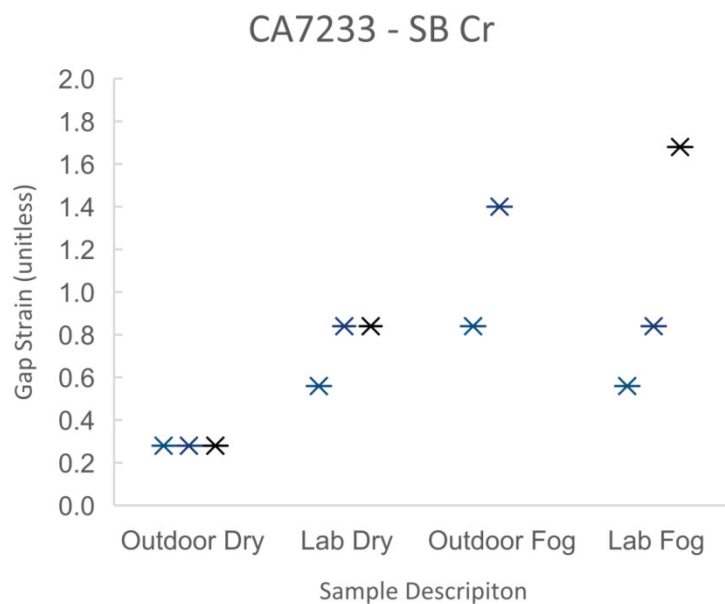
- Tests were performed in a ground-air-ground (GAG) chamber, and controlled humidity salt spray chamber
- Cracking is promoted by both dry and cold conditions
- Chromate solvent borne CA7233 and non-chrome solvent borne 02GN084 behaved similarly in terms of the crack susceptibility

Description	Condition	Strain to Cracking
Deep freeze	-54 °C	0.14%
Cold/dry	25 °C and RH 35%	0.42%
Hot/fog	35 °C and RH 100%	1.20%



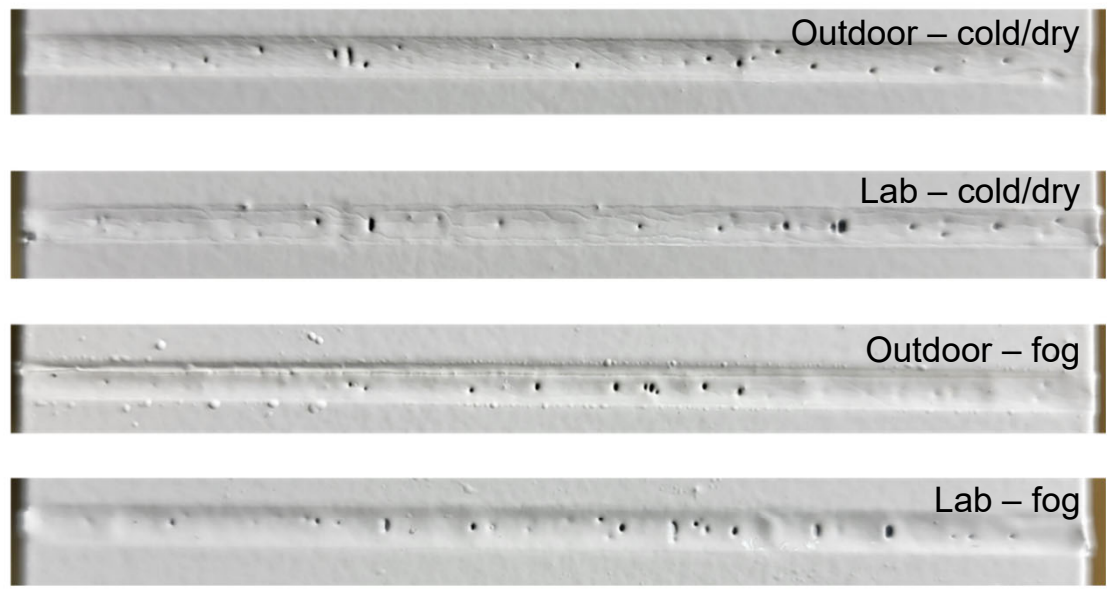
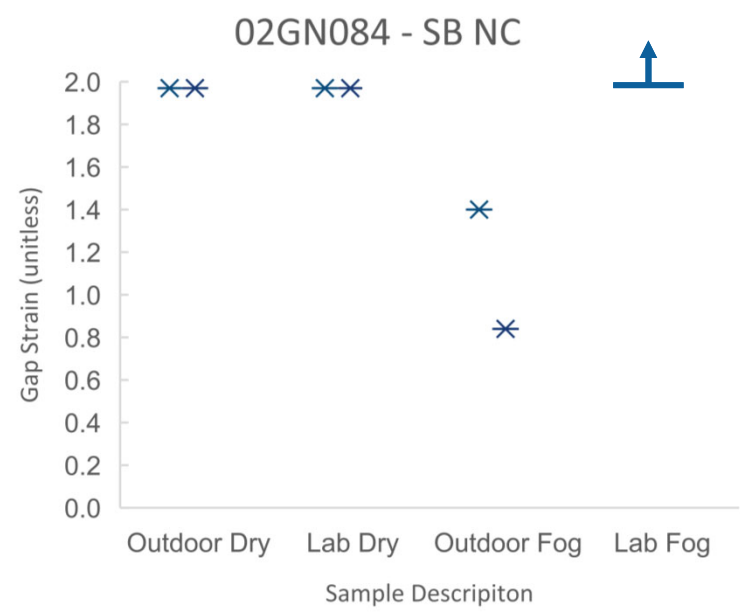
Influence of Outdoor Aging on Coating Cracking

- Laboratory stored and nine month outdoor exposed gap panels were mechanically tested in cold/dry and hot/fog conditions



Influence of Outdoor Aging on Coating Cracking

- Laboratory stored and nine month outdoor exposed gap panels were mechanically tested in cold/dry and hot/fog conditions



Slide 16

FF2

remove

Fritz Friedersdorf, 12/7/2023

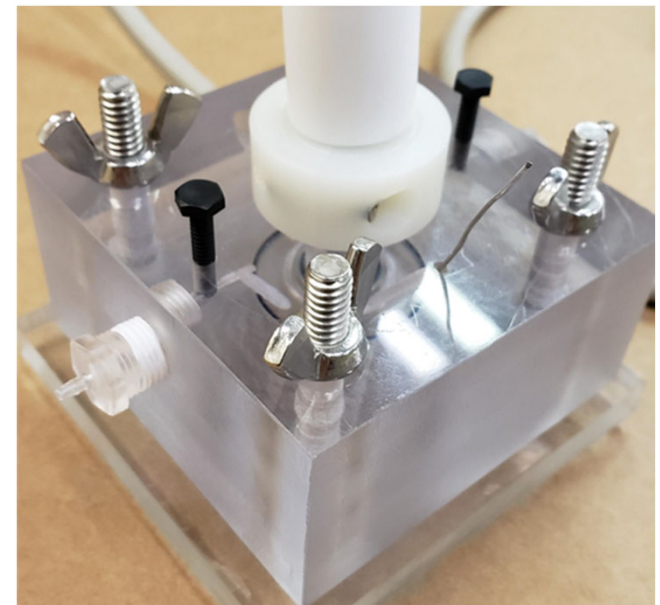
Summary – Coating Cracking

- Ground and flight environment affect the coating flexibility
 - ◆ dry or deep freeze conditions increase crack susceptibility
 - ◆ strain at cracking was 0.1% to 2.0%
- Strains at fasteners and gaps are expected to be 3% to 10%
- Outdoor aging degraded coating crack susceptibility

INHIBITOR PERFORMANCE - IMMERSION

Inhibitor Exhaustion Testing

- A multi-electrode array (MEA) test system was used to evaluate coating inhibitor performance
 - ◆ AA7075 T-0 / 316SS, 250 μm diameter, 18 / 2 wire probe
- A small volume (0.53 ml) flow cell and large volume cell (50 ml / 2 ml) are used to expose coating samples and the MEA probe
 - ◆ 0.6 M NaCl
 - ◆ pH 7 and pH 3
- Inductively coupled plasma mass spectrometry (ICP-MS) was used for determining solution concentration of inhibitors
- Initial tests included:
 - ◆ PPG 02Y040 (MIL-PRF-85285, Class C),
 - ◆ Hentzen 16708 (MIL-PRF-23377, Class N)
 - Barium sulfate and calcium silicate



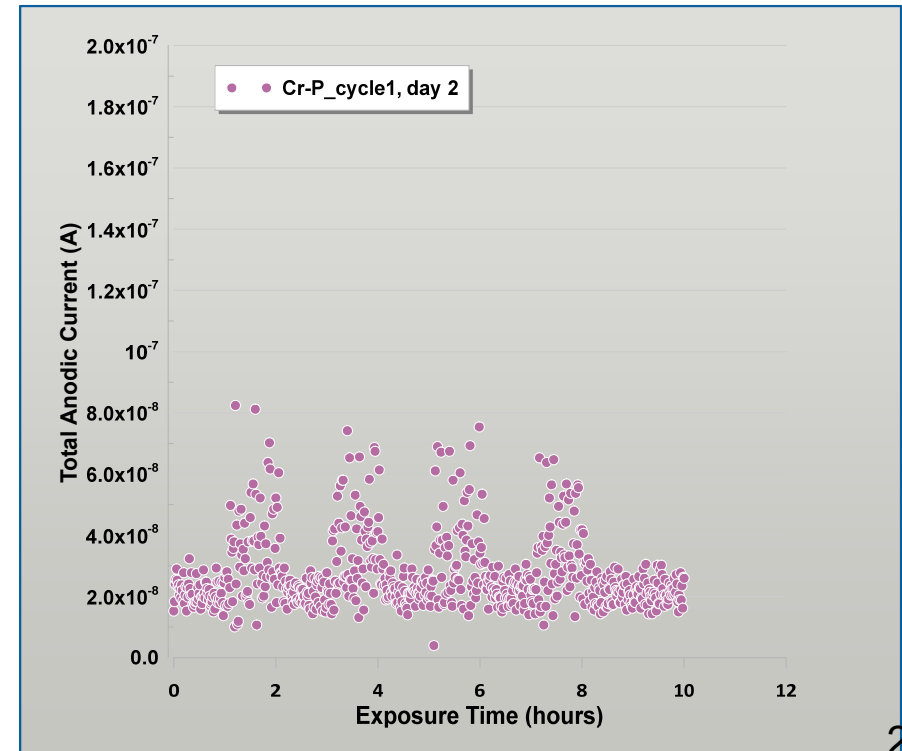
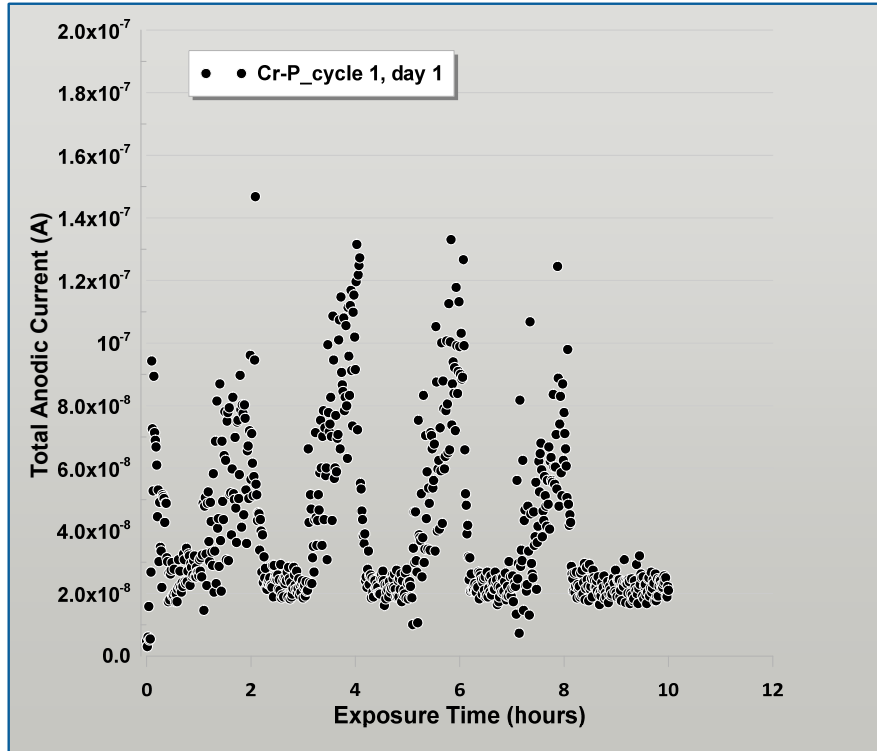
Inhibitor Exhaustion Testing

A number exposure protocols were used

- Testing under flowing conditions was performed to assess
 - ◆ the relative strength of various inhibitors, and
 - ◆ the conditions for inhibitor release into solution
- Flowing and static condition testing was used to assess exposure time required to deplete inhibitors from a coating system

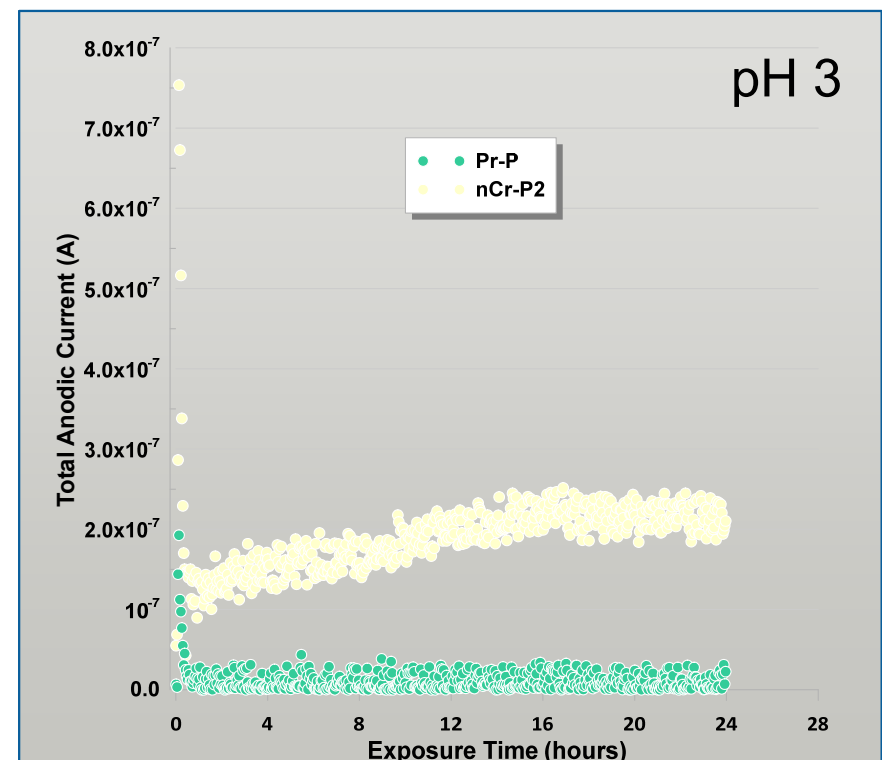
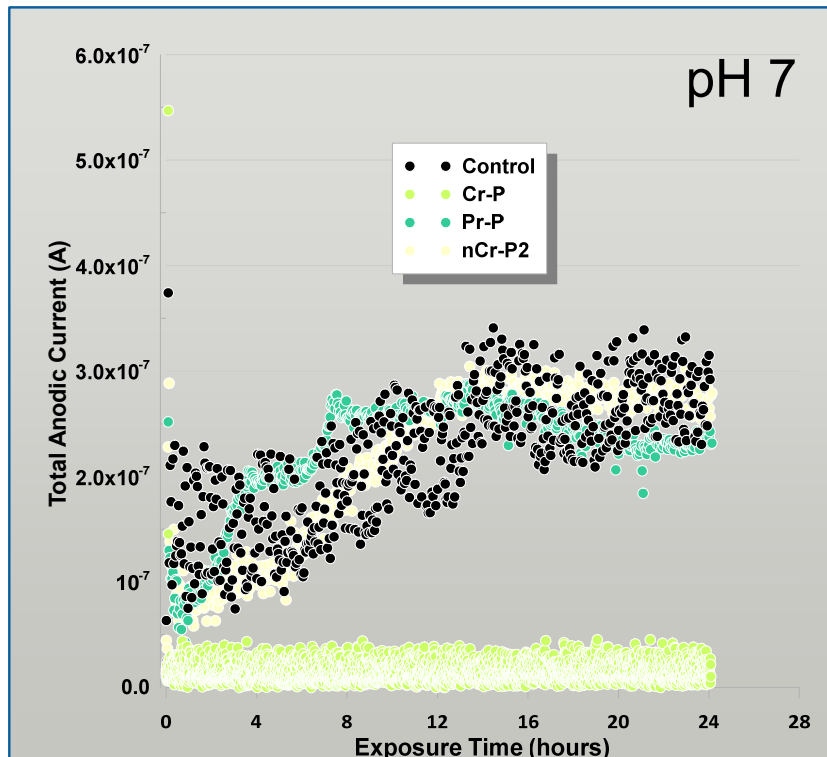
Sequential Flow Test - Cr

- Peak corrosion rate continuously decreases with each high flow cycle
 - Indicates that chromate inhibitor forms a persistent protective film
 - ◆ corrosion products or chromate oxy-hydroxide
 - Both inhibitor leaching and formation of stable film are protection mechanisms
 - ◆ presents another time constant to be considered
- Sequential stagnant and high flow (7.2 ml/min) testing of a waterborne chromate primer
 - Continuous leaching and dilution of inhibitor



pH Testing of Non-Cr Primers

- Stagnant corrosion cell tests at pH 7 and pH 3
 - ◆ The chromate coating is protective in pH 7 solution
 - Neither of the non-Cr (praesidium, barium sulfate are protective)
 - ◆ The praesidium non-Cr is protective at pH 3

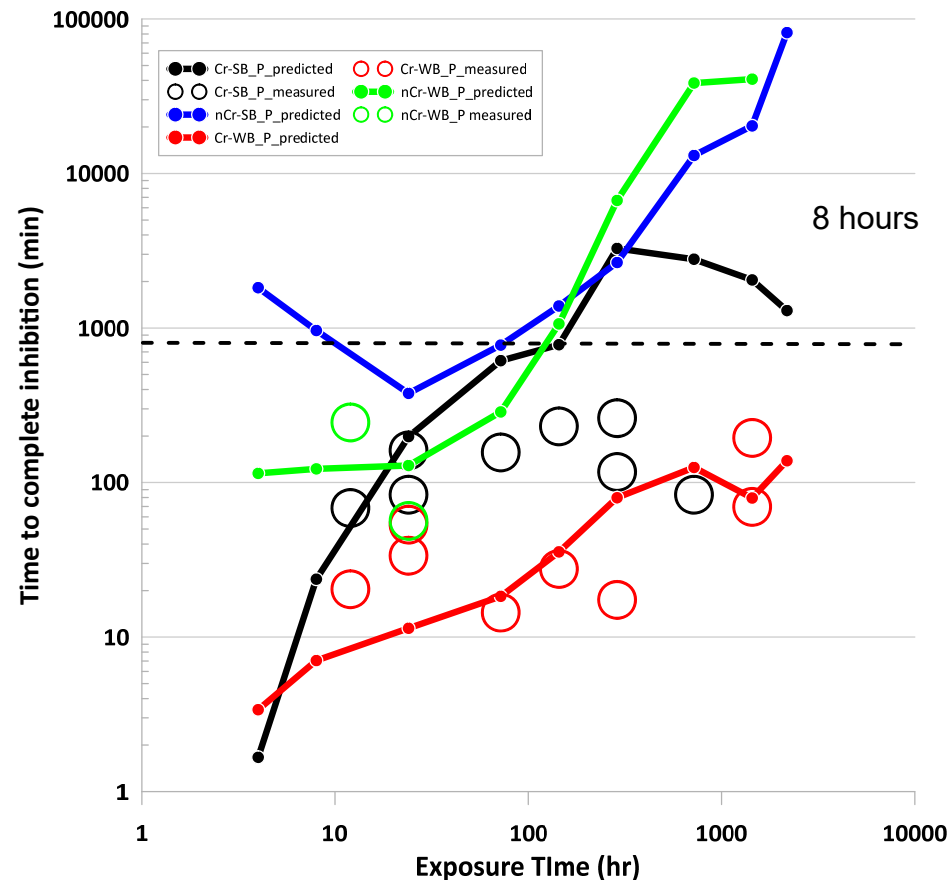
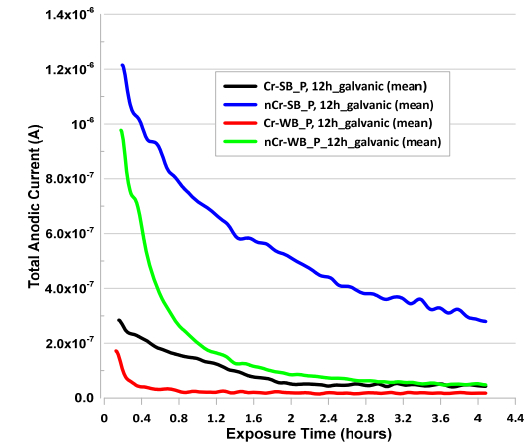


Leaching Time Effects

- The time to complete inhibition was determined in MEA current decay tests
 - ◆ Refreshed solutions
 - ◆ Complete inhibition for anodic current below 5×10^{-8} A
 - ◆ Open circles are experimental measurements of time complete inhibition
- Waterborne chromate primer had the best inhibition
 - ◆ Consistent with high leach rates from the waterborne coating
- The waterborne praeisidium provides some protection for short exposure time

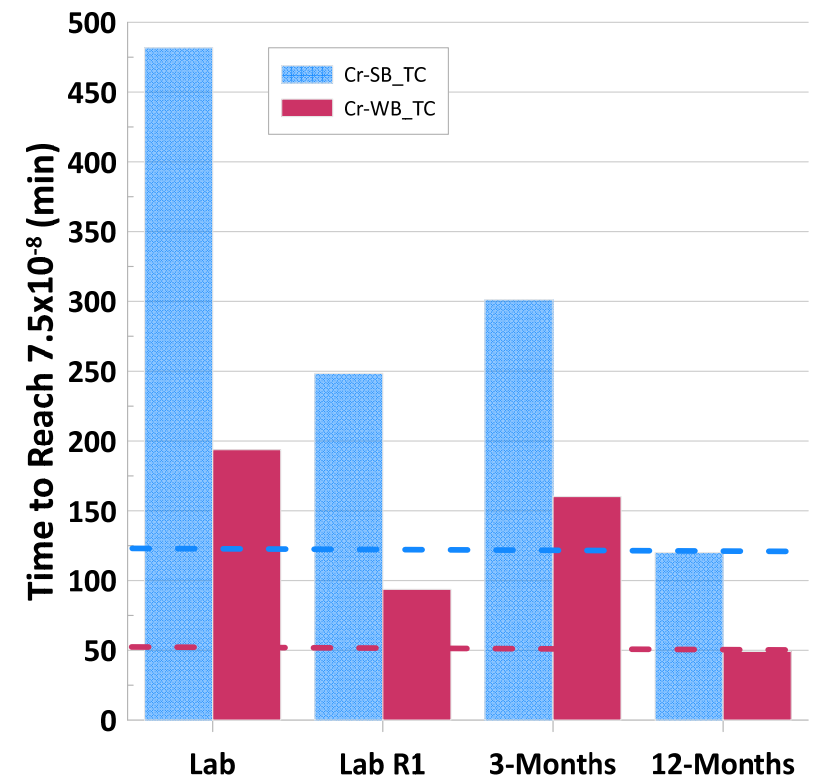
Time to complete inhibition was predicted using leach rate and critical inhibitor concentrations

- ◆ 5×10^{-6} M chromate
- ◆ 1×10^{-4} M praeisidium (Pr_2O_3)



Influence of Outdoor Aging - MEA

- Outdoor aging did not reduce coating inhibitor efficacy based on MEA measurements on aged and then scribed coatings
- Primer and topcoat samples were aged by:
 - ◆ Laboratory stored
 - ◆ Outdoor exposure at Battelle's Florida site



Summary

- Chromate inhibitors protect by:
 - ◆ leaching inhibitor into the solution
 - ◆ forming a protective film
 - ◆ highest leaching and best protection was for waterborne coating
- Praesidium non-chrome primer protected only by inhibitor concentration in low pH solution
 - ◆ No protection at high pH or for solvent borne coating
- Outdoor aging prior to coating damage (scribe) does not degrade coating corrosion protection

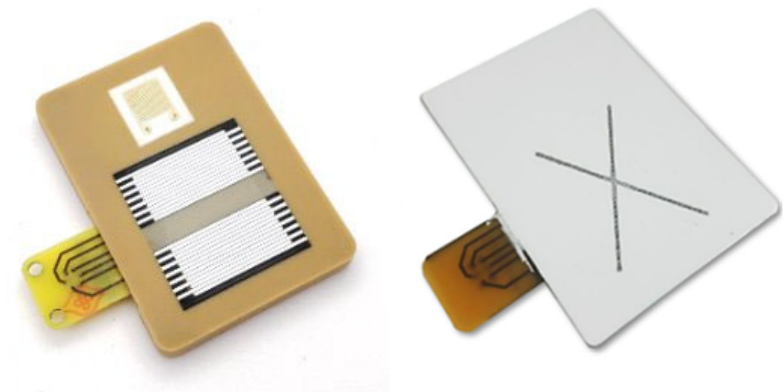
COATING CORROSION PERFORMANCE – ATMOSPHERIC TESTING

Coating Protection Measurement

- Electrochemical measurement systems have been used to measure coating performance
- The multi-sensor panels are used to measure coating barrier properties, free corrosion, and galvanic corrosion
- System includes local measurements of environment
 - ◆ panel temperature, air temperature, relative humidity, and contaminant deposition

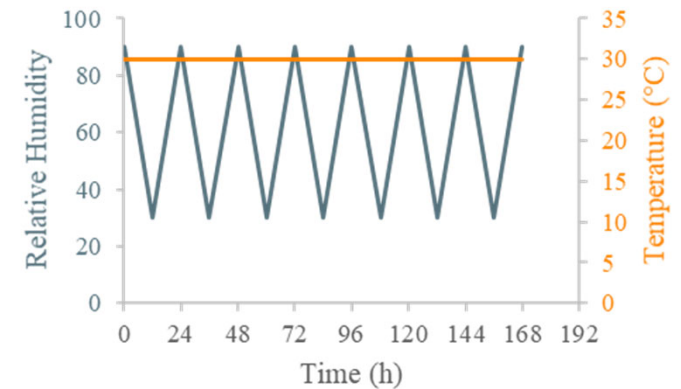


IDE Sensor	Measurement	Measurement Technique
Gold	Coating and contaminant conductance	Impedance 10 mVpp @ 10 Hz, 25 kHz
Aluminum	Free corrosion current	Impedance 10 mVpp @ 0.5 Hz
Bimetallic	Galvanic current	Zero resistance ammeter



Atmospheric Exposures

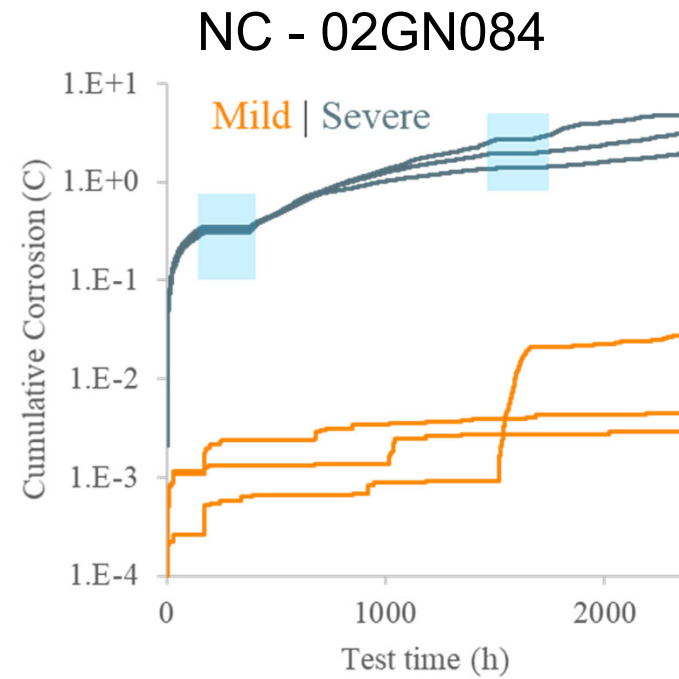
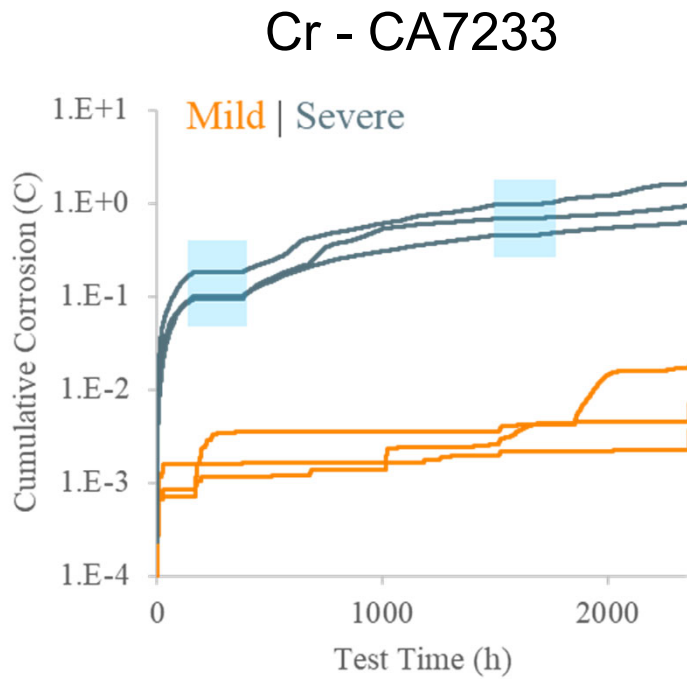
- Simplified humidity cycle using controlled salt loading
- Cyclic accelerated corrosion test – GMW 14872
- Outdoor testing at Battelle FL intracoastal site



Severity Designation	Chloride Conc [M]	Salt loading (mg/m ² /day)
Mild	0.089	5
Medium	0.112	50
Moderate	0.335	150
Severe	2.64	750

Control of Severity

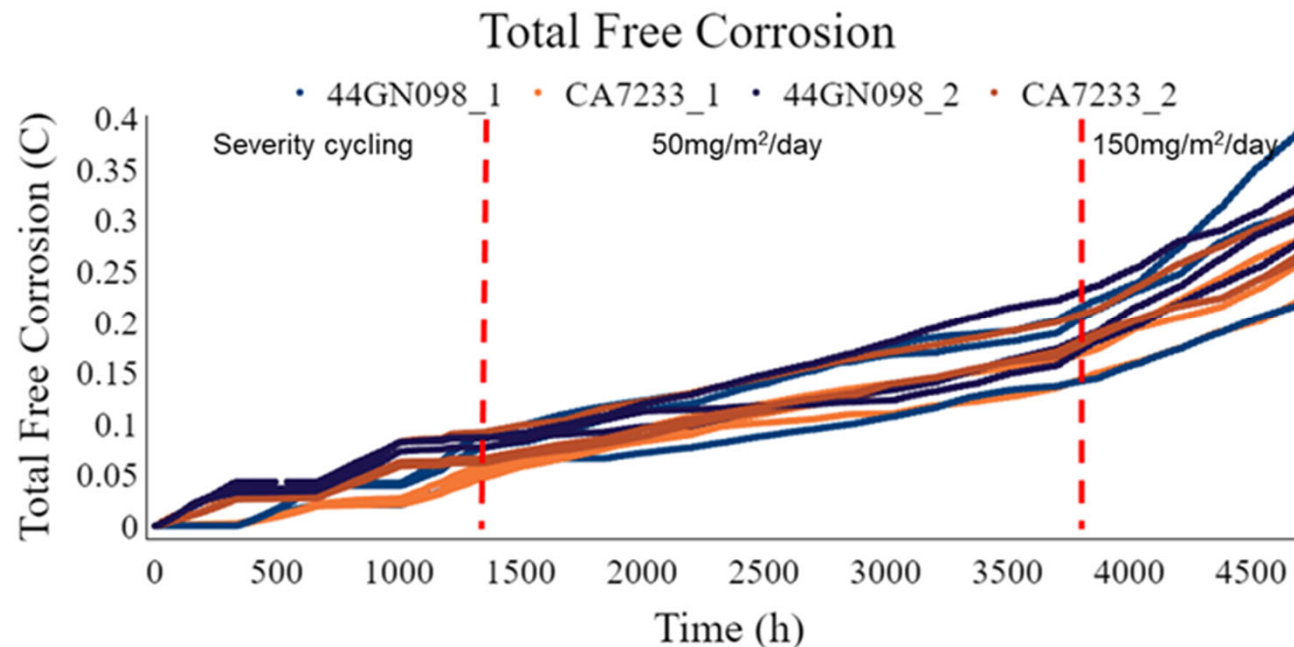
- Test severity was controlled by salt deposition during simplified humidity cycles



Sequence of Severity

- The influence of order for different severity conditions were investigated to see if sequence had a lasting effect on coating performance
- Free corrosion response was not order dependent
- The chromate and non-chrome coatings provided similar free corrosion protection

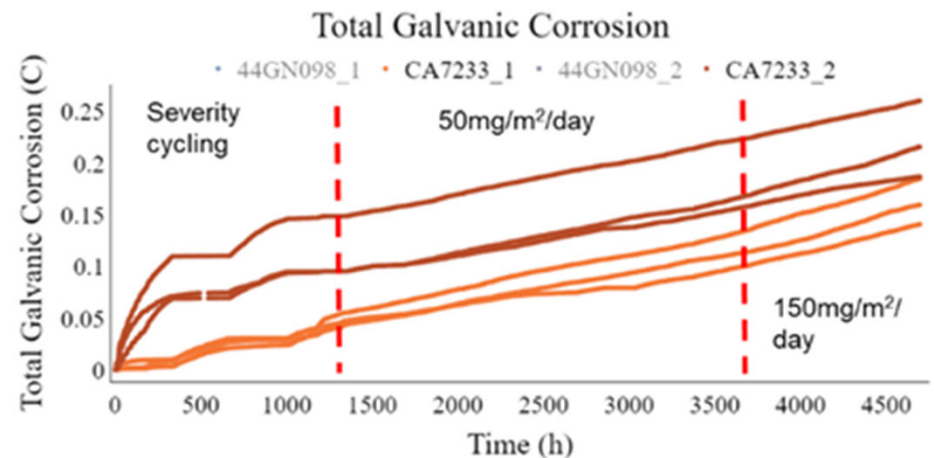
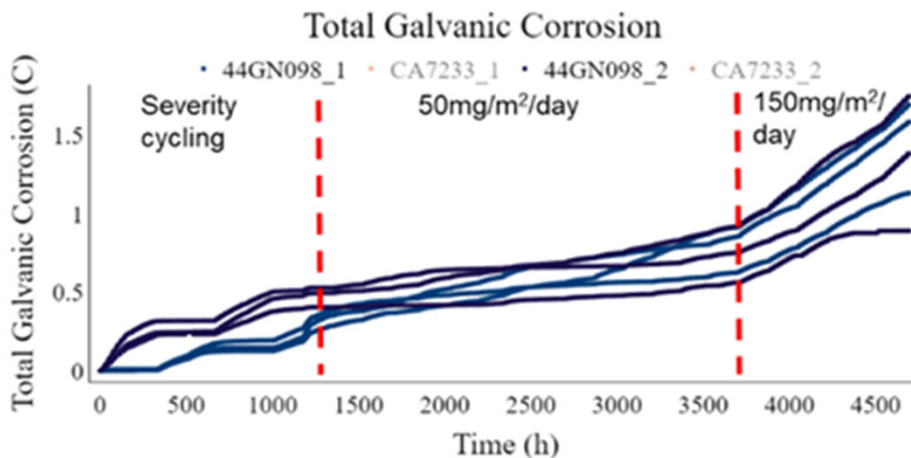
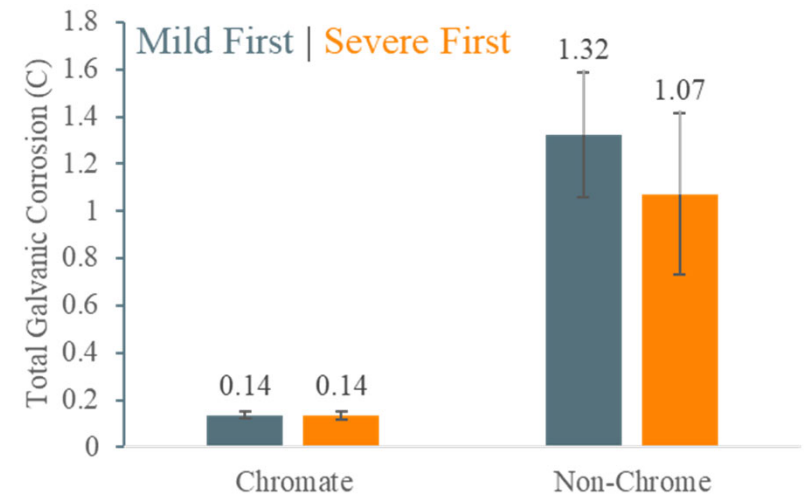
Test Time (h)	Salt Deposition Rate (mg/m ² /d)	
	Mild 1st	Severe 1st
0 - 334	5	750
334 - 666	750	5
666 - 1010	5	750
1010 - 1343	750	5
1343 - 3700	50	
3700+	150	



Sequence of Severity

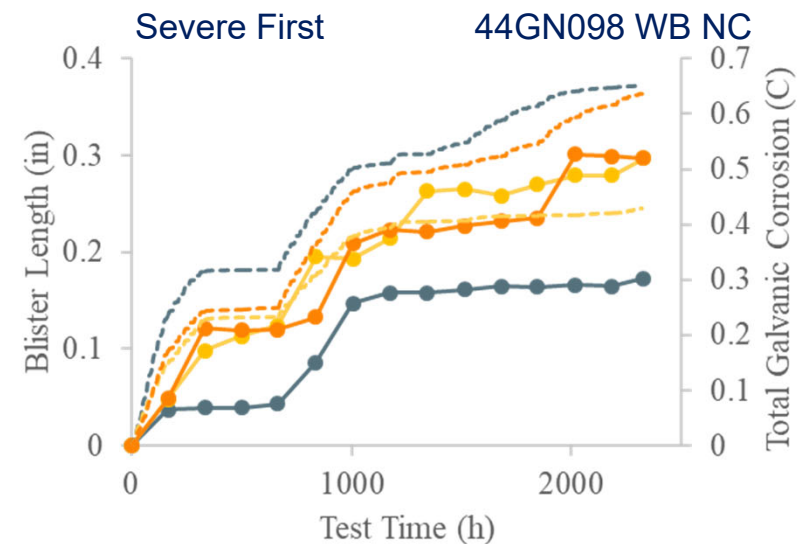
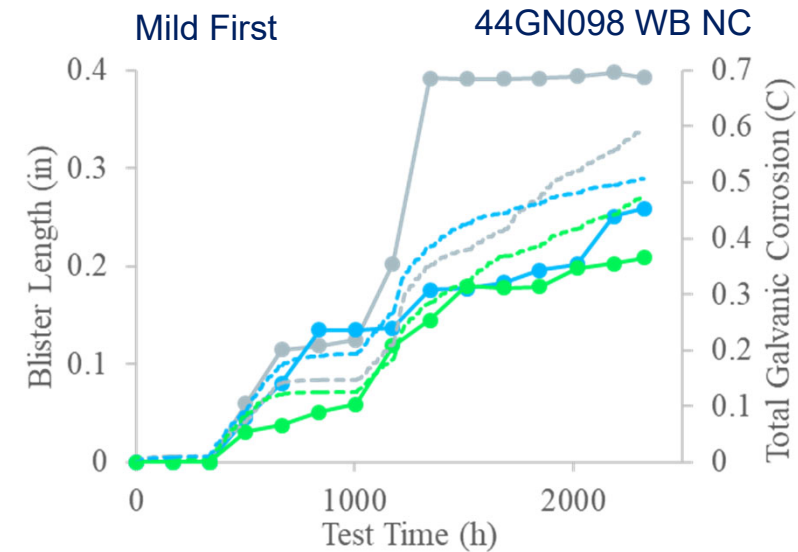
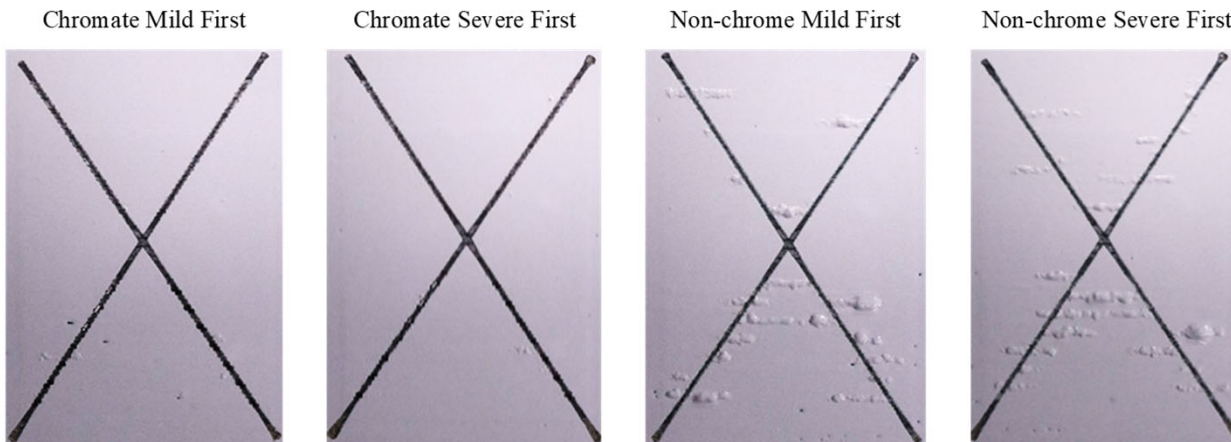
- The galvanic corrosion for the non-chrome coating was not dependent on sequence of severity
- The chromate coating reduced the galvanic corrosion relative to the non-chrome coating
 - ◆ The first high severity condition for the chromate coating did produce initial corrosion that created an offset
 - ◆ Offset is artifact of method and associated with protection of chromate

Totals with first cycle removed



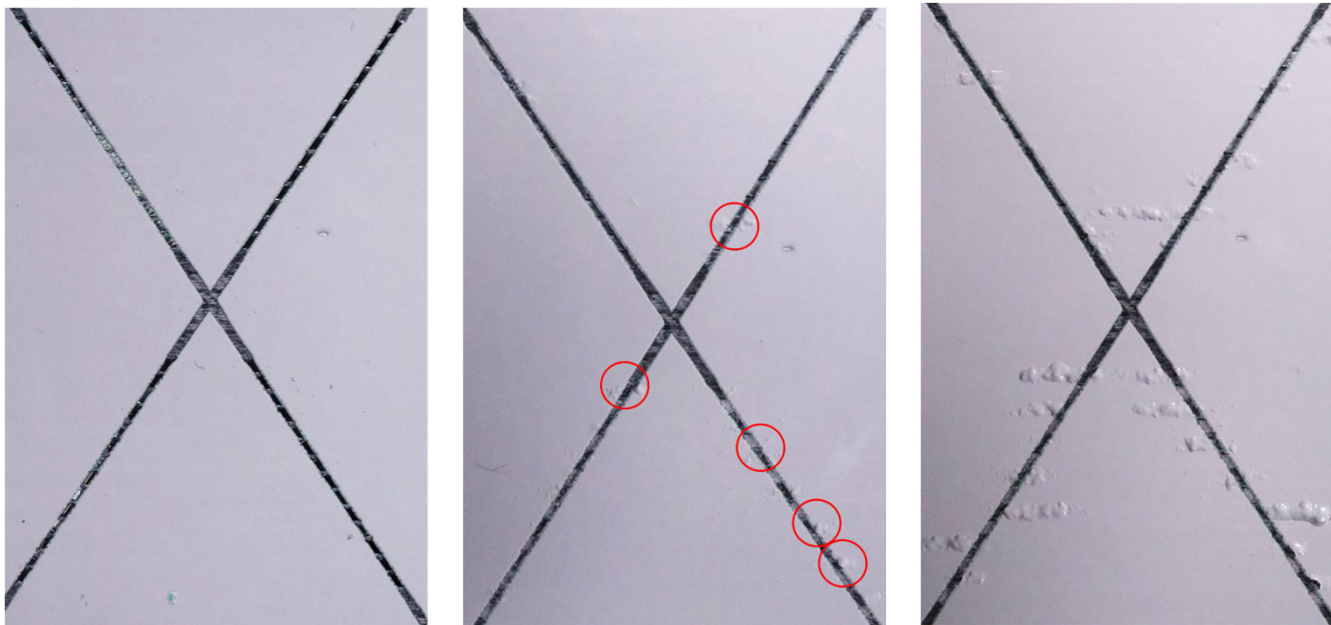
Sequence of Severity

- Measurements of corrosion agreed with visual observations
- The degree of blistering was dependent on the coating system and independent of the order of applied environment severity



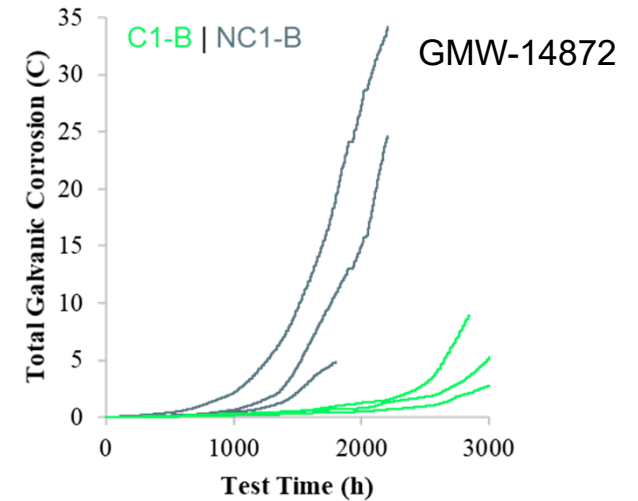
Coating Assessment

- Using visual observations, three blister conditions were defined
 - ◆ No blistering (rating 0)
 - ◆ Blister initiation (rating 1)
 - ◆ Blister propagation (rating 2)

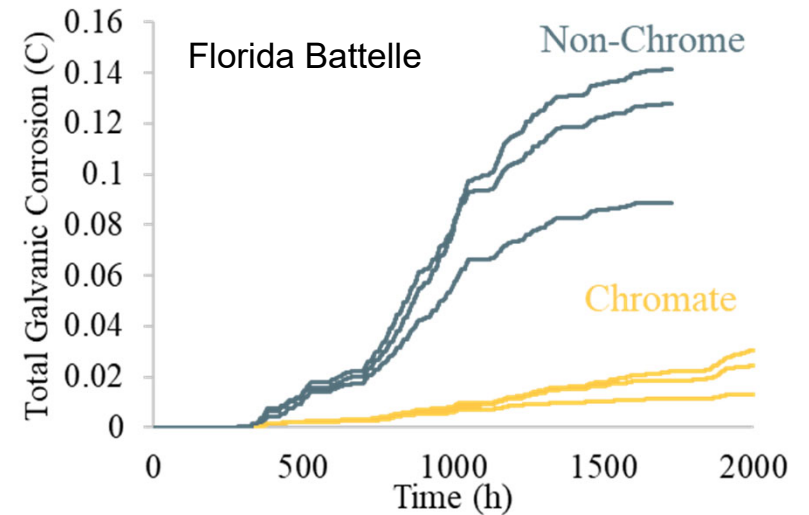
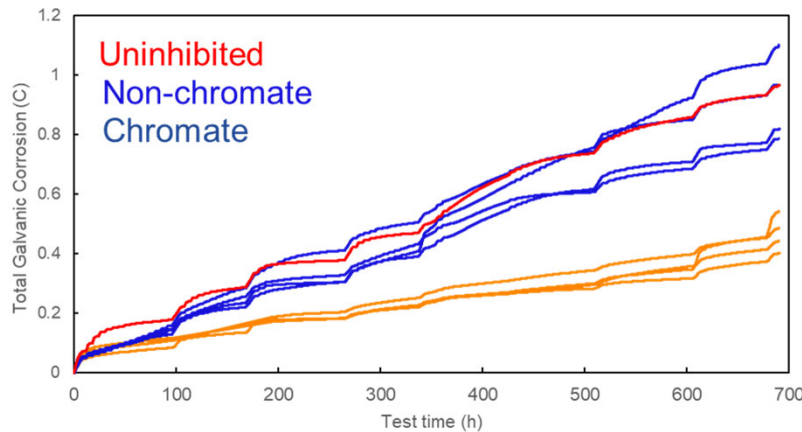


Coating Degradation

- In all tests, similar results were obtained where the non-chrome had higher galvanic corrosion
 - ◆ Simplified RH cycle
 - ◆ GMW 14872
 - ◆ MDACT (WP18-5087)
 - ◆ Battelle FMRF, Florida

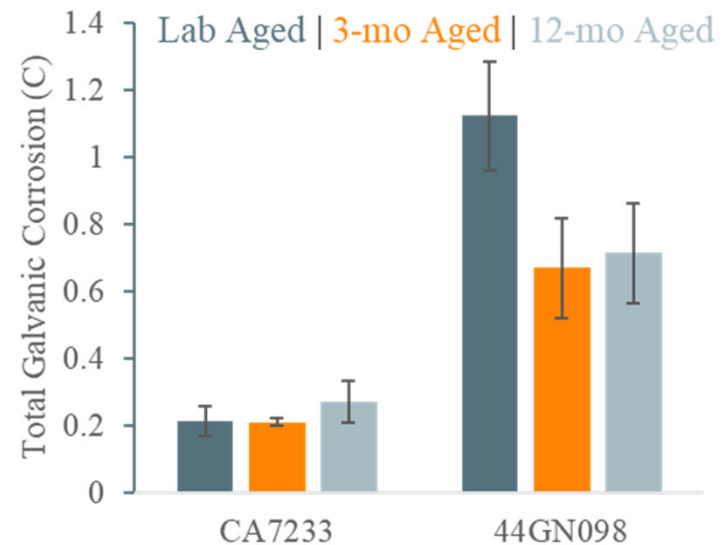
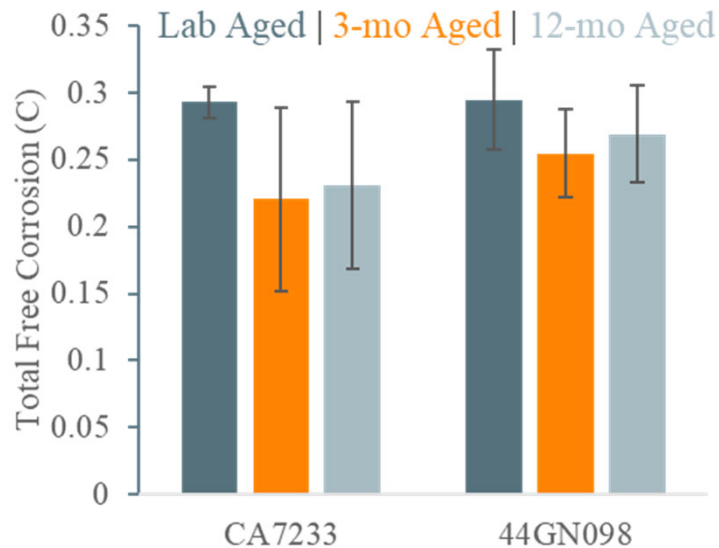
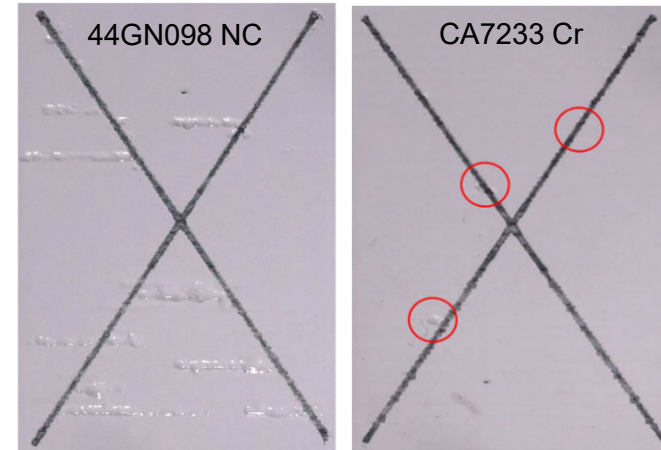


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Outdoor Aging

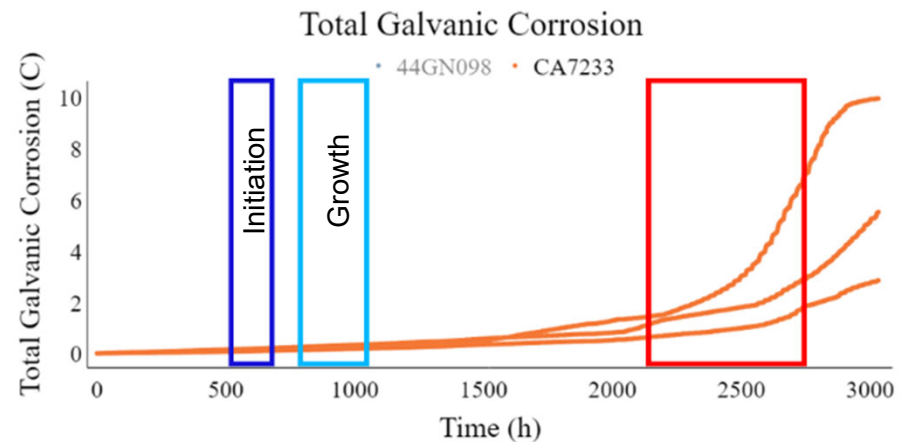
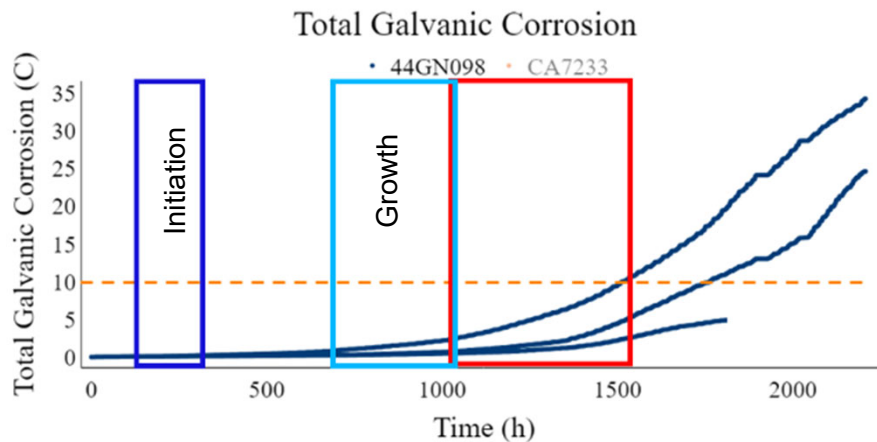
- Corrosion testing comparing laboratory stored and outdoor aged samples indicates that exposure prior to damage does not reduce protective properties



Coating Degradation in Accelerated Testing

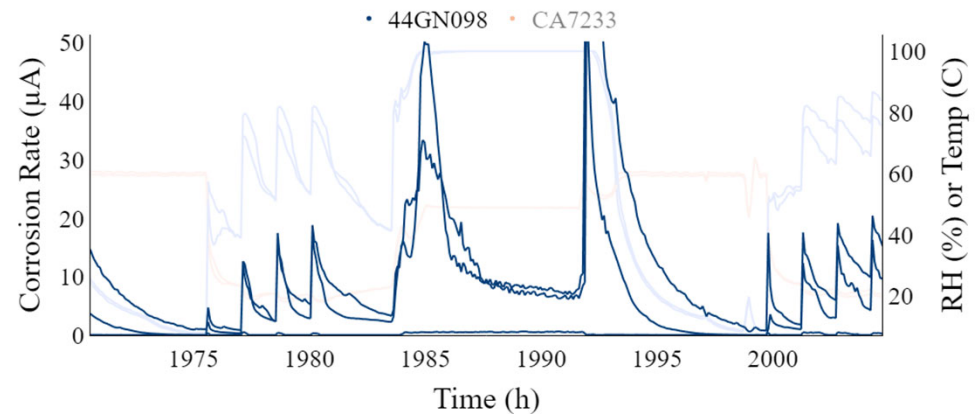
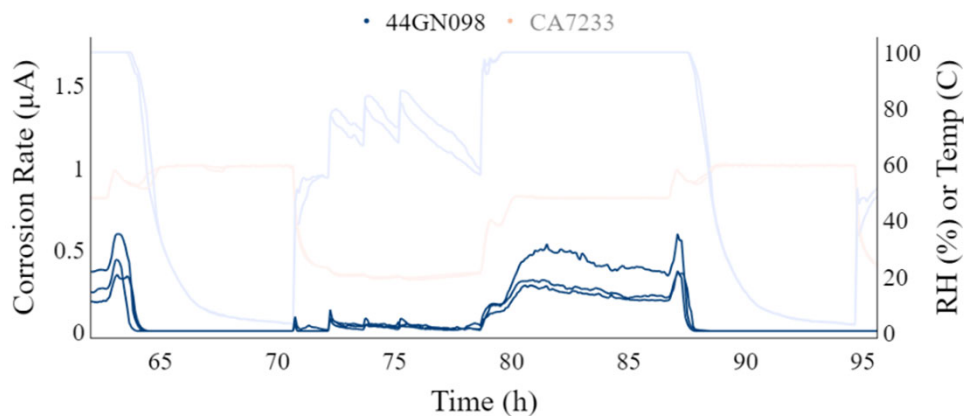
- The total galvanic corrosion measurement has inflection points indicative of coating failure
 - ◆ non-chrome ≈1400 hours
 - ◆ chromate ≈2500 hours
- Inflection point is not necessarily aligned with blister initiation and growth observations

GMW-14872



Coating Degradation in Accelerated Testing

- The two coatings exhibited similar corrosion rate behaviors at different magnitudes before and after change points
- Current profiles exhibit dramatic changes and decay rate of the current during drying



Summary

- Corrosion was dependent on severity
- Corrosion was not dependent on the sequence of severity

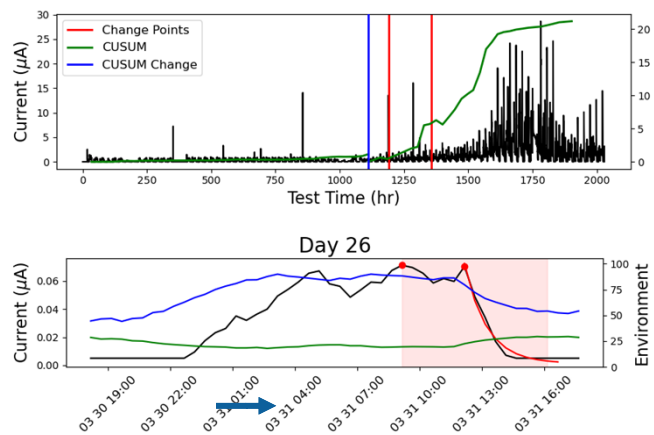
MODELING COATING PERFORMANCE

Modeling

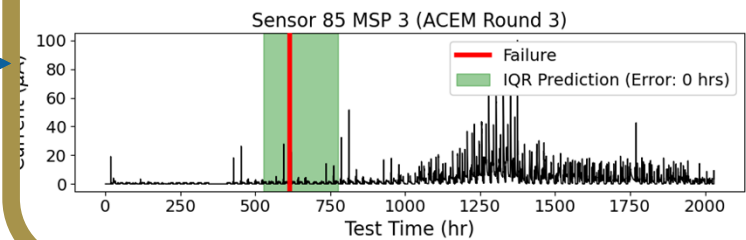
- Stochastic modeling has been done to detect loss of inhibitor protection and predict coating failure in comparison to observations
 - ◆ Modeling used laboratory and outdoor data for galvanic corrosion
- Statistical models use discrete events to forecast coating failure
 - ◆ Temporal point processes (TPPs) predict discrete events in time
 - ◆ Self-exciting TPPs (Hawkes processes) also assume that past events impact the probability of future events

Modeling Approach

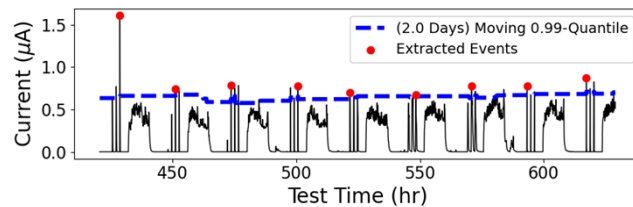
Define Failure



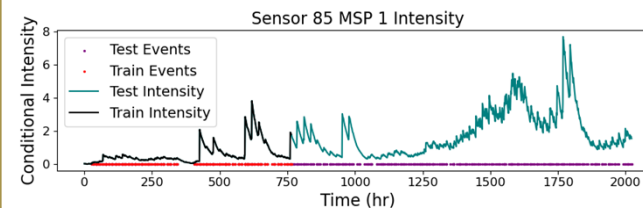
Predict Failure Window



Define Events

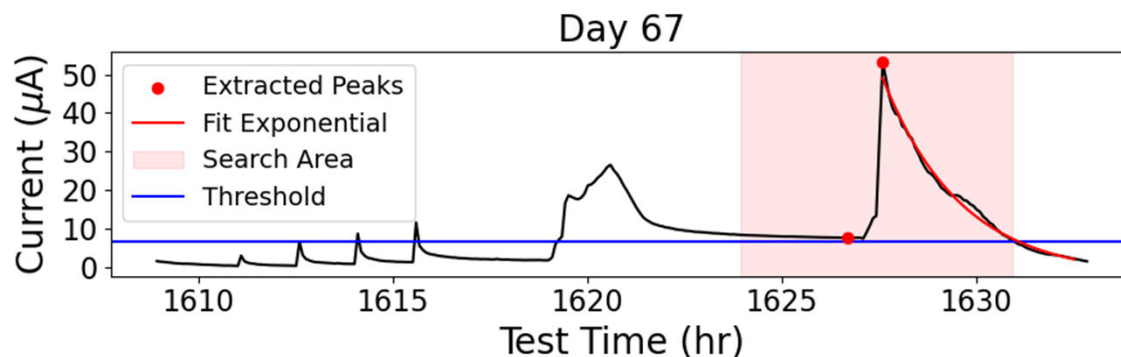
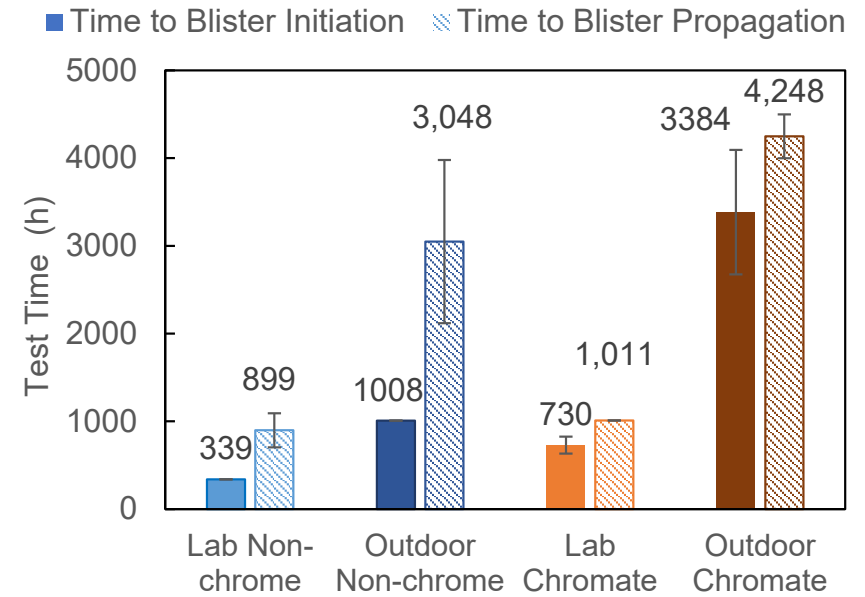


Predict Events



Modeling – Define Failure

- The state of blistering at a given time
 - ◆ Occurrence of a blister
 - ◆ Propagation of a coating blister
- Change in the corrosion rate response as measured by the current decay rate (τ) during drying
 - ◆ Cumulative sum approach was used to track τ and determine when τ exceeds a threshold value



$$y(t) = A \cdot \exp\left(-\frac{t}{\tau}\right) + C$$

Modeling – Define Events

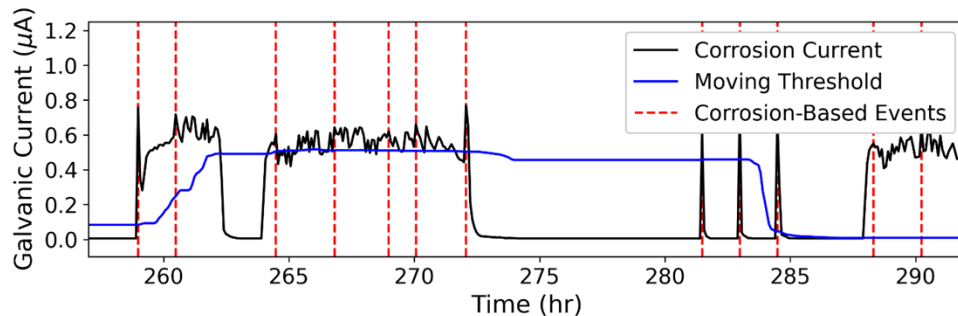
- Accumulation of discrete degradation events are associated with failure

A given combination, magnitude, and time for environmental conditions constitute a severe event

$$ToW = f(RH) = \begin{cases} \sum(t), & RH > 70\% \\ 0, & RH \leq 70\% \end{cases}$$

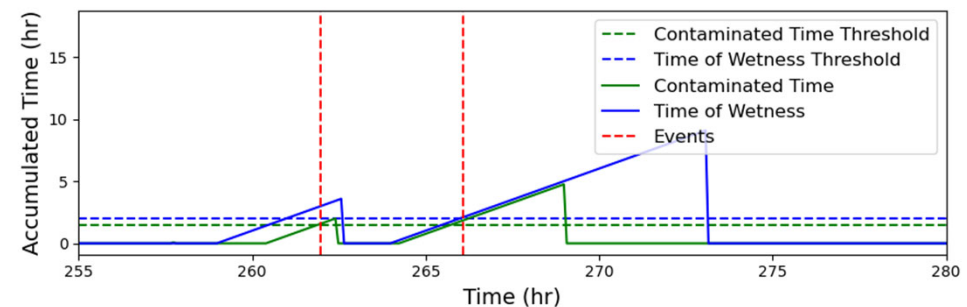
$$ToW_{threshold} = ToW > 2 \text{ hr}$$

Galvanic corrosion current local maxima characterizes aggressive degradation events



$$ToC = f(Cond.) = \begin{cases} \sum(t), & Cond. > 9,500 \mu S \\ 0, & Cond. \leq 9,500 \mu S \end{cases}$$

$$ToC_{threshold} = ToW > 0.5 \text{ hr}$$

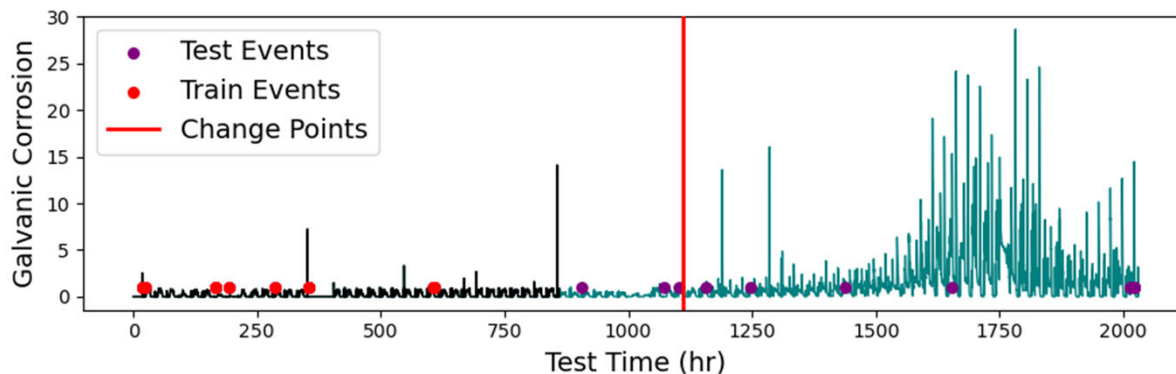


Model - Predict Events

- Process models were trained for predicting either corrosion events or environment events
- A time and magnitude history for degradation events was used to train the TPP

$$\lambda(t|\mathcal{H}_t) = \alpha \cdot \mu(t) + \omega \sum_{\{i: t_i \in \mathcal{H}_t\}} m_i \cdot \beta \cdot \exp(-\beta(t - t_i))$$

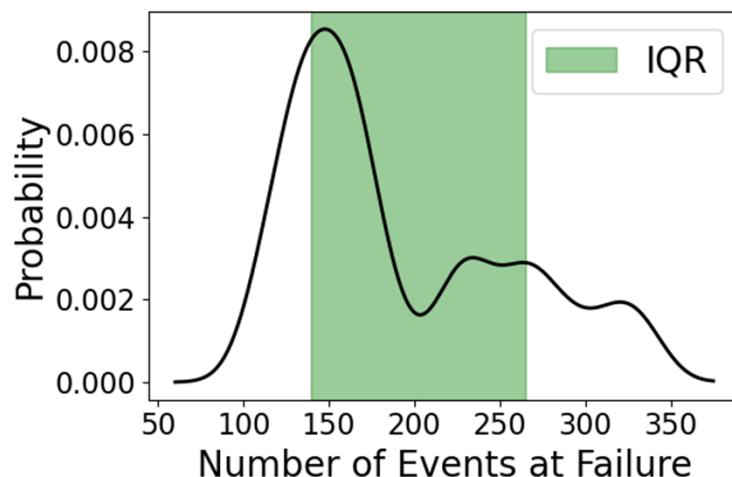
α - background intensity
 ω - self-exciting intensity
 β - self-exciting influence decay



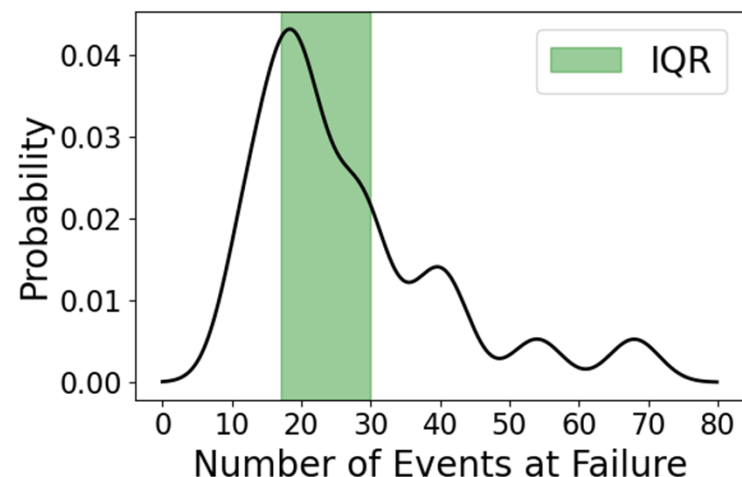
Model - Predict Events Failure Window

- The training data is used determine the event failure window
 - ◆ The failure prediction window is based on the 25th and 75th percentiles (inter-quartile range or IQR)
 - ◆ The window size is a measure of the variation in events to failure

corrosion events



environment events



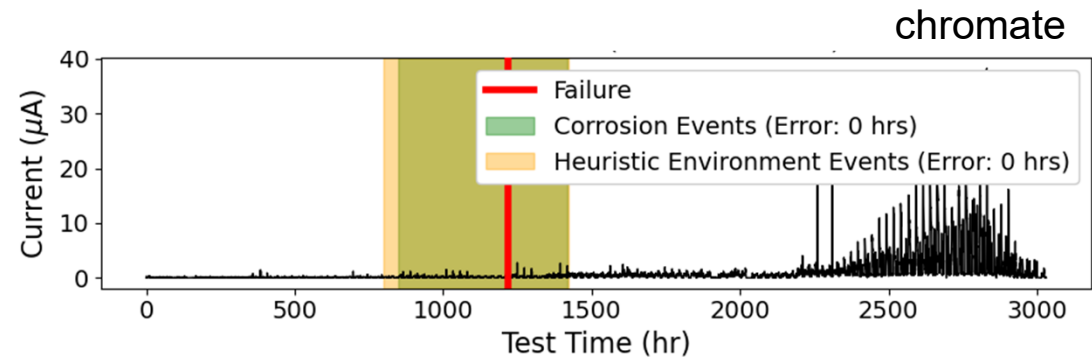
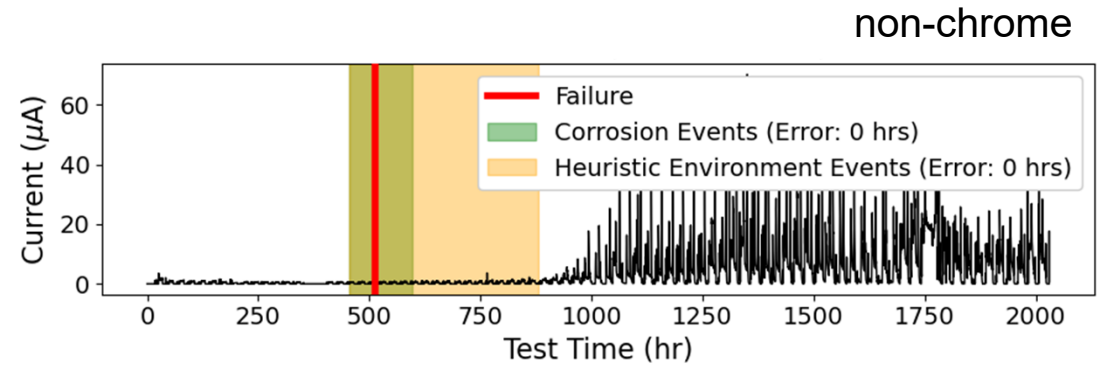
Event probability distribution

Model - Predict Time to Failure Window

The failure time window is predicted based on the IQR of events

- Compare intervals using environment events versus corrosion events

Environmental event predictions resulted in larger IQR prediction windows and correspondingly higher success rates in capturing true failure (τ)



Corrosion-event and environmental-event based failure models using laboratory data

Type of samples	No. of samples	Percentage of true failure within prediction window		Avg. prediction window size [hr]	
		Corrosion-event model	Environmental-event model	Corrosion-event model	Environmental-event model
Non-chrome	15	60%	33%	195	241
Chromate	9	44%	44%	257	530

Model - Time to Failure for Outdoor Tests

- Coating failure prediction was evaluated using outdoor exposure data and the environment event model
 - ◆ Failure was defined as the onset of blistering

Environmental event-based failure models, using outdoor data				
Type of samples	No. of samples	Percentage of true failure within prediction window	Avg. prediction window size [hr]	Avg. time interval of missed failure [hrs]
All non-chrome	3	100%	916	N/A
All chromate	3	0%	924	950

Modeling Summary

- Temporal point process models using discrete events for failure prediction windows are more appropriate as compared to direct time based models of total corrosion
- Models using environment events, appropriate for service life forecasting and asset tracking, have yielded promising results

END OF RESULTS

Next Steps

- Conduct focused outdoor exposures with relevant test samples and measurements to demonstrate a generalized model
 - ◆ Apply model to combined effects testing of representative samples
 - NRL Key West C-CoAST testing
- Draft standard method for revision/addendum to AMPP TM21449-2021, “Continuous Measurements for Determination of Aerospace Coating Protective Properties.” Include coating system evaluation protocol for:
 - ◆ Coating cracking measurements
 - ◆ Leaching tests, critical inhibitor concentration, and time to inhibition, and flow rate response
 - ◆ Laboratory and outdoor measurements of events to failure (τ and visual observations)
- Incorporate temporal point process model as part of asset tracking for probabilistic estimate of coating failure using actual individual aircraft usage within enterprise maintenance systems

Technology Transfer Examples

- Brandi Clark. Predictive Coating Condition Model for Advanced Asset Management. SERDP & ESTCP Webinar Series, June 2022.
- AMPP TM21449-2021, Continuous Measurements for Determination of Aerospace Coating Protective Properties.
- See backup slide for publications and presentation list.

Key Points

- Event (temporal point process) models were found to be more suitable for coating and corrosion modeling compared to direct modeling of cumulative corrosion
 - ◆ Maintenance may want to consider contribution of severe events
- Inhibition is dependent on leaching rate to achieve a critical concentration and formation of protective films that may be persistent over long time periods
 - ◆ Non-chrome coatings did not exhibit persistent protective films
- Non-chrome coatings were not as protective as chromate coatings in every lab and outdoor test in this study
 - ◆ Non-chrome coating implementation should consider increased inspection and preventative maintenance relative to structures protected with chromate coatings
- Coating cracking at structural discontinuities and protection of galvanic couples are appropriate assumptions and focus for aerospace coating protection testing and modeling
 - ◆ Free corrosion may not be a strong or relevant performance discriminator

BACKUP SLIDES

Publications

- Victoria Avance, Rebecca Marshall, Fritz Friedersdorf, Matt Repasky, Henry Yuchi, Yao Xie. Real-time measurement of aerospace organic coating condition and performance in atmospheric corrosion conditions. AMPP 2024 Annual Conference (accepted).
- Victoria Avance, Lindsay Davis, Brandi Clark, Fritz Friedersdorf. Real-Time Measurement Of Organic Coating Performance For Atmospheric Galvanic Corrosion Protection. AMPP 2023 Annual Conference.
- Clark, B., Avance, Victoria, Repasky, Matthew, and Henry Yuchi, “Real-Time Measurement of Aerospace Coating Condition and Detection of Corrosion Protection Change Point for Predictive Coating Condition Modeling.” DoD Corrosion Conference 2023 (Tuscon, AZ), p. 14.
- Brandi Clark. Predictive Coating Condition Model for Advanced Asset Management. SERDP & ESTCP Webinar Series, June 2022.
- J. F. Dante, “Inhibitor Exhaustion from Aerospace Primers,” presented at the AMPP Annual Conference + Expo, Mar. 2022.
- Victoria Avance, Brandi Clark, Liam Agnew, and Fritz Friedersdorf. Predictive Coating Condition Model For Coating Lifetime Under Environmental Stressors. AMPP 2022 Annual Conference.
- Kris Williams et al. Boeing patents related to electrochemical monitoring during environmental tests using a flexor.
- J. F. Dante, “The Effect of Flow Rate on Corrosion Currents from Various Aircraft Primers,” presented at the CORROSION 2021, Apr. 2021.
- AMPP TM21449-2021, Continuous Measurements for Determination of Aerospace Coating Protective Properties.
- Brandi Clark, Jacob Wright, Liam Agnew, and Fritz Friedersdorf. “Predictive Coating Condition Model for Coating Lifetime Under Environmental and Mechanical Stressors.” CORROSION 2021, Virtual Conference. April 19 – 30, 2021.
- Clark, B., J. Wright, F. Friedersdorf, R. Meekins, and L. Agnew, “Measurement and Prediction of Aerospace Corrosion Rate Using Real-Time Sensor Measurements and Machine Learning Approaches,” in NACE International Corrosion Conference Proceedings (Virtual: NACE International, 2020), pp. 1–9.

Publications- Posters

- Victoria Avance, Rebecca Marshall, Matt Repasky, Yao Xie, Ivan Karayan, Jim Dante, Andrew Keller, Fritz Friedersdorf. “Predictive Coating Condition Model for Advanced Asset Management (WP9-1168).” SERDP ESTCP Symposium 2023.
- Brandi Clark, Victoria Avance, Yao Xie, Ivan Karayan, Jim Dante, Andrew Keller, Fritz Friedersdorf. “Predictive Coating Condition Model for Advanced Asset Management (WP9-1168).” SERDP ESTCP Symposium 2022.
- Fritz Friedersdorf and Brandi Clark. “Predictive Coating Condition Model for Advanced Asset Management (WP9-1168).” SERDP ESTCP Symposium 2021, Virtual Conference Poster.
- Matthew Repasky, Henry Shaowu Yuchi, Yao Xie, Data Driven Material Degradation Modelling for Aircraft Coating. Poster presentation at the Annual Georgia Tech undergraduate research symposium, April 2021.
- Fritz Friedersdorf and Brandi Clark. “Predictive Coating Condition Model for Advanced Asset Management (WP9-1168).” SERDP ESTCP Symposium 2020, Virtual Conference Poster.
- Fritz Friedersdorf and Brandi Clark. “Predictive Coating Condition Model for Advanced Asset Management (WP9-1168).” 2020 ASETSDefense, Virtual Conference Poster, August 4 – 6, 2020.
- Fritz Friedersdorf and Brandi Clark. “Predictive Coating Condition Model for Advanced Asset Management (WP9-1168)” SERDP ESTCP Symposium 2019. Poster Presented 12/03/2019. Washington, DC.

WP19-1168: Predictive Coating Condition Model for Advanced Asset Management

Performers: Luna Labs, Georgia Institute of Technology, Southwest Research Institute, The Boeing Company, University of Dayton Research Institute, Air Force Corrosion Prevention and Control Office

Technology Focus

- *Evaluation methods, measurements, and model that accurately characterizes and predict the cumulative damage state of a coating system*

Research Objectives

- *Summarize research objectives and criteria for success*
- *1) Coating prognostic model for predicting coating damage and inhibitor exhaustion; 2) Verified model predictions; 3) Detail test protocol for extending the model; 4) Model designed for integration with Air Force CBM+ systems*

Project Progress and Results

- *Revised understanding of inhibitor mechanisms and degradation processes for contribution of severe events to coating failure*
- *Reduced galvanic protection of non-chrome coatings with important implications for non-chrome implementation and aircraft maintenance*

Technology Transition

- *Formally detail evaluation methods and validate with broader range of coating systems an outdoor environments*

Temporal point process model for environment and corrosion event modeling of coating failure

