Galvanic Corrosion Test Method for Coatings and Materials

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ASETS Defense 2012
# Galvanic Corrosion Test Method for Coatings and Materials

**Summary**: The report presents a method for testing the galvanic corrosion of coatings and materials. It includes an overview of the test procedure, experimental setup, and data analysis. The effectiveness of the method is demonstrated through case studies on various materials.

## Abstract

The galvanic corrosion test method described in this report is designed to assess the corrosion resistance of coatings and materials in a controlled environment. The methodology includes a detailed experimental protocol that simulates real-world conditions to accurately predict material performance. Case studies are provided to illustrate the application of the test method in evaluating different materials under various conditions.

## Subject Terms

- Corrosion
- Galvanic corrosion
- Coatings
- Materials engineering
- Test methods

## Security Classification

- **Report**: Unclassified
- **Abstract**: Unclassified
- **This Page**: Unclassified

## Limitation of Abstract

- **Same as Report (SAR)**

## Number of Pages

- **15**

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Galvanic Corrosion Basics

- Occurs when two or more dissimilar metals are brought into electrical contact in the presence of electrolyte
- Anode – sacrificial; corrodes faster than normal
- Cathode – corrodes slower than normal
- Electron Transfer from anode to cathode
- Corrosion rate can increase when:
  - Voltage difference increases
  - Cathodic surface area increases relative to anode
Why is the Navy concerned?

- Majority of all structural damage on US Navy and Marine Corps aircraft are at holes with galvanic incompatibility between aluminum and another material
- Commonly used test panels do not account for this failure mode and give no indication of primer effectiveness in slowing galvanic corrosion
Galvanic Corrosion Drivers for Holes

- Dry installation
- Choice of strong cathode (CRES worse than Ti due to higher cathodic current density)
- Low performing protection schemes
- Cathodic coatings (conductive paint, sealants, LO materials)
- Damage to protective materials
- Improper or low quality repair
Notes:
1. Fabricate coupons from AA2024-T3 and AA7075-T6
2. Coupon size: 3” X 6” X .25”
3. Drill #11 holes 8 places
4. Debur all holes and surfaces
5. 
   - Titanium Hardware
6. 
   - Stainless Steel Hardware
7. Install Titanium Hardware 4 places, 10-32 x 0.75 Socket Cap Screw 6AL-4V, 6AL-4V 10-32 washers and 10-32 6AL-4V hex nut, A product of RIGHTech Fabrications Northbrook IL
8. Install Stainless Steel Hardware 4 places, 10-32 X ¾” hex machine 316 SS bolts, 10-32 316 SS flat washers, 10-32 hex nut 316 SS, Product of Hardware Specialties Co., Inc, Long Island City NY
9. Torque All bolts to 100 in oz.
10. Scribe bottom row of bolts 4 places, make an “X” over the hole with each line extending ½” from the center of the hole.
NAVAIR Galvanic Assemblies

Representative of worst case observed installation of fasteners in aluminum structure

Titanium  SS316

PRIMER ONLY  PRIMER & TOPCOAT
## Rating Method

<table>
<thead>
<tr>
<th>1st Digit- Scribe appearance</th>
<th>2nd Digit – Undercutting (ASTM 1654)</th>
<th>3rd Digit- Face blistering (ASTM D714)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Bright and clean</td>
<td>0 No lifting of coating</td>
<td>0 None (None (#10))</td>
</tr>
<tr>
<td>1 Staining, no corrosion</td>
<td>1 Lifting or loss of adhesion up to 1/16” (2mm)</td>
<td>1 Very small (#8) &lt;1 mm</td>
</tr>
<tr>
<td>2 1-10% corrosion product</td>
<td>2 Lifting or loss of adhesion up to 1/8” (3mm)</td>
<td>2 Small (#6) 1-2 mm</td>
</tr>
<tr>
<td>3 11-25% corrosion product</td>
<td>3 Lifting or loss of adhesion up to 1/4” (7mm)</td>
<td>3 Sm to Med (#4) 2-3 mm</td>
</tr>
<tr>
<td>4 26-50% corrosion product</td>
<td>4 Lifting or loss of adhesion up to 1/2” (13mm)</td>
<td>4 Med to Lg (#2) 3-5 mm</td>
</tr>
<tr>
<td>5 51-100% corrosion product</td>
<td>5 Lifting or loss of adhesion up to &gt;1/2” (&gt;13mm)</td>
<td>5 Large (#0) &gt;5mm</td>
</tr>
</tbody>
</table>

Based on:
# Test Method

<table>
<thead>
<tr>
<th>Test Method</th>
<th>ASTM B117</th>
<th>ASTM G85.A4</th>
<th>KSC Outdoor Exposure Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Duration</strong></td>
<td>504 hours (3 weeks) of exposure</td>
<td>336 hours (2 weeks) of exposure</td>
<td>9 months of exposure</td>
</tr>
<tr>
<td><strong>Rating Interval</strong></td>
<td>Every other day for 1 week, then once a week until test completion</td>
<td>Every other day for 1 week, and every couple days the 2\textsuperscript{nd} week.</td>
<td>Once a month</td>
</tr>
<tr>
<td><strong>Rating Method</strong></td>
<td>Modified Rating Chart</td>
<td>Modified Rating Chart</td>
<td>ASTM D1654, Undercutting rating only</td>
</tr>
</tbody>
</table>
Galvanic Corrosion:
ASTM G85.A4
Galvanic Corrosion:
ASTM G85.A4
United Technologies Corrosion Modeling

• Supplying corrosion data to UT to develop galvanic assembly life modeling
  – *Plot when systems fail (date) vs comparing ratings over a test interval*

• Goal – develop life model for coatings and aircraft assemblies
NAVAIR/OSU Technology Corrosion Collaboration (TCC)

• Understanding the NAVAIR Galvanic Assembly
  – Isolating fasteners and recording current measurements
  – Finding that the fasteners interact with one another through surface electrolyte film
    • Increases the corrosion rate of the “weak link”
NAVAIR/OSU TCC

- Use information gathered in this project to improve the design/develop galvanic corrosion test method(s) for:
  - Paint specifications
  - Corrosion Modeling
  - Acquisition Program Support
Questions?