CHO-TM100
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Test Method For Assessing Galvanic Corrosion Caused By Conductive Elastomers

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1.0 SCOPE

1 .1 This is a test method to determine, in a quantitative manner, the corrosivity of conductive elastomers toward aluminum alloys and the electrical and dimensional stability of the conductive elastomer after exposure to a salt fog environment.

1 .2 This test method covers the selection of materials, specimen preparation, test environment, method of exposure, and method of evaluating results in order to characterize conductive elastomer/aluminum alloy galvanic couples in a corrosive environment.

1 .3 This test method may involve the use of hazardous materials The procedures described herein do not address all of the safety issues associated with their use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2.0 APPLICABLE DOCUMENTS

2.1 ASTM Standards

B117 Method of Salt Spray (Fog) Testing
G1 Preparing, Cleaning, and Evaluating Corrosion Test Specimens
G46 Examination and Evaluation of Pitting Corrosion

2.2 Military Standards

MIL-C-5541E Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-DTL-83528C Gasketing Material, Conductive Shielding Gasket, Electronic, Elastomer, EMI/RFI General Specifications For

3.0 SIGNIFICANCE AND USE

3.1 Conductive gaskets are used to seal apertures in electronic enclosures and airframes against leakage of electromagnetic radiation. Metal filled elastomers (conductive elastomers) are one type of "EMI gasket" used for this purpose. Conductive elastomers consist of small (typ. 30 to 150 micron) metal particles in an elastomer binder. Typical metal fillers include silver, silver plated materials (e.g., copper, glass, aluminum, nickel), nickel, and carbon. Typical binders include silicone, fluorosilicone, and EPDM. The elastomer binder is highly loaded with the metal filler to provide low volume resistivity, in use, these conductive elastomers are compressed between mating surfaces so that a low impedance bond is formed.

3.2 Aircraft structures and electronic enclosures are typically made from aluminum alloys. When these aluminum alloys are sealed with conductive elastomers and exposed to a salt fog environment, the necessary and sufficient conditions for galvanic corrosion exist: two dissimilar metals, electrolyte, and an electronic path.

3.2.1 The aluminum alloy is the more active material in a conductive elastomer/aluminum alloy galvanic couple. Corrosion of the aluminum alloy can lead to pitting (and in severe cases to structural damage) and build-up of non-conductive corrosion products between the conductive elastomer and aluminum alloy enclosure or airframe structure.

3.2.2 The conductive elastomer is the more noble material in the conductive elastomer/aluminum alloy galvanic couple. However, the conductive elastomer can undergo deterioration in the salt fog environment due to filler particle corrosion or changes in the elastomeric binder or both. Such deterioration can result in increased volume resistivity and changes in the physical properties of the conductive elastomer.

3.2.3 Build-up of non-conductive corrosion products between the conductive elastomer and mating aluminum alloy flanges and changes in the electrical and physical properties of the conductive elastomer, may increase the interface impedance and decrease the shielding effectiveness of the system.

3.3 This test method describes procedures for assigning a quantitative value to the corrosivity of a conductive elastomer and measuring its electrical and dimensional stability after exposure to a salt fog environment

3.3.1 The corrosivity of the conductive elastomer is determined by measuring the weight loss of an aluminum alloy test coupon after exposure of the galvanic couple to a salt fog environment.

3.3.2 The electrical stability of the elastomer is determined by measuring its volume resistivity before and after exposure of the galvanic couple to the salt fog environment.

3.3.3 The dimensional stability of the conductive elastomer is determined by measuring its thickness before and after exposure of the galvanic couple to a salt fog environment.

3.4 The values obtained for aluminum alloy weight loss, conductive elastomer volume resistivity and dimensional changes are indicative of corrosivity and stability of the conductive elastomer in a salt fog test environment. Care should be used in applying the absolute values obtained to other test environments or to a natural environment

4.0 EQUIPMENT AND TEST SPECIMENS

4.1 The text fixture is shown in Figure 1. The conductive elastomer and aluminum coupon are held in contact by compression between two cylindrical Delrin blocks. Compressive force is supplied by a central 3.25” (8.26cm) long 1/4-20, 18-8 stainless steel bolt and an 18-8 stainless steel nut. Fluid is prevented from penetrating to the bolt-conductive elastomer/aluminum alloy coupon interface by use of non-conductive silicone sealing washer, between the bolt head and the upper Delrin block and between the bottom of the aluminum coupon and the lower Delrin block.

4.1.1 The aluminum alloy coupon and conductive elastomer test specimen are shown in detail in Figure 2. The circular aluminum coupon has a 1.75” (4.45cm) outer diameter with a 0.25” (0.64cm) hole in the center. It should be machined from an aluminum sheet on a lathe and should not be formed by stamping. The coupon should be of a thickness such that it does not pit through during exposure to the

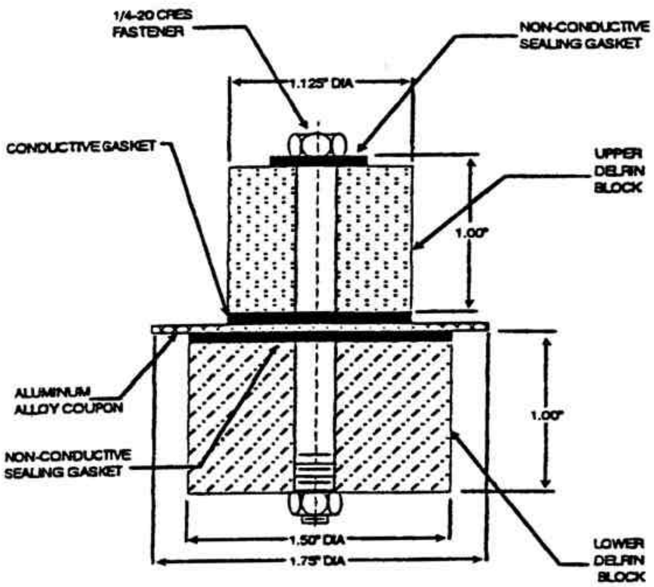

Figure 1
Test Fixture

corrosive environment. For 168 hours exposure, a 0.05” (0.127cm) thick coupon of 6061-T6 aluminum alloy is recommended. The coupon should be conversion coated in accordance with MIL-C-5541 E, Class 3.

4.1.2. The conductive elastomer specimen is a washer of 1.141” +/0.010” (2.90cm +/0.0254cm) outer diameter with a 0.25” +/- 0.005” (0.64cm +/- 0.0127cm) center hole. The elastomer should be 0.062” +/- 0.007” (0.157” +/- 0.0178cm) thick. Deviations to these dimensions from the nominal value may affect the results. The conductive elastomer washer should be formed by die-cutting from sheet stock.

4.1.3 Figure 3 shows the nonconductive sealing gaskets in more detail. They should be made from a silicone rubber of 45 Shore A hardness. The sealing gasket used underneath the aluminum coupon should be a washer of 1.5” (3.81 cm) outer diameter with a 0.25” (0.64cm) hole in the center. A thickness of 0.062” (0.157cm) is recommended. The sealing gasket used under the bolt head should be a washer of 0.6875” (1 .746cm) outer diameter with a 0.25” (0.64cm) hole in the center.

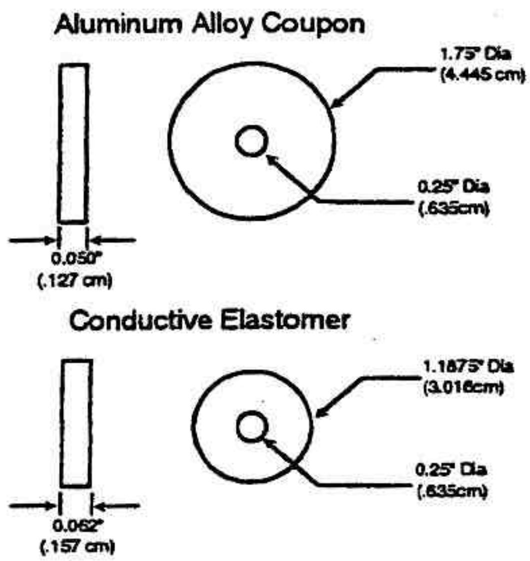

Figure 2
Aluminum Alloy Coupon and
Conductive Elastomer

4.2 The fixture holder is shown in Figure 4. The intent of the fixture holder is to hold the test fixture at a fixed angle in the test chamber. This angle should be 75° to the horizontal. The fixture holder should be made from nonmetallic, inert materials.

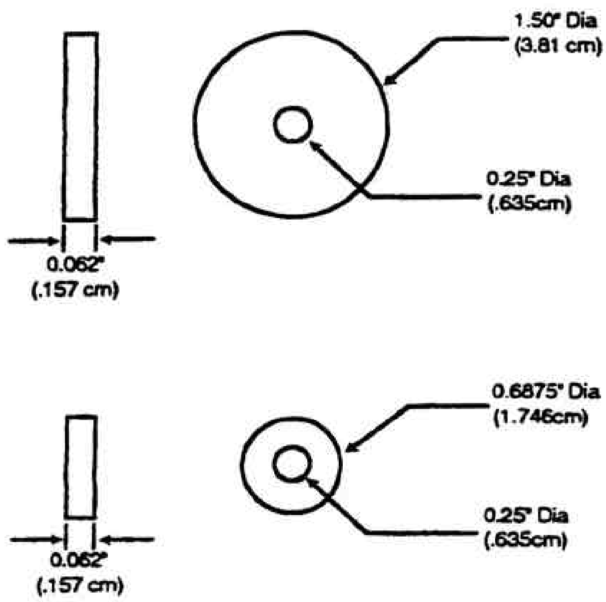

Figure 3
Non-Conductive Sealing Gaskets

4.3 The following equipment is required to determine the volume resistivity of the conductive elastomer specimen

4.3.1 A four point probe digital ohmmeter with a measuring range of 10-4 to 104 ohms and an accuracy of + /- 0.02 percent of the reading

4.3.2 A thickness gauge capable of measuring in 0.001 "(0.025mm) increments.

4.3.3 Silver (or silver plated) electrodes with a diameter of 1.2" (3.05cm) or greater and suitable provision for attaching ohmmeter leads

4.3.4 An appropriate fixture or apparatus having the capability of supporting the electrodes and a suitable means of applying 100 psi of pressure (.69MPa) or 105.8 lbs of force (47.99kg) to the conductive elastomer.

4.4 Weights of aluminum alloy coupons should be measured on an analytical balance capable of +/-0.1 mg precision.

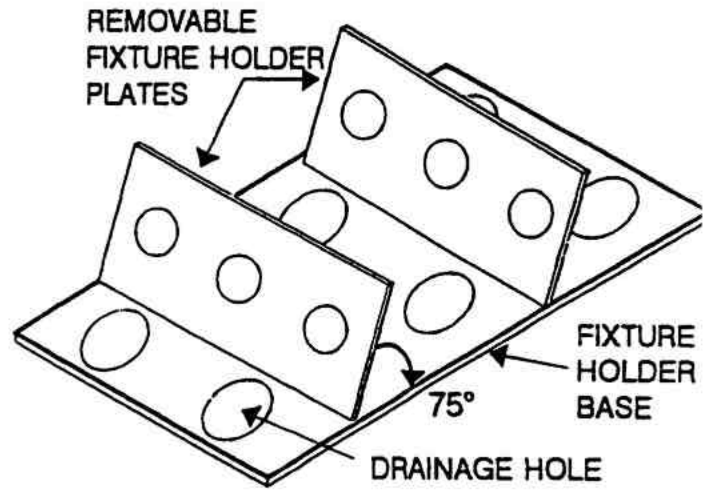

Figure 4
Fixture Holder

4.5 A *Sharpie* fine point permanent marker (or equivalent) can be used to mark aluminum and conductive elastomer samples for identification.

5.0 ASSEMBLY PROCEDURE AND PRE-EXPOSURE MEASUREMENTS

5.1 No less than two test assemblies of each conductive elastomer type shall be exposed for each test.

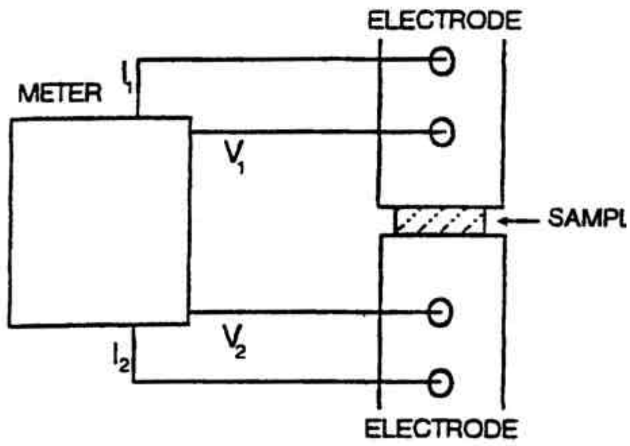

Figure 5
Ohmmeter Connection

5.2 Mark each aluminum alloy disk with a sample number.

Note 1: The aluminum alloy disks should be handled with gloves so as to prevent fingerprints and soil from causing weighing errors.

5.3 Mark each conductive elastomer specimen with a sample number.

5.4 Weigh the aluminum alloy coupons and record the weights.

5.5 Measure the resistance and thickness and calculate the volume resistivity of the conductive elastomer specimens using the following procedures:

5.5.1 Prepare the specimen and apparatus as follows:

5.5.1.1 The conductive elastomer should be clean and free of dirt and foreign matter. If necessary, it should be wiped with a clean, alcohol soaked rage to remove soil. Allow the alcohol to evaporate before making any measurement.

5.5.1.2 The silver electrodes should be cleaned by wiping with alcohol before use. The electrodes must be properly aligned and the contact faces must be flat and parallel to each other.

5.5.1.3 The ohmmeter should be connected to the electrodes as shown in Figure 5.

5.5.2 Perform the measurement as follows:

5.5.2.1 Measure and record the thickness of the conductive elastomer.

5.5.2.2 Position the conductive elastomer between the electrodes and apply a pressure of 100 psi (.Ô9MPa) or 105.8 lbs of force (47.99kg).

5.5.2.3 Maintaln a constant pressure for 30 seconds and record the resistance reading.

5.5.3 The volume resistivity is calculated from the following formula:

p = RA / L
Where: p = volume resistivity (ohm-cm)
R = measured resistance (ohm)
A = Area of conductive elastomer (cm2)
L = measured thickness (cm)

For the conductive elastomer of the dimensions given in section 4.1 .2,
A = 6.280 cm2

5.6 To assemble the fixture, start by placing the smaller non-conductive gasket under the head of the stainless steel bolt. Insert the bolt through the upper Delrin block, through the conductive elastomer, through the aluminum alloy coupon, through the lower Delrin block and through the fixture holder plate. Place any needed washers and the hex nut oft the threaded portion of the bolt. Apply sufficient torque to the bolt so that the conductive elastomer is deflected 10% [about 8 in-lbs (.9N m) for most filled silicones]. Repeat this procedure for each fixture.

5.7 After assembling the fixtures onto the fixture holder plates, the plates should be placed into the fixture holder base.

6.0 TEST CONDITIONS

6.1 The fixtures should be exposed to neutral salt fog according to the conditions given in ASTM B117.

6.2 Exposure periods ranging from 72 to 500 hours have been used. An exposure period of 168 hours (1 week) is recommended.

7.0 EVALUATION OF SPECIMENS

7.1 The fixtures should be removed from the salt fog chamber at the end of the exposure period. Disassemble the fixtures and rinse the aluminum alloy coupons with deionized water. Loosely adhered corrosion products can be removed with a soft nylon brush

7.2 The aluminum alloy coupons should be further cleaned of corrosion products using a modification of the procedure given in ASTM G 1-88. The coupons are placed in 1.42 specific gravity (concentrated) nitric acid for 15 minutes. After removal from the nitric acid the disks should be rinsed in deionized water, blotted dry, and relabeled with the marking pen (if necessary).

Note 2: Concentrated nitric acid should be used in a fume hood and proper safety equipment should be worn.

7.3 Dry the aluminum alloy coupons for 2 hours at 100°C. Coupons should be placed in a desiccator and allowed to cool to room temperature.

7.4 Reweigh the coupons on a balance capable of + /- 0.1 mg precision and record the results.

7.5 Measure and record the thickness of the portion of the conductive elastomer specimen showing the maximum dimensional change.

7.6 Measure and record the resistance of the specimen according to the procedure given in Section 5.5.

8.0 INTERPRETATION AND CALCULATION OF

8.1 The corrosivity of the conductive elastomer is proportional to the weight loss of the aluminum alloy coupon

8.1 .1 Calculate the aluminum alloy coupon weight loss according to:

Weight Loss (mg) =
[Initial Weight (g) - Final Weight (g)] x 1000

8.1.2 Calculate the average coupon weight loss for each conductive elastomer type.

8.2 The dimensional stability of a conductive elastomer is related to its ability to continue to provide an EMI and environmental seal during environmental exposure.

8.2.1 Calculate the maximum percent dimensional change of the conductive elastomer specimen according to

% Dimensional Change =

$$\frac{\text{final thickness - initial thickness}}{\text{initial thickness}} \times 100$$

8.2.2 Calculate the average maximum percent dimensional change for each conductive elastomer type

8.3 The volume resistivity of a conductive elastomer is directly related to its ability to prevent leakage of electromagnetic radiation through an aperture.

8.3.1 Calculate the volume resistivity according to the equation given in section 5.5.3.

8.3.2 Determine conformance of the volume resistivity to any applicable specification

9.0 REPORT

9.1 A test report containing the following information shall be issued at the completion of the test. It must include each of the following elements.

9.1.1 The exposure time in salt fog.

9.1.2 The aluminum alloy exposed and the conversion coating applied.

9.1.3 The weight loss for each aluminum alloy coupon.

9.1.4 The average weight loss of the aluminum alloy coupons for each type of conductive elastomer.

9.1.5 The volume resistivity of the conductive elastomer specimen before and after

9.1.6 The maximum percent dimensional change of each conductive elastomer specimen.

9.1.7 The average maximum percent dimensional change for each conductive elastomer type.

9.2 A suggested Word document form for reporting the results is given in the Appendix.

Reviewed and revised by Gary Brown
9/08/2005