

Determination of the Corrosion Resistance of CHO-SEAL[®] 1298 Conductive Elastomer Used in Conjunction with CHO-SHIELD[®] 2001 Conductive Coating

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SUMMARY

Conversion coatings, typically MIL-C-5541 Class 3, are used as barriers to prevent the occurrence of galvanic corrosion between aluminum substrates and conductive elastomers when exposed to marine-type environments. The purpose of this test program was to determine if CHO-SHIELD® 2001 coating added any further protection to 6061-T6 aluminum (MIL-C-5541 Class 3 conversion coated) when mated with a CHO-SEAL® 1298 conductive elastomer gasket. After 1000 hours exposure to ASTM B117 salt fog, the 6061-T6 aluminum substrate was completely protected without any evidence of corrosion. The volume resistivity of the CHO-SEAL 1298 gasket remained within the MIL-G-83528, Type D specification and there was minimal swell of the gasket.

INTRODUCTION

Sensitive electronic equipment is often contained within a metal enclosure to prevent EMI. The metal enclosure "shields" against external fields and keeps radiated emissions within acceptable limits. Metal, because of its inherent ability to reflect and absorb electromagnetic energy, provides excellent shielding performance.

In general, the more conductive the metal, the greater its ability to shield. However, imperfect junctions of real-world metal enclosures and apertures that exist to connect cables or wires to the internal power source, significantly reduce shielding performance. This problem can be solved by using an EMI shielding gasket to

provide electrical continuity across seams and imperfect junctions of the enclosure.

The enclosure is often made from an aluminum alloy, while the EMI shielding gasket contains metal fillers such as silver, silver-plated metals, nickel, carbon, etc. If the enclosure and gasket are subjected to a marine or coastal environment, the conditions for a galvanic couple are created: two dissimilar metals (aluminum substrate and metal-filled elastomer), an electrolyte (salt fog), and an electric current pathway. The effect of such a galvanic couple is corrosion, usually observed in the form of pits, bubbles, or small holes in the aluminum enclosure material. Corrosion by-products can also migrate beneath the gasket to create air gaps. These pits, air gaps, etc. ultimately result in a loss in shielding effectiveness, which can allow EMR leakage and susceptibility.

In corrosive environments, conductive elastomers (small metal particles in an elastomer binder) are usually chosen because of their good environmental sealing ability. A previous test program^{1,2,3} showed that certain silver-plated-aluminum-filled fluorosilicone elastomers were the most galvanically compatible with aluminum in a salt fog environment. However, even the least

¹ P. Lessner, "Quantitative Determination of the Corrosion Resistance of Conductive Elastomers: Part I. Materials Based on Silver and Silver Plated Fillers", Report No. CHO-TR19A, Chomerics, Inc., Woburn, MA, August 1992.

² P. Lessner, "Quantitative Determination of the Corrosion Resistance of Conductive Elastomers: Part II. Materials Based on Nickel and Nickel Coated Fillers", Report No. CHO-TR19B, Chomerics, Inc., Woburn, MA, September 1992.

³ P. Lessner, "Quantitative Determination of the Corrosion Resistance of Conductive Elastomers: Part III. Materials Based on Silver-Plated Aluminum Fillers (various Manufacturers)", Report No. CHO-TR19C, Chomerics, Inc., Woburn, MA, September 1992.

corrosive of these materials, CHO-SEAL 1298, caused more corrosion than a non-conductive silicone control gasket. One method of further protecting the aluminum substrate is to apply an electrically conductive coating between the aluminum and the conductive elastomer. One

radiused corner would allow better coating adhesion and corrosion resistance. The aluminum coupons were conversion coated per MIL-C-5514 Class 3. A sodium hydroxide etch was included in the process to promote better adhesion of the CHO-SHIELD coating.

such coating is CHOSHIELD 2001, which was developed specifically to remain electrically conductive and protect aluminum substrates in corrosive environments^{4,5}.

This test program was developed to determine

the corrosion resistance of CHO-SHIELD 2001 coating used with a CHO-SEAL 1298 conductive

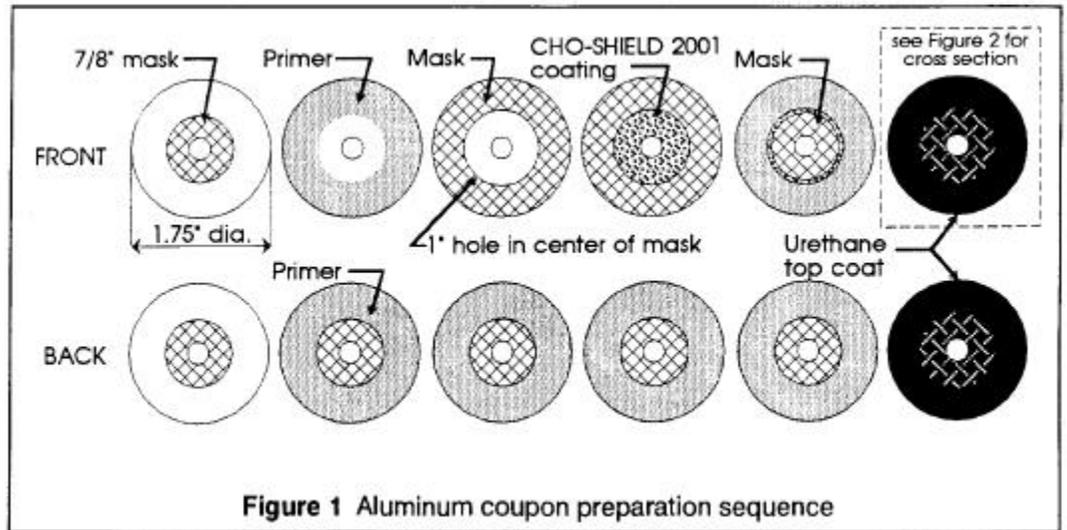


Figure 1 Aluminum coupon preparation sequence

TEST METHOD

Chomerics' test procedure CHO-TM1006 was used to determine corrosion resistance. The sharp edges of each 6061-T6 aluminum coupon were radiused to form a smooth transition between the face and edge of the coupon. In previous tests, blisters appeared on the sharp edge of the coupon. It was determined that a

Aluminum Substrate Preparation

Three coatings were used to protect the aluminum substrate: CHO-SHIELD 2001, MIL-P23377 yellow primer, and a green polyurethane top coat. A precise method and sequence of coating was used to prepare the aluminum coupons. The method is described here and depicted in Figures 1 and 2:

Using a 7/8" diameter masking tape, the center of the 1.75" coupon was masked on the front and back. Both sides of the coupon were sprayed with MIL-P-23377 yellow primer and cured at room temperature for 24 hours. The mask was removed from the front but left on the back. The front of the coupon was then remasked with a 1" diameter opening left in the center and sprayed with CHO-SHIELD 2001 coating. It was

cured at room temperature for 2 hours, then for

4 P. Lessner, "Corrosion Resistant Materials for EMI Applications", Paper No. 336, Corrosion/91, National Association of Corrosion Engineers, March 1991.
 5 P. Lessner, "Evaluation of CHO-SHIELD 2000 Series Coatings Subjected to Salt Fog Exposure", Report No. CHO-TR30A, Chomerics, Inc., Woburn, MA, September 1992.
 6 P. Lessner, "Test Method for Assessing Galvanic Corrosion Caused By Conductive Elastomers", Report No. CHO-TM100, Chomerics, Inc., Woburn, MA, May 1992.

20 minutes at 250° F (121° C). The mask was removed from the front and then another 7/8" diameter mask was applied to the center of the coupon. Both the front and back were sprayed with MIL-C-46168 forest green urethane top coat and cured at room temperature for 24 hours.

A CHO-SEAL 1298 gasket specimen was mated against the prepared aluminum coupon (Figure 2). The entire system -- gasket, coating, primer, top coat, and coupon -- was exposed to salt fog for periods of 168, 336, 500, and 1000 hours, in the fixture of CHO-TM100. After exposure, the coatings were dipped in ECCOSTRIP 93, a coating stripper, to remove the protective

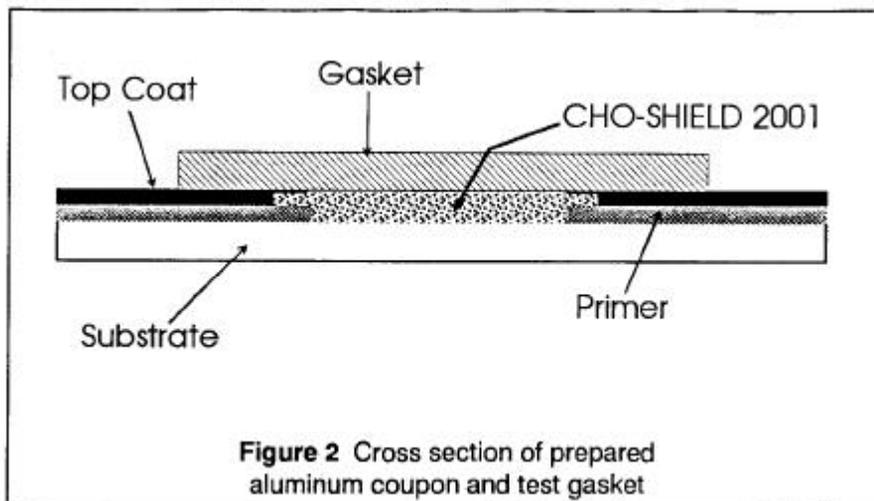


Figure 2 Cross section of prepared aluminum coupon and test gasket

Figure 4 reports dimensional stability, recorded as percent swell, of the gasket over time. The elastomer had virtually no swell after 336 hours. Minimal swell of less than 5% was recorded after 500 hours. Previous tests on silverplated-aluminum filled elastomers showed significant swellings.

CONCLUSION

CHO-SHIELD 2001 coating did prevent corrosion between the aluminum coupon and CHO-SEAL 1298 gasket even after 1000 hours. Volume resistivity of CHO-SEAL 1298 was stable up to 1000 hours.

This corrosion resistant system, CHOSHIELD 2001 coating and CHO-SEAL 1298 EMI shielding gasket, is therefore recommended for the control of EMI and corrosion in military/ aerospace type applications which are subjected to marine environments.

RESULTS

Weight loss of the aluminum coupons was insignificant after all of the salt fog exposure periods. Moreover, there was no visual evidence of corrosion (pitting) on the coupons.

Figure 3 shows the volume resistivity of the gasket after each exposure period. CHOSEAL 1298 remained below the 15 mohm-cm aging specification (MIL-G-83528, Type D). Previous tests on nickel-filled elastomers showed dramatic loss of conductivity after salt fog exposure⁸.

⁷ ECCOSTRIP is a trademark of Emerson & Cuming,
⁸ P. Lessner, op.cit., Report No. CHO-TR19B.

⁹ P. Lessner, op.cit., Report No. CHO-TR19C.

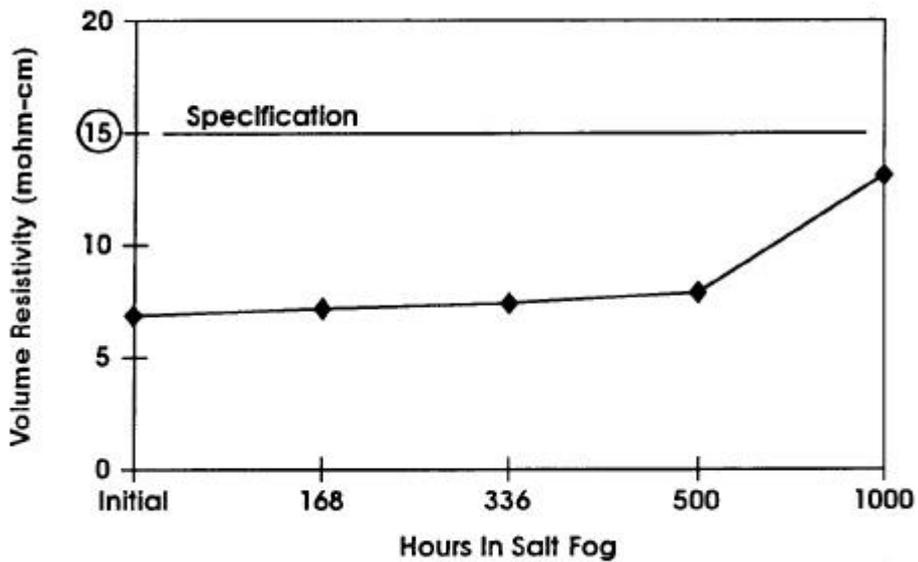


Figure 3 Volume resistivity of the CHO-SEAL 1298 EMI gasket after salt fog exposure

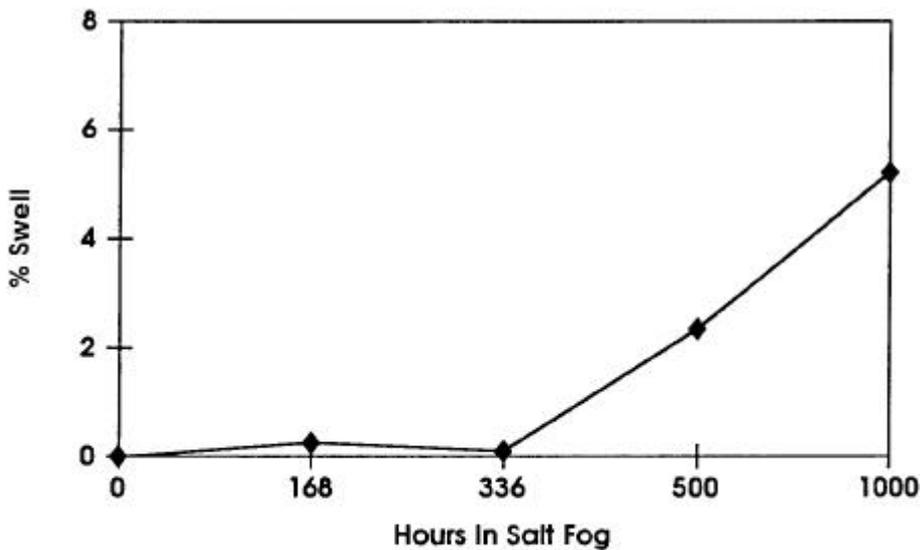


Figure 4 Dimensional stability of the CHO-SEAL 1298 EMI gasket after salt fog exposure