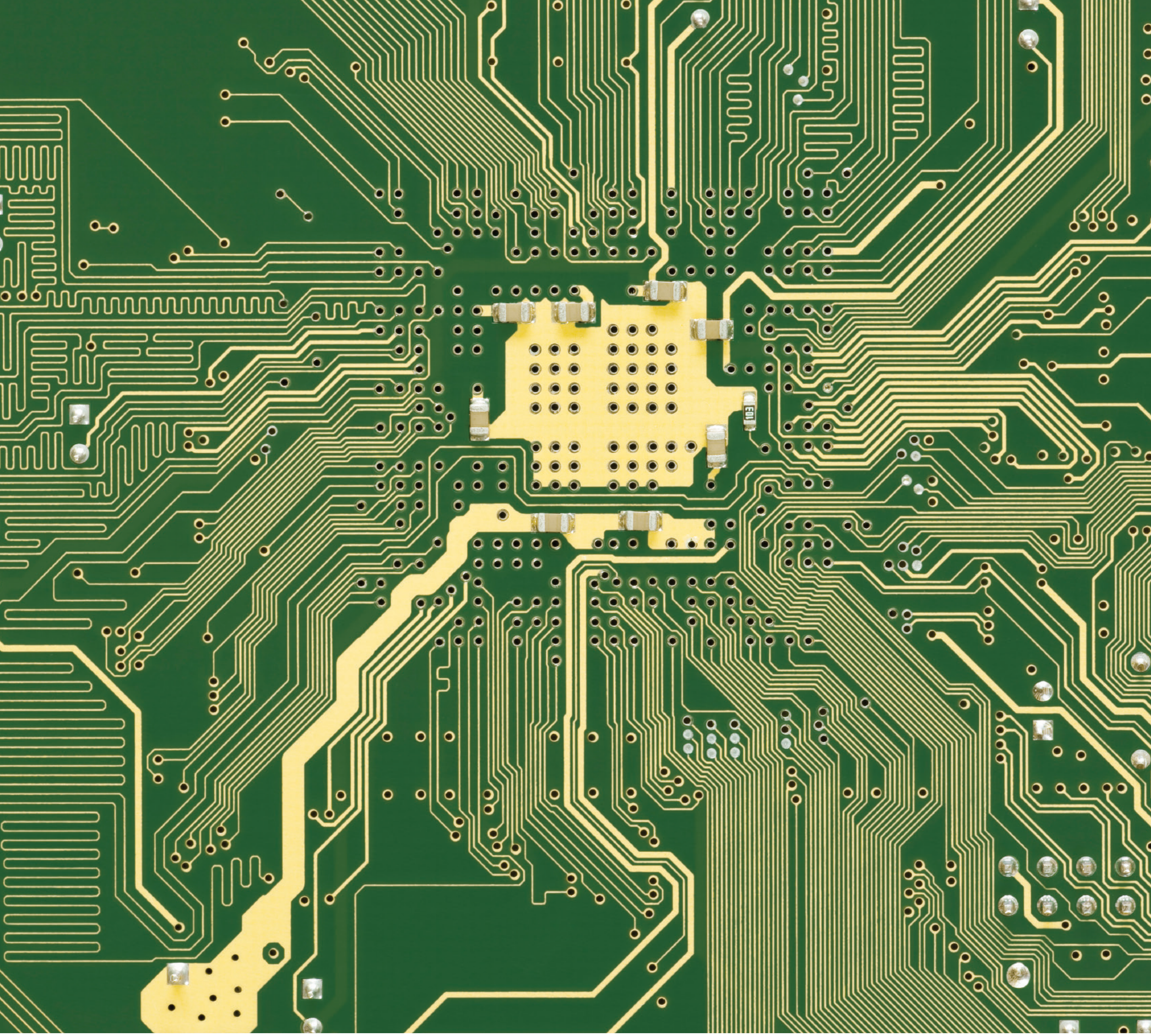

Corrosion Testing of Conductive Elastomer and Form-In-Place (FIP) EMI Gasket Materials Against ENIG

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Corrosion Testing of Conductive Elastomer and Form-In-Place (FIP) EMI Gasket Materials Against ENIG

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Over the years, Parker Chomerics has invented electrically conductive elastomeric gaskets specifically designed to address progressive requirements within the electromagnetic interference and electromagnetic compatibility (EMI/EMC) marketplace. As a result, Parker Chomerics is routinely asked about corrosion effects of these materials when in contact with Electroless nickel/immersion gold (ENIG). This paper outlines the results of corrosion testing performed to address this question.

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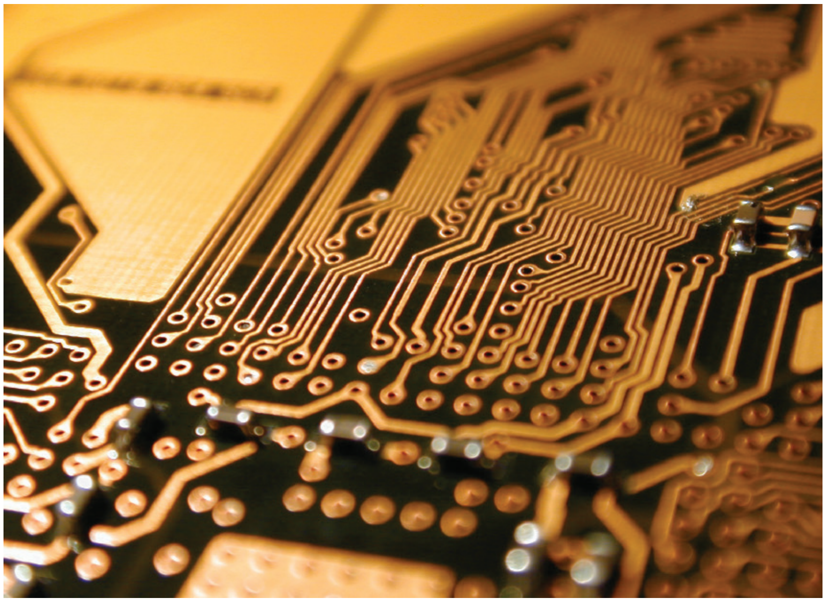
Introduction

Parker Chomerics has invented electrically conductive elastomeric gaskets specifically designed to address progressive requirements within the EMI/EMC marketplace. These revolutionary gasket materials, consisting of particles dispersed within a silicone, fluorosilicone or EPDM resin system, provide a gasket capable of offering both electromagnetic shielding and a degree of environmental protection. Filler particle material technologies have been nickel-graphite, silver-aluminum and nickel-aluminum.

Parker Chomerics changed the market with the development of CHO-SEAL® 1285 and CHO-SEAL 1298 silver plated aluminum silicone and fluorosilicone conductive elastomer gasket materials for environmental protection. Then, with the release of CHO-SEAL 6502 and CHO-SEAL 6503 nickel aluminum particle filled series of conductive elastomers, Parker Chomerics further improved environmental protection and increased corrosion resistance.

This technology was then expanded by using these fillers in EPDM resin systems (such as CHO-SEAL 6460) and form-in-place (FIP) gasket materials (such as CHO-FORM® 5560).

Today, Parker Chomerics is routinely asked about corrosion effects of these materials when in contact with ENIG. This paper outlines the results of corrosion testing performed to address this question.



Electroless Nickel/ Immersion Gold

Electroless nickel/immersion gold (ENIG) is a popular plating technique for printed circuit boards (PCBs). ENIG is one of the surface finishes used as an interface between electromagnetic interference (EMI) shielding gasket systems and the printed circuit board. ENIG is an electroless nickel layer capped with a thin layer of immersion gold. It is a multi-functional printed circuit board surface finish used for soldering, wire bonding and general electrical conductivity. IPC International, the global association that helps OEMs, EMS, PCB manufacturers and suppliers build electronics better, details the industry ENIG performance specification in the IPC-4552A international standard.

Gasket Material Options

Electromagnetic interference (EMI) grade gaskets consist of a homogeneous dispersion of electrically conductive particles, process modifiers and additives within an elastomer binder system. Traditional electrically conductive fillers include pure silver, silver-plated copper, silver-plated aluminum, silver-plated glass and nickel-plated graphite. Silicone and fluorosilicone-based resin systems are typically the elastomer binders of choice primarily due to processability, excellent compression set performance across a wide temperature range and the ability to compress at low closure forces. EPDM based resin systems would be used in applications exposed to harsh chemicals.

This article focuses on CHO-SEAL electrically conductive elastomer and CHOFORM form-in-place gasket materials which have been proven to simultaneously provide the best corrosion resistance (per Parker Chomerics test method CHO-TM100), and the highest degree of shielding effectiveness after long term aging tests of any EMI shielding elastomer gasket material. Gaskets included in this evaluation were as follows:

Chomerics Material	CHO-SEAL 1298	CHO-SEAL 6460	CHO-SEAL 6502	CHO-SEAL 6503	CHO-SEAL 1285	CHO-SEAL 6452	CHO-SEAL S6305	CHOFORM 5575	CHOFORM 5560
Conductive Filler	Ag/Al	Ni/Al	Ni/Al	Ni/Al	Ag/Al	Ni/Gr	Ni/Gr	Ag/Al	Ni/Al
Elastomer Binder	Fluorosilicone	EPDM	Silicone	Fluorosilicone	Silicone	EPDM	Silicone	Silicone	Silicone

Typical Elastomer Fluid Resistance			
Exposure/Fluid	**Elastomer Choice**		
	Silicone	**Fluorosilicone**	**EPDM**
High Temp	Excellent	Good	Fair
Low Temp	Excellent	Excellent	Excellent
ASTM 1 Oil	Fair/Good	Good	Poor
Hydraulic Fluids (Phosphate Ester)	Poor	Poor	Good
Hydrocarbon Fuels	Poor	Good	Poor
Ozone, Weather	Good	Good	Good
STB (NBC Decontamination Fluid)	Poor	Fair/Good	Good
Dilute Acids	Fair	Good	Good

Shielding Material Manufacturing Options

EMI shielding grade elastomers offer a wide range of design flexibility and can be manufactured into almost any shape using molding, extrusion, form-in-place or die-cutting processes. Thought should also be given to the manufacturability and ease of assembly of a particular EMI shielding solution – this is especially true for electronic devices produced in high volume.

Extruded Elastomer Gaskets

Extruded electrically conductive elastomer gaskets can be supplied in a wide range of solid and hollow cross-sectional geometries. Compared to solid configurations, hollow profiles require less closure force and reduce design complexity by allowing for thinner covers, fewer fasteners and greater deflection ranges. This makes hollow extruded profiles ideal for use in applications such as appliance door sealing, where it is often difficult or inconvenient to generate high closure forces, and where there may be significant tolerance buildup over long lengths. Extrusion grade conductive elastomers can be supplied in forms that include standard or custom lengths for high volume applications, spliced O-rings and four corner spliced gaskets.

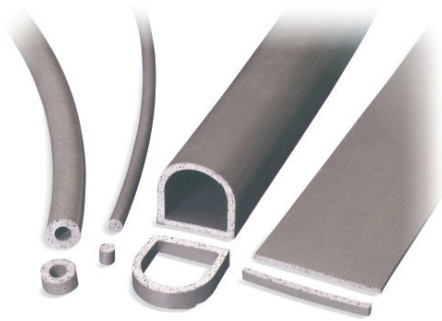


Figure 1 – Extruded EMI gaskets

Molded Elastomer Gaskets

Molding grade electrically conductive elastomer gaskets are typically manufactured by traditional compression or injection molding techniques. The molding process can produce conventional sheet stock in a variety of thicknesses ranging from 0.020 in (0.508 mm) to 0.125 in (3.175 mm) as well as various standard and custom molded geometric profiles. Specialized molding techniques can also "vulcanize" a gasket directly onto an enclosure housing, simplifying both the design and assembly of an enclosure. In addition, elastomers can also be molded with fabric reinforcement providing world class mechanical tear resistance.

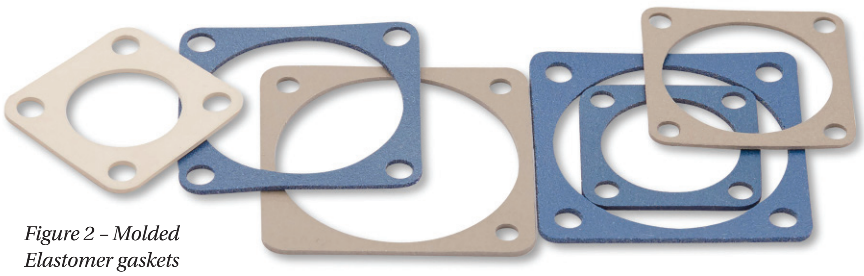


Figure 2 – Molded Elastomer gaskets

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Form-in-Place Gaskets

Form-in-place (FIP) grade electrically conductive elastomers can be precisely dispensed onto the narrowest possible flange allowing for smaller package sizes and increased space for printed circuit boards and other system components.

Not only do these materials provide excellent adhesion to various surfaces including chromate treated aluminum, they also offer low compression set for long term sealing, low Shore A hardness for reduced closure force and high tensile strength and elongation for gasket damage resistance in handling.

Additional benefits offered by FIP gasket systems include fast moisture and thermal cure systems and lower overall costs of ownership through decreased assembly labor and supply logistics in high-production environments.

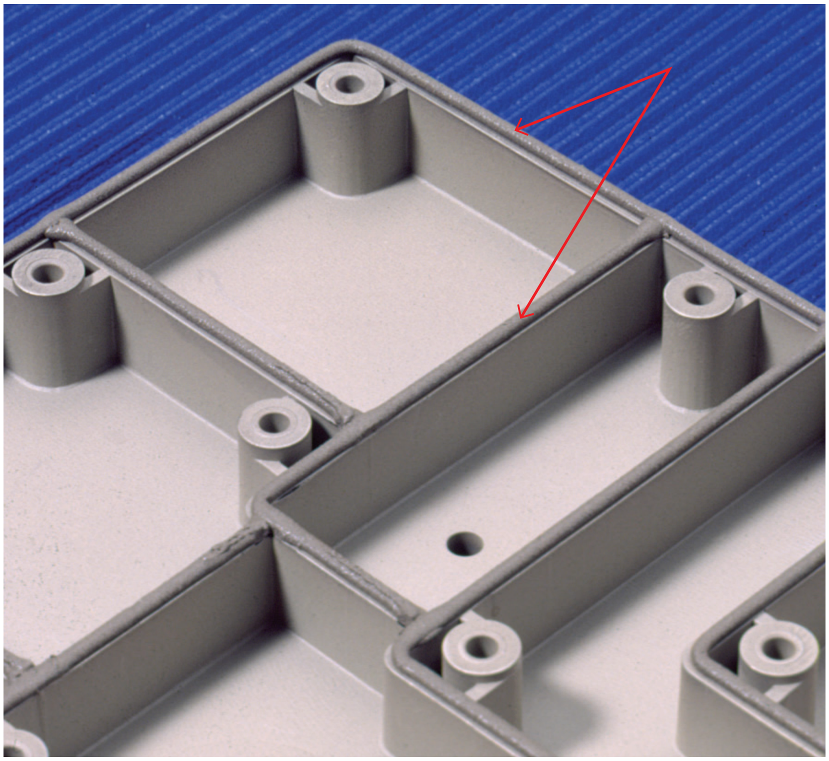


Figure 3 – Form-in place gasket is the contact point between the housing and ENIG circuit board

Gasket Design Options

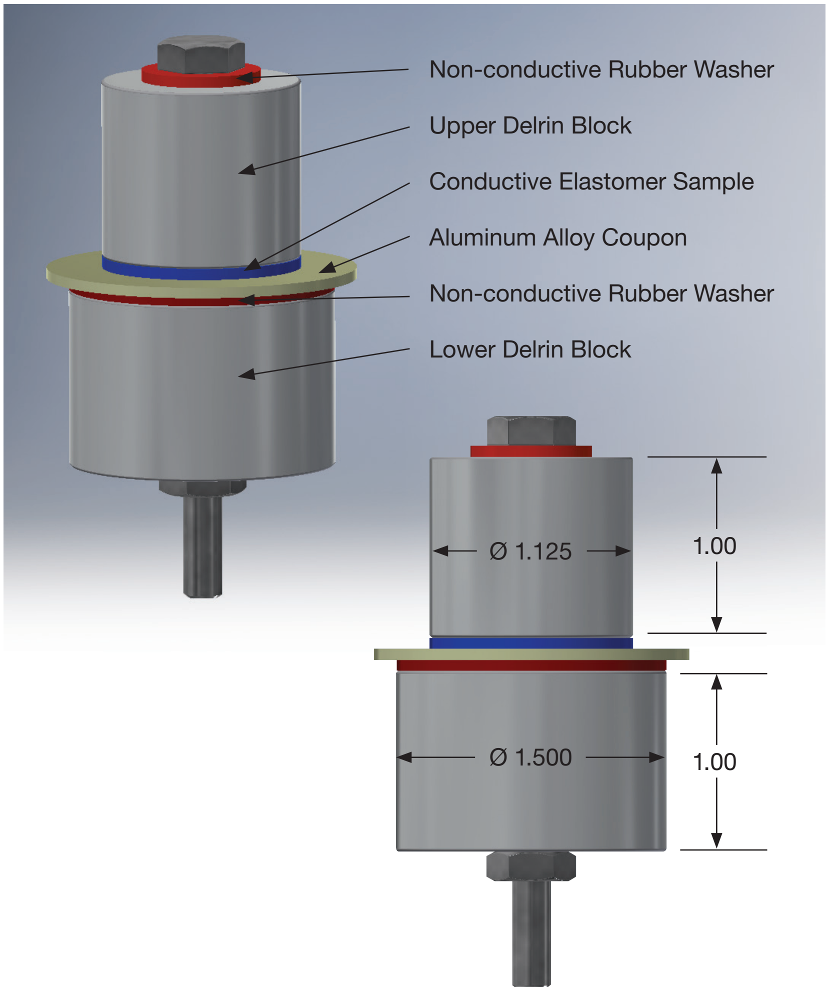
Gasket designs for use in uncontrolled environments can avoid:

- Ni or Sn plating of Al flanges and housings
- Secondary outboard non-conductive gaskets
- Secondary outer enclosures
- Complicated partial flange painting

Galvanic Corrosion Testing

Galvanic corrosion tests were performed in accordance with Parker Chomerics Test Method CHO-TM100. This test method was used to determine, in a quantitative manner, the corrosivity toward aluminum alloys of the conductive elastomer after exposure to a salt fog environment.

The test fixture shown below illustrates how the conductive elastomer and aluminum coupon (simulating an aluminum mating flange) are held in contact by compression between two cylindrical Delrin® blocks. Compressive force is supplied by a central stainless-steel bolt which is environmentally sealed on each end using a non-conductive gasket to prevent fluid from penetrating into the middle of the fixture.



The neutral salt fog exposure for this evaluation was in accordance with ASTM B117 for a duration of 500 hours. After the test, samples were disassembled, cleaned and dried according to the test method and were evaluated in our lab.

The corrosivity of the conductive elastomer material is proportional to the weight loss of the aluminum alloy coupon. Weight loss of the coupon is calculated as follows:

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

Three fixtures were tested for CHO-SEAL elastomers and two for CHOFORM elastomers given the number of ENIG coupons available. The test results were averaged.

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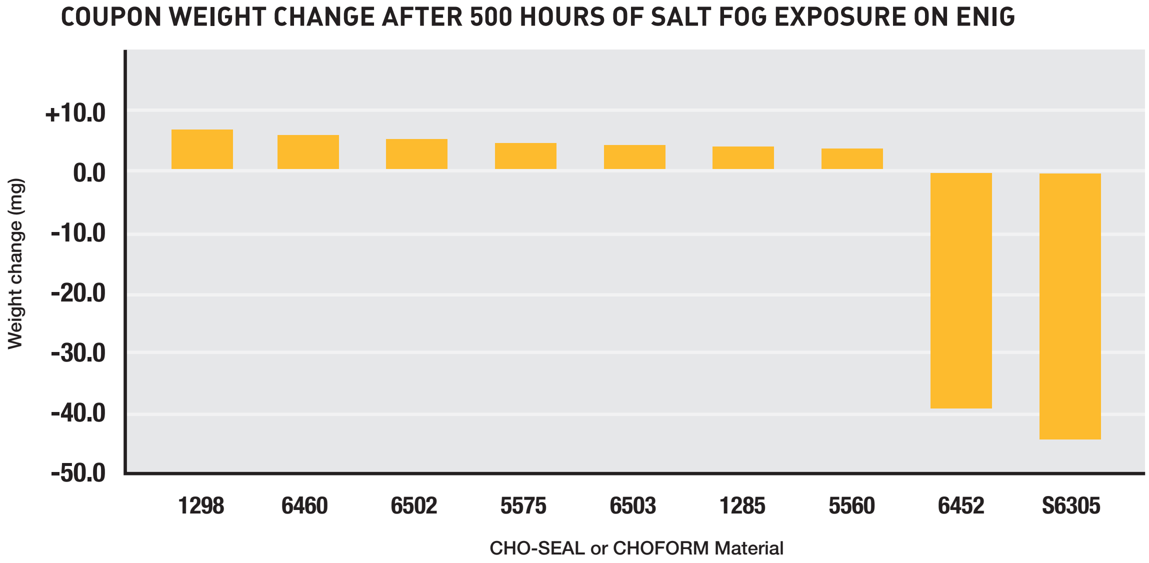
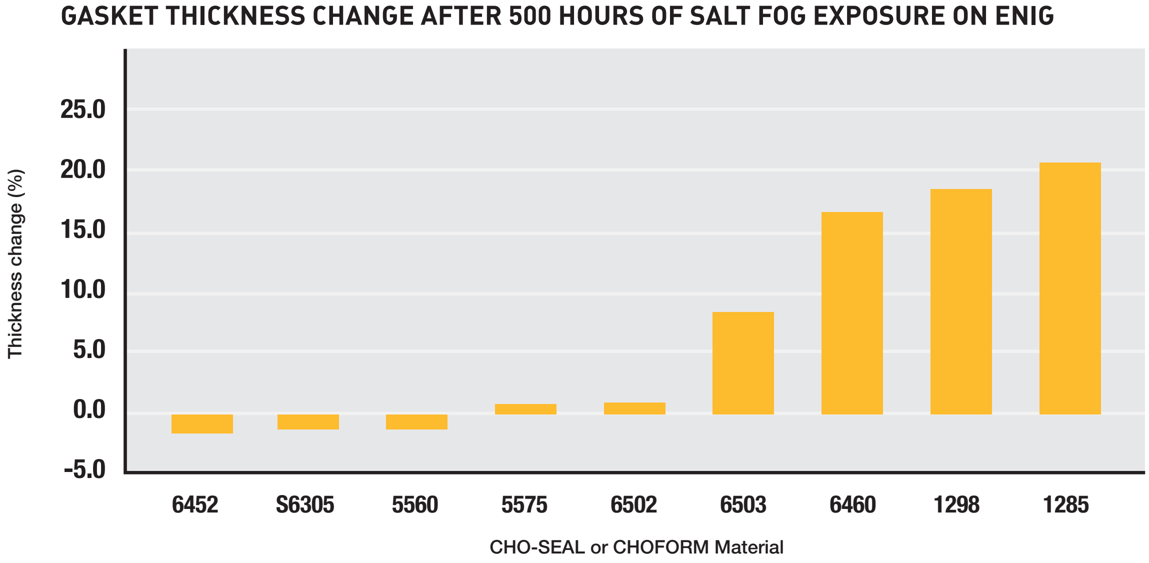
Galvanic Corrosion Testing continued

The chart below outlines the aluminum coupon weight loss test results:



The chart below outlines the gasket dimensional change results:



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Galvanic Corrosion Testing continued

A four-point pressure probe connected to a digital ohmmeter with a measuring range of 10-4 to 104 ohms (Ω) was used to measure volume resistivity.

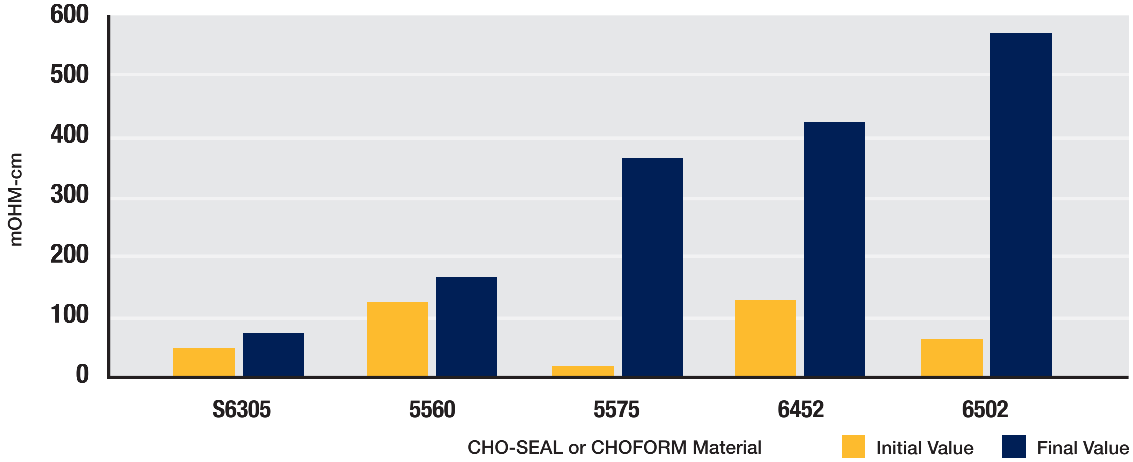
The volume resistivity was calculated from the following formula:

$$\rho = RA / L$$

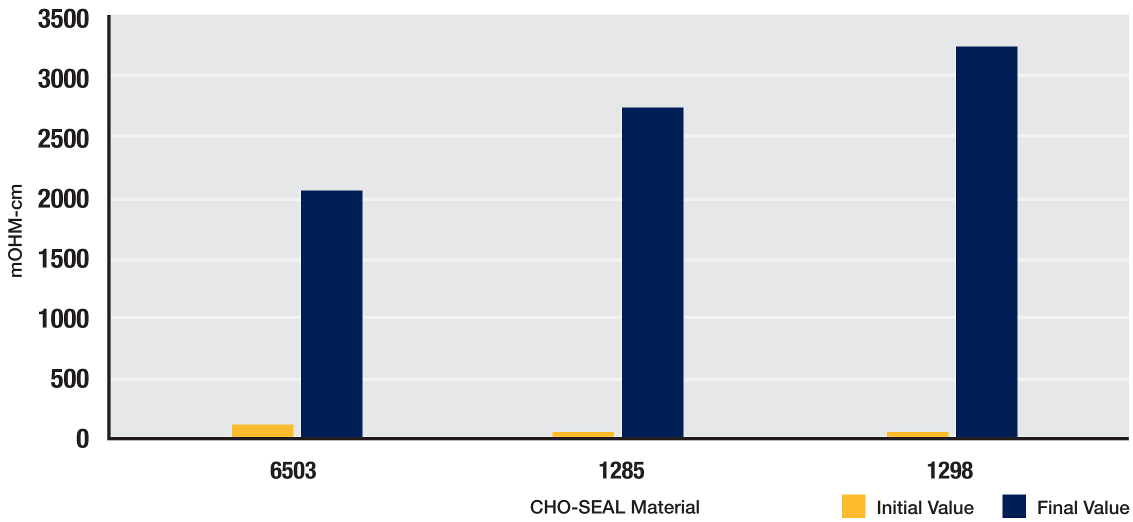
Where: ρ = volume resistivity (ohm-cm)
R = measured resistance (ohm)
A = area of conductive elastomer (cm^2)
L = measure thickness (cm)

The gasket volume resistivity test data was listed in two groups due to the range of the test results. CHO-SEAL 6460 was not included because its volume resistivity exceeded 600 mOhm-cm after 500 hours of salt fog exposure.

INITIAL / FINAL VOLUME RESISTIVITY AFTER 500 HOURS OF SALT FOG EXPOSURE ON ENIG - GROUP 1



INITIAL / FINAL VOLUME RESISTIVITY AFTER 500 HOURS OF SALT FOG EXPOSURE ON ENIG - GROUP 2



Summary

Multiple gasket fillers and resin systems were evaluated.

1. Overall comparison – form-in-place (FIP) gaskets outperformed even the conductive elastomers after salt fog exposure.
2. Within the FIP gaskets tested, CHOFORM 5560 (Ni/Al) outperformed CHOFORM 5575 (Ag/Al) in volume resistivity and gasket dimensional change.
3. CHO-SEAL 6503 (Ni/Al-Fl), CHO-SEAL 6460 (Ni/Al-EPDM), CHO-SEAL 1298 (Ag/Al-Fl), and CHO-SEAL 1285 (Ag/Al-Si) outperformed CHO-SEAL S6305 (Ni/Gr-Si) and CHO-SEAL 6452 (Ni/Gr-EPDM) in ENIG coupon weight loss, but exhibited more gasket swelling, resulting in greater dimensional and volume resistivity changes.
4. CHO-SEAL S6305 (Ni/Gr-Si) and CHO-SEAL 6452 (Ni/Gr-EPDM) were highest in average coupon weight loss but showed the least change in volume resistivity and thickness.
5. There were no significant differences in nickel-aluminum vs silver-aluminum fillers, regardless of whether silicone, fluorosilicone, or EPDM elastomer binders.

Choosing the right gasket requires knowledge of both electrical and mechanical requirements. Shear forces, environmental effects, compression set, method of application and pricing are just some of the factors influencing choice of gasket which is best for a particular application. Materials must be both cost effective as well as ensure equipment and system compliance with military and commercial EMI/EMC test requirements as well as environmental test requirements.

References

Chomerics Test Method CHO-TM100, September 2005, "Test Method for Assessing Galvanic Corrosion Caused by Conductive Elastomers"

Chomerics Test Report TR 1044 EN "Test Report on Galvanic Corrosion After 504 Hours of Salt Fog for Chomerics CHO-SEAL 6502, CHO-SEAL 6503, CHO-SEAL 1298, CHO-SEAL 1285, CHO-SEAL L6303 and CHO-SEAL 6370", November 2009

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