The Origin of Conductive Ethylene Propylene Elastomers

Two new conductive elastomers, based on a completely different polymer chemistry - ethylene propylene rubber - have been developed.

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INTRODUCTION

Metal-filled conductive elastomers have been used successfully in EMI/RFI shielding applications for a number of years. Their unique physical, mechanical, and electrical properties have made them very effective as environmental seals, as well as EMI shields. The fillers used in conductive elastomers range from conductive carbon black to pure silver, and include silver-plated copper, silver-plated aluminum, silver-plated nickel, silver-plated glass, and pure nickel.

The elastomeric matrices used as the backbone for these materials have historically been silicone and fluorosilicone polymers. The rationale behind these choices is a very logical one. Silicone and fluorosilicone polymers possess very wide temperature range capabilities, very low compression/deflection properties, very low percentages of volatile materials, and good-to-excellent resistance in a variety of media. Fluorosilicone takes the property of fluid resistance a step further; it exhibits excellent resistance to a number of harsh media including jet fuels, gasoline, oils, synthetic lubricants, and dielectric fluids.

Despite the diversity of these polymers, a group of applications exist, both chemical as well as mechanical, in which the conductive silicone or fluorosilicone compound does not function adequately. Conductive materials were needed to satisfy those applications where silicone or fluorosilicone polymers are ineffective. As a result of this need, two new conductive elastomers were developed based on a completely different polymer chemistry, namely, ethylene propylene rubber.

PROPERTIES OF ETHYLENE PROPYLENE RUBBER

Ethylene propylene rubber is a synthetic hydrocarbon-based material manufactured as a copolymer of ethylene and propylene or as a terpolymer in which a third monomer is added to the backbone structure of the polymer. Due to its resistance to phosphate ester fluids, good abrasion resistance, and low/high temperature capabilities, ethylene propylene, although a relatively new polymer, has found widespread use as a seal material. Historically, this material has found extensive use in aircraft hydraulic and brake systems containing phosphate ester fluids. In addition, it has excellent resistance to ozone and weathering. Because of its higher temperature capabilities, it has all but replaced butyl rubber as a seal material in many applications. Ethylene propylene can be compounded for continuous service over a temperature range of -65°F to +300°F. As a result, this material is useful in applications requiring both low and high temperature capabilities.

This unique compounding knowledge and expertise has been applied to EMI/EMP shielding technology. As shielding requirements become more stringent, environmental severity will also increase. This need has been anticipated with the development of two conductive ethylene propylene elastomers. The physical properties of these two materials are shown in Table 1. As can be seen, these new conductive EP elastomers compare very well with conductive silicones and fluorosilicones currently available in the marketplace.

One of the more notable features of these materials is their tear resistance. This one property fills a void that has existed when conductive silicones and fluorosilicones were used in dynamic or pseudo-dynamic EMI applications. Silicones and fluorosilicones do not exhibit the necessary tear and abrasion resistance to warrant their use in applications where any type of movement or vibration might exist. The most notable examples of this might be aircraft or shipboard applications where electronic enclosures would be subjected to almost constant vibrational forces. Over time, the EMI integrity of a conductive silicone or fluorosilicone would be compromised, as has been proven previously. Now however, alternative conductive materials exist that withstand these types of applications without sacrificing their elastic properties.

As has been mentioned previously, the chemical compatibility profile of ethylene propylene is quite unique. This holds true for the EMI applications as well. Table 2 illustrates some of the most common and important types of fluids, solvents, and other media that are compatible with the new compounds.

With regard to the shielding of eletronic enclosures, the most immediate need for this new technology lies with NBC (Nuclear, Biological, Chemical warfare) applications. In order to use equipment that has been exposed to a nuclear, biological or chemical attack, it must be cleaned, or decontaminated, thoroughly. Many cleaning agents have been developed to address this issue, two of which are especially effective (DS2, STB). The exact makeup of these materials is beyond the scope of this article, but note should be taken that these agents are very aggressive, especially with regard to elastomeric seals. Various agencies have determined that silicone and fluorosilicone polymers are completely incompatible with these agents. The need for an alternative material that can withstand these harsh environments, as well as shield effectively, has been filled by conductive ethylene propylene elastomers. The material presented in this article thus far is true of conductive, as well as nonconductive, ethylene propylene elastomers. The last area, and the most important from the shielding point of view, is the electrical properties of this new class of materials. Table 3 shows the shielding capabilities of the compounds.

As the data shows, compound #1 contains silver-plated nickel particles that give it excellent conductivity. Silver-plated nickel particles have been proven to be the best

Phospate Ester-based Fluids
Water
Steam
Silicone Oils and Greases
Dilute Acids
Dilute Alkalies
Ketones (MEK, Acetone)
Alcohols
Decontamination Agents (DS2,STB)

Table 2. Media Compatible with New Compounds.

	Compound #1	Compound #2
Specific Gravity	3.9	1.1
Hardness (Shore A)	75	80
Tensile Strength (PSI)	200	2500
Elongation (%)	200/500	300/500
Tear Strength (PPI)	80	350
Compression Set (%)	40	30
Upper Operating Temp.	+125°C	+125°C
Lower Operating Temp.	-54°C	-54°C
Compression Deflection (%)	3.0	3.0
Filler Type	Silver/Nickel	Carbon

Table 1. Physical Properties of Two Conductive Ethylene Propylene Elastomers.

	Compound #1	Compound #2
Volume Resistivity (ohm-cm) (as Supplied)	.006	10.0
Shielding Effectiveness (dB)		
200 kHz (H Field)	60	30
100 MHz (E Field)	110	70
500 MHz (E Field)	100	60
2 GHz (Plane Wave)	100	40
10 GHz (Plane Wave)	100	30
Electrical Stability		
After Heat Aging (ohm-cm)	.008	15.0
After Break (ohm-cm)	.007	12.0

Table 3. Electrical Properties of New Compounds. (Note: Results according to Parker Seal Research and Development Report #900801.)

choice of filler when the electronic enclosure might be exposed to a corrosive environment which could cause galvanic corrosion. Compound #2 is loaded with a proprietary conductive carbon that, although not as conductive as silver-plated nickel, offers very good electrical properties. This material would be a very cost-effective candidate for an electronic enclosure requiring lower levels of signal attenuation.

SUMMARY

Conductive ethylene propylene elastomers satisfy applications where silicone or fluorosilicone polymers are not adequate. A new level has been achieved in the design and application of conductive elastomers for the sealing/shielding of electronic enclosures and the suppression of electromagnetic interference.

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