

Overview

Most elastomers, including rubbers, polyurethanes and silicones, are natural insulators. Electrical conductivity can be improved in an elastomer by including conductive additives in the elastomer's manufacturing process. The traditional method for improving conductivity in elastomers has been to include carbon or metal particles in the elastomer, as high as 30% - 60% by weight. This solution, however, compromises the mechanical and physical properties of the materials, and decreases material life and performance.

Always at the leading edge of polyurethane material technologies,

Mearthane Products Corporation's (MPC) conductive technology combines its superior Durethane® thermoset polyurethane materials with its patented metal salts technology to create Durethane® C conductive polyurethanes. This powerful combination creates a family of conductive materials that maintain the versatility and strength of thermoset polyurethanes.

MPC's Metal Salts Technology

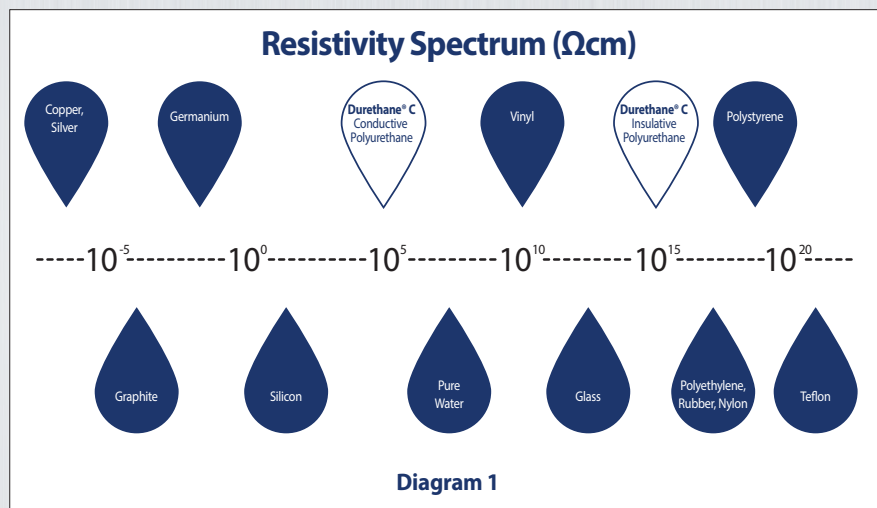
MPC's patented metal salts technology starts when the conductive agent is dissolved within the liquid polymer in a controlled environment, prior to curing the material. This process assures that the conductive

elements are homogeneously dissipated throughout the polyurethane mixture. Within the mixture, the polyurethane molecules engage in an electro-chemical interaction with the conductive elements, which is maintained throughout the casting process.

This chemical process results in materials with homogeneous conductivity while preserving the polyurethane's strength, resilience, thermal stability and other physical properties.

Durethane® C's unique chemistry relies on electron movement across an ionic network to transfer electrical charges. Atoms in the polyurethane chains remain in place while the network transfers excess charges. This characteristic of the material accounts for its low and stable bulk resistivity. The resistivity of Durethane® C will remain constant over its normal service life. Durethane® C materials can be formulated to exhibit resistivities from approximately E5 Ωcm to E11 Ωcm .

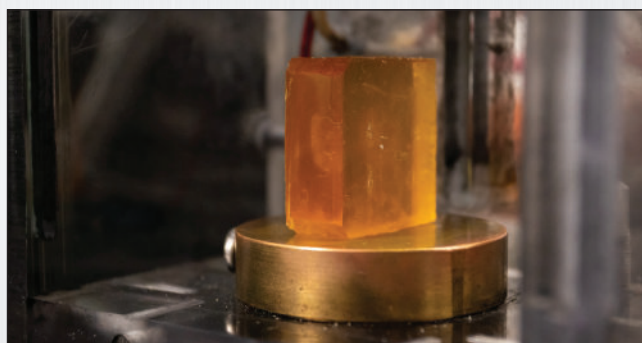
Diagram 1 portrays how different materials compare on the volume resistivity spectrum, including MPC's Durethane® materials.



Choosing the Right Material

When evaluating materials for a new product or component, there are four important considerations to keep in mind:

- **Successful operation** – The first key consideration should be about the physical properties required for the product or component to fulfill its operational purpose. In this regard, conductivity can play an important role in products that need to transfer an electrical charge as part of an operation.
- **Maintenance and service life** – Designers must consider the expected service life of the product or component, along with any maintenance requirements. Durethane® C showcases improved physical properties over other conductive elastomers. Moreover, including conductive parts and components in an assembly may prolong assembly or machine service life by dissipating unwanted static.



- **Scalability of manufacturing process** – All products should be designed with a manufacturing method in mind. Making prototypes requires different capabilities from making full production volumes. Durethane® C can be easily adapted to molding processes and made in a wide range of volumes.
- **Overall cost of use** – Last, but not least, designers must consider the overall cost of use of a material. This includes material cost, tooling costs, the cost structure of the manufacturing process, and the expected service life of the material.

Nonconductive Durethane®

DC Volume Resistivity (Ωcm)

Durometer (Shore Scale)	10A-55A	65A	75A	85A	90A	50D	60D	70D	85D
Typical at 75°F	4.3 x E11	5.2 x E11	8.8 x E11	2.8 x E11	3.6 x E12	8.0 x E13	4.0 x E14	4.4 x E15	6.2 x E15
150°F	2.4 x E11	3.9 x E11	6.4 x E11	1.7 x E11	3.0 x E12	7.7 x E14	8.2 x E13	3.1 x E14	2.0 x E15
212°F	1.9 x E11	2.7 x E11	4.3 x E11	1.0 x E11	2.3 x E12	3.1 x E14	7.6 x E13	2.4 x E14	7.2 x E14

Conductive Durethane®

DC Volume Resistivity (Ωcm)

Durometer (Shore Scale)	10A-55A	65A	75A	85A	90A	50D	60D	70D	85D
Typical at ambient	5 x E5	5 x E6	5 x E6	5 x E7	5 x E8	5 x E8	5 x E8	5 x E9	5 x E10

Diagram 2

Note: Typical properties are not a sole representation of the conductivity in the specified durometers. Typical properties are representative of various polymer reactions to identical or similar conductive agent volume. Actual durometer, DC volume resistivity and physical properties are determined by application.

Conductivity and Environmental Conditions

Electrical resistivity (Ωcm) is reciprocal to conductivity ($\Omega^{-1}\text{cm}^{-1}$), which changes exponentially with environmental fluctuations, specifically temperature and humidity. As a result it is important that operating conditions be considered when evaluating conductivity requirements. Due to this phenomenon, electrical properties are best determined after two weeks of material stabilization at 72°F (22°C) and 50% relative humidity in an environmental chamber. Diagrams 3 and 4 represent the relationship between resistivity and these two environmental factors.

**Resistivity Relative to Temperature
72°F**

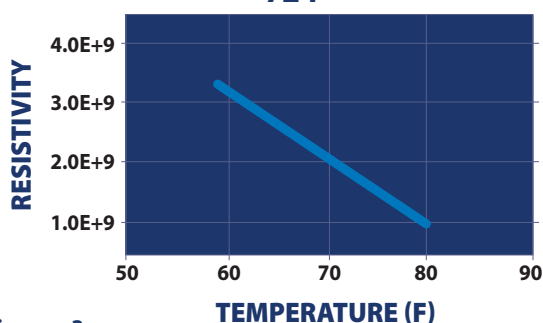


Diagram 3

**Resistivity Relative to Humidity
at 50% RH**

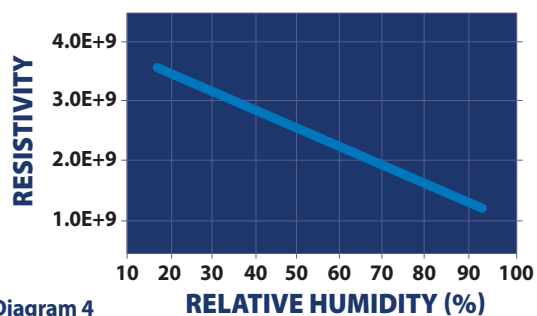
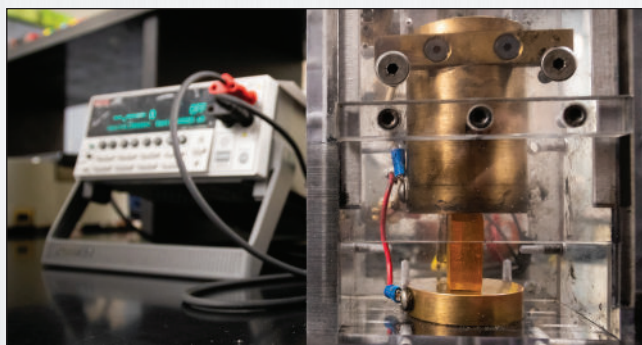


Diagram 4



Advantages of Durethane® C Conductive Polyurethanes

Due to its unique chemical composition, MPC's Durethane® C possesses numerous advantages over other conductive elastomer technologies. Among these advantages are:

- **Design what you envision, without compromise** – MPC's patented metal salts technology enhance conductivity without compromising thermoset polyurethane's superior performance: high abrasion and chemical resistance, a wide choice of hardnesses, coefficient of friction, resiliency, and many more.
- **Uniform conductivity** – Uniform dispersion of the conductive elements throughout the polyurethane material results in exceptionally uniform conductivity throughout the product or component. In addition, the conductive element does not migrate or leech as the material wears.
- **Superior conductivity range** – Durethane® C ranges in volume resistivity from E5 Ωcm to E11 Ωcm , without sacrificing any of the other properties that make polyurethane a high-performance material.
- **Manufacturing flexibility** – Since very low quantities of conductive additives are used in formulating Durethane® C, the material can be easily adapted to most casting process that are commonly used in manufacturing thermoset polyurethanes.

Applications

Durethane® C conductive polyurethanes are ideal for applications that require dissipation of static build-up or the transfer of an electrical charge. In the first case, electrostatic build-up may occur in an assembly or mechanism where surfaces repeatedly come in contact and create friction. Static build-up may generate a discharge that can damage sensitive electronics or disrupt user experience. Durethane® C can be included in a design to safely and effectively bring static build-up to ground. Conductive polyurethanes can also play a key role in electro-mechanical mechanisms that require superior material properties and the transfer of electrical charges.

This powerful combination of electrical conductivity and durable material properties make Durethane® C ideal in a variety of industries, including:

- Medical Devices
- Cleanroom Systems
- Food Processing
- Conveyance Systems
- Digital Printing & Imaging
- Currency Handling
- Electronics and Electronics Manufacturing

