

# ELECTRICALLY CONDUCTIVE ELASTOMERS AND COATINGS

## Volume Resistivity And Surface Resistance Measurement Procedures

### 1.0 SCOPE:

This document describes equipment and procedures, used to measure surface resistance and volume resistivity of electrically conductive elastomers and coatings. It further describes test procedures intended to measure long-term electrical stability of conductive elastomers by exposure to heat and tensile set conditioning.

### 2.0 APPLICABLE DOCUMENTS:

ASTM 0412 - Standard Test Method for Rubber Properties in Tension.

### 3.0 VOLUME RESISTIVITY TEST:

#### 3.1 Equipment:

**3.1.1** Ohmmeter capable of accuracy to  $\pm 0.001$  ohm.  
Suggested source: Kiethley 197 autoranging ohmmeter or equivalent.

**3.1.2** Dimensional gauge capable of measuring  $\pm 0.005$  inches (e.g., snap gauges or Verniers).

**3.1.3** Anhydrous isopropyl alcohol (IPA).

**3.1.4** Clean lint-free cloth.

**3.1.5** Four-point test probe in accordance with Figure 1.  
Suggested source: Chomerics, Part Number 52-99-B305-0002.

#### 3.2 Sample Preparation:

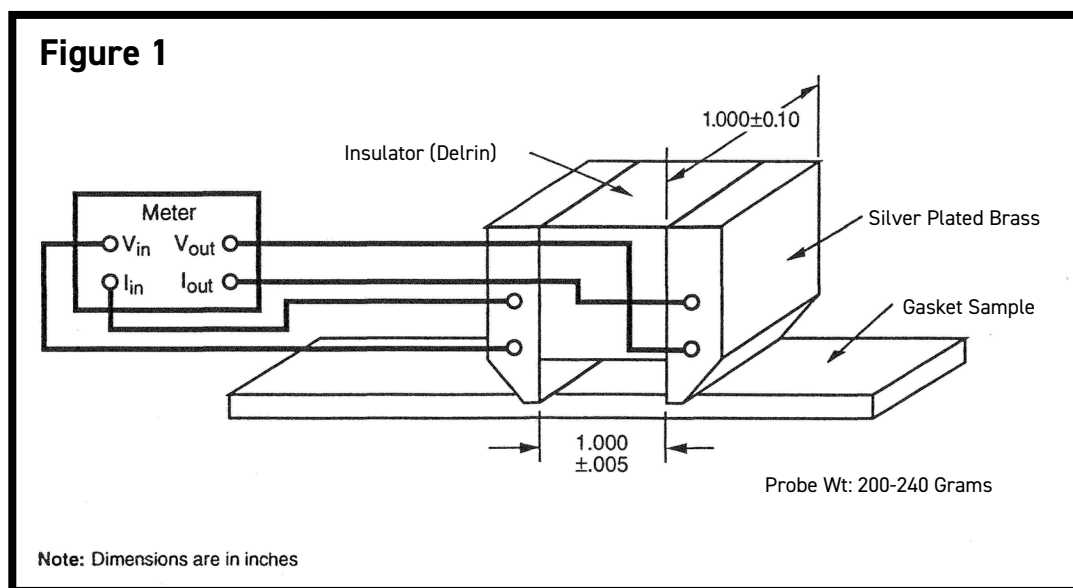
Test specimen should be clean and free of dirt or excessive hand oils. If dirt is present, use IPA dampened cloth and wipe surface clean. Test specimen should be allowed to sit in an unrestrained condition for a minimum of 15 minutes at room temperature (65-80°F) prior to any test measurement. If IPA wipe has been performed, ensure that all solvent has evaporated from the surface of the test specimen.

#### 3.3 Surface Resistivity Measurement:

Probe should be connected to ohmmeter in accordance with Figure 1. Measure the surface resistivity of the test specimen longitudinally by placing the probe on top of the sample such that as much of the probe contact surface comes in contact with the test specimen as its cross section will allow. The weight of the probe should be evenly distributed on the test specimen. One to two pounds of manual force may be placed on the probe by the operator. Allow the surface resistivity reading to stabilize (about 30 seconds) and record resistance in ohms.

#### 3.4 Cross Section Determination:

In order to calculate volume resistivity, the cross sectional area of the test specimen must be determined. Measure all cross sectional dimensions needed to calculate to the nearest .001 inch. For example, measure only the diameter of a solid "O" cross section. A rectangular cross section would need width and height measured, etc.



### 3.5 Volume Resistivity Calculation:

The volume resistivity is calculated by Formula 1.

#### Formula 1

$$R_{vol.} = (R \times A) / \ell$$

Where:

R = Resistance in ohms.

A = Test specimen cross sectional area in cm<sup>2</sup>.

ℓ = Distance between probe contact points in cm.

For this method the probe is defined as having one inch electrode spacing, making ℓ = 2.54 cm.

R<sub>vol.</sub> = Volume resistivity in ohm-centimeters.

### 4.0 SURFACE RESISTANCE TEST:

#### 4.1 Equipment:

4.1.1 Ohmmeter capable of accuracy to ±.001 ohm.

Suggested source: Kiethley 197 autoranging ohmmeter or equivalent.

4.1.2 Dimensional gauge capable of measuring ±.005 inches (e.g., snap gauges or Veniers).

4.1.3 Anhydrous isopropyl alcohol (IPA).

4.1.4 Clean lint-free cloth.

4.1.5 Four-point test probe in accordance with Figure 1.

Suggested source: Chomerics, Part Number 52-99-B305-0002.

#### 4.2 Procedure:

Test specimen should be clean and free of dirt or excessive hand oils. If dirt is present, use IPA dampened cloth and wipe surface clean. Test specimen should be allowed to sit in an unrestrained condition for a minimum of 15 minutes at room temperature (65-80°F) prior to any test measurement. If IPA wipe has been performed, ensure that all solvent has evaporated from the surface of the test specimen.

#### 4.3 Surface Resistance Measurement:

Probe should be connected to ohmmeter in accordance with Figure 1. Measure the surface resistance of the test specimen longitudinally by placing the probe on top of the sample such that as much of the probe contact surface comes in contact with the test specimen as its cross section will allow. The weight of the probe should

be evenly distributed on the test specimen. One to two pounds of manual force may be placed on the probe by the operator.

Allow the resistivity reading to stabilize (about 30 seconds) and record surface resistance in ohms/square.

### 5.0 HEAT AGE TESTING:

#### 5.1 Equipment:

The equipment needed includes all equipment in Section 3.1 of this specification plus an air circulating oven capable of 1.25 times the maximum operating temperature of the specimen material as specified on the manufacturer's data sheet.

#### 5.2 Procedure:

Determine the initial volume resistivity of the test specimen (for reference purposes) using Sections 3.1-3.5 of this specification. Place test specimen into oven and expose for 24 continuous hours at 1.25 times the specimen material's maximum operating temperature. After 24 hours of heat exposure remove sample and allow to cool to room temperature. Wipe test specimen clean with IPA dampened cloth. Allow to dry and determine volume resistivity as described in Sections 3.1-3.5 of this specification. CAUTION: If specimen material contains silver, oven must be free of sulfur bearing materials (e.g., neoprene rubber, most paper products) to prevent the formation of silver sulfides.

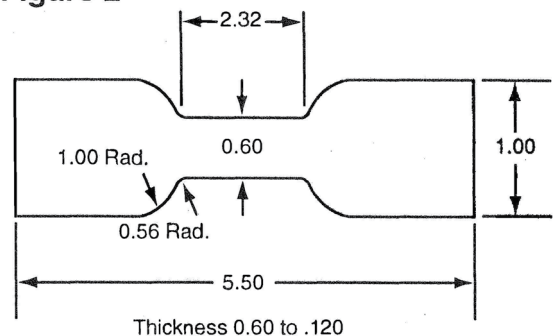
### 6.0 POST TENSILE TESTING:

#### 6.1 Equipment:

The equipment needed includes all equipment in Section 3.1 of this specification plus the following items:

- A. Tension testing machine in accordance with ASTM 0412.
- B. Die capable of cutting test sample as shown in Figure 2.

Figure 2



Note: Dimensions are in inches. Tolerances shall be ±.01.

## 6.2 Procedures:

Cut test specimen from stock material in accordance with Figure 2. Determine the initial volume resistivity of the test specimen by using Sections 3.1-3.5 of this specification (for reference purposes). Elongate test specimen to break in accordance with ASTM 0412. Within 30 minutes determine the volume resistivity of the largest of the two pieces by using Sections 3.1- 3.5 of this specification. The cross sectional area of the test specimen is defined as the smallest cross section between the probe contact points. This test is recommended to be a qualification test only. However, it is also recommended that the same test be performed on an actual part of an occasional basis (since it is a destructive test).



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