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Standard Specification for Crosslinkable Ethylene Plastics¹

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1. Scope*

1.1 This specification covers a general classification system for crosslinkable ethylene plastics compounds (Note 1). The requirements specified herein are not necessarily applicable for use as criteria in determining suitability for the end use of a fabricated product.

NOTE 1—It is to be noted that this specification describes materials that are available commercially in their uncrosslinked form. Therefore, they are crosslinkable compounds despite the fact that measurement of the parameters used for their classification and specification will usually be carried out after curing has been effected.

1.2 Two types of compounds are covered, namely, mechanical types in which mechanical strength properties are of prime importance in applications, and electrical types in which electrical insulating or conducting properties also are of prime importance in applications.

1.3 The parameters used to classify and specify the mechanical types are ultimate elongation, elongation retention after aging, apparent modulus of rigidity, and brittleness temperature.

1.4 The parameters used to classify and specify the electrical types are ultimate elongation, elongation retention after aging, apparent modulus of rigidity, brittleness temperature, dielectric constant, dissipation factor, and volume resistivity.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 The following safety hazards caveat pertains only to the test methods portion, Section 7, of this specification: *This specification does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this specification to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

¹ This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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NOTE 2—There is no known ISO equivalent to this standard.

2. Referenced Documents

2.1 ASTM Standards:²

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

D573 Test Method for Rubber—Deterioration in an Air Oven

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

D746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

D883 Terminology Relating to Plastics

D991 Test Method for Rubber Property—Volume Resistivity Of Electrically Conductive and Antistatic Products

D1043 Test Method for Stiffness Properties of Plastics as a Function of Temperature by Means of a Torsion Test

D2765 Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics

D3892 Practice for Packaging/Packing of Plastics

IEEE/ASTM SI-10 Standard for Use of the International System of Units (SI): (The Modernized Metric System)

2.2 Military Standard:

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes³(Obsolete 1995)

3. Terminology

3.1 *Definitions:* For definitions of plastics terms used in this specification, see Terminology D883.

3.2 *Abbreviations:* Units, Symbols, and Abbreviations—For units, symbols, and abbreviations used in this specification see IEEE/ASTM SI-10.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from Defense Automation and Production Service, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

*A Summary of Changes section appears at the end of this standard.

4. Classification

4.1 *Classification System*—Table 1 and Table 2 provide a classification system for these compounds so that the relations among them can be delineated and those that are commercially available can be readily specified. It is not the intent to indicate that all the combinations of properties possible are represented by commercial products or that they are technically possible at the present state of knowledge.

4.2 *Types*—This specification covers two general types of compounds: *Type I*—Mechanical types (Table 1), and *Type II*—Electrical types (Table 2).

4.3 *Grades*—A grade is designated by first indicating the type (I or II) followed by cell numbers for each property in the order in which they are listed in the tables. Where there is no interest in a property, a “0” is entered in place of a cell number.

5. General Requirements

5.1 The compound shall be in powder, pellet or granular form, as agreed upon between the seller and the purchaser.

5.2 The compound, after crosslinking, shall conform to the requirements given in Table 1 or Table 2, whichever is applicable, for the type and grade specified when tested in accordance with the procedures given in Sections 6, 7, and 8.

6. Sampling

6.1 Unless otherwise agreed between the seller and the purchaser, sampling shall be statistically adequate to ensure that the material was manufactured by a process in statistical control and tested in accordance with this specification.

7. Specimen Preparation

7.1 Unless otherwise agreed upon between the seller and the purchaser, the test specimens shall be formed and cured in accordance with the compound manufacturer’s recommendations.

8. Test Methods

8.1 *Conditioning*—Condition the test specimen at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and $50 \pm 10\%$ relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D618, for those tests where conditioning is required and in all cases of disagreement.

8.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and $50 \pm 10\%$

relative humidity, unless otherwise specified in the test methods or in this specification.

8.3 *Ultimate Elongation*—Test Method D638, using three Type IV specimens tested at 500 mm/min (20.0 in./min). If any absolute value differs more than $\pm 20\%$ from the average, two additional samples shall be tested, making a total of five specimens. The average value for these specimens shall be used for the classification.

8.4 *Elongation Retention After Aging*—Age three or five test specimens, conforming to Type IV of Test Method D638, in accordance with the number evaluated in 8.3. Use a circulating air oven at either $121 \pm 2^\circ\text{C}$ ($250 \pm 3.6^\circ\text{F}$) or $150 \pm 2^\circ\text{C}$ ($302 \pm 3.6^\circ\text{F}$) in accordance with Test Method D573 and ensure that the hot air circulates freely around each specimen for 7 days (168 h). After 7 days, recondition the test specimens and measure the ultimate elongation in accordance with 8.3. Average the results and designate as A. Calculate the percentage elongation retention, as follows:

$$\text{Elongation retention, \%} = (A/I) \times 100 \quad (1)$$

where:

I = original elongation from 8.3.

8.5 *Apparent Modulus of Rigidity*—Condition and test specimens in accordance with 8.1 and 8.2 and measure in accordance with Test Method D1043.

8.6 *Brittleness Temperature*—Test Method D746.

8.7 *Dielectric Constant*—Test Method D150 at 1000 Hz (cycles per second) and $23 \pm 1^\circ\text{C}$ ($73.4 \pm 1.8^\circ\text{F}$).

8.8 *Dissipation Factor*—Test Methods D150 at 1000 Hz and $23 \pm 1^\circ\text{C}$ ($73.4 \pm 1.8^\circ\text{F}$).

8.9 *Volume Resistivity*—Test Methods D257. For precise evaluation of specimens below $10^6\Omega\text{-cm}$, use Test Method D991 as an alternative.

8.10 *Degree of Crosslinking*—Test Methods D2765, with Method A to be used for referee tests.

9. Inspection

9.1 Inspection of the materials shall be agreed upon between the purchaser and the supplier as part of the purchase contract.

10. Packaging and Marking

10.1 *Packaging*—The material shall be packaged in standard commercial containers, so constructed as to ensure acceptance by common or other carriers for safe transportation

TABLE 1 Type I, Mechanical Compound Requirements

| Designation Order No. | Property | Cell Limits | | | | | |
|--------------------------|---|-------------|-----------------|-----------------------|------------------------|---------------------|------------|
| | | 0 | 1 | 2 | 3 | 4 | 5 |
| 1 | Ultimate elongation, % | unspecified | <25 | ≥ 25 | ≥ 150 | ≥ 250 | ≥ 450 |
| 2 | Minimum of 75 % retention of elongation after aging at the specified temperature for 168 h, °C (°F) | unspecified | 121 (250) | 150 (302) | | | |
| 3 | Apparent modulus of rigidity, MPa (psi) | unspecified | <70 (10 000) | ≥ 70 (10 000) | ≥ 275 (40 000) | | |
| 4 | Brittleness temperature, °C (°F) | unspecified | <-75 (-103) | ≤ -54 (-65) | ≤ -40 (-40) | ≤ -29 (-20) | |
| 5 | Percent extract (measure of degree of cross-linking) | unspecified | <10 | ≥ 10 | ≥ 20 | ≥ 30 | |