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Standard Classification System for Polychlorotrifluoroethylene (PCTFE) Plastics¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This classification system covers polychlorotrifluoroethylene (PCTFE) plastics that consist of at least 90 % chlorotrifluoroethylene and are suitable for extrusion and for compression and injection molding. Additional components allow for chemical modifications, such as co-monomers, but not colorants, fillers, plasticizers, or mechanical blends with other resins. This classification system does not cover recycled PCTFE materials.

1.2 The physical and electrical properties of parts molded or extruded from PCTFE molding compounds vary with the crystalline content obtained during processing and subsequent annealing. Accordingly, the numerical values listed in [Table 1](#) apply only to the test specimens molded in accordance with [Section 8](#). These values are not applicable as design criteria to semi-finished and finished parts prepared and annealed under other conditions.

1.3 The values stated in SI units as detailed in [IEEE/SI-10](#) are to be regarded as the standard. The values given in parentheses are for information only.

1.4 The following precautionary statement pertains only to the test methods portion, [Section 10](#), of this classification system: *This standard 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 standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—Although this classification system and ISO 12086-1 (1995) and ISO 12086-2 (1995) differ in approach or detail, data obtained using either are technically equivalent.

¹ This classification system is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials (Section D20.15.12).

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2. Referenced Documents

2.1 ASTM Standards:²

- D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation
 - D618 Practice for Conditioning Plastics for Testing
 - D621 Test Methods for Deformation of Plastics Under Load (Withdrawn 1994)³
 - D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
 - D883 Terminology Relating to Plastics
 - D1600 Terminology for Abbreviated Terms Relating to Plastics
 - D3418 Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry
 - D3892 Practice for Packaging/Packing of Plastics
 - D4591 Test Method for Determining Temperatures and Heats of Transitions of Fluoropolymers by Differential Scanning Calorimetry
 - D4895 Specification for Polytetrafluoroethylene (PTFE) Resin Produced From Dispersion
 - D7194 Specification for Aerospace Parts Machined from Polychlorotrifluoroethylene (PCTFE)
 - D7211 Specification for Parts Machined from Polychlorotrifluoroethylene (PCTFE) and Intended for General Use
 - IEEE/SI-10 Standard for Use of the International System of Units (SI): The Modern Metric System
- #### 2.2 ISO Standard:⁴
- ISO 12086-1 (1995) Plastics—Fluoropolymer Dispersions and Moulding and Extrusion Materials, Part 1

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 The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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

TABLE 1 Requirements for PCTFE Molded Test Specimens

Group	Class	Description	Grade	Properties								
				Specific Gravity, ^A 23/23°C	Zero Strength Time, s ^B	Deformation Under Load ^{C,D}	Melting Point, °C ^E	Dielectric Constant ^F , max		Dissipation Factor ^G , max		
								KhZ	MHz	KHz	MHz	
01	1	homopolymer	1	2.10-2.15	100-199	10	210-220	2.70	2.50	0.030	0.012	
			2	2.10-2.15	200-299	10	210-220	2.70	2.50	0.030	0.012	
			3	2.10-2.15	300-450	10	210-220	2.70	2.50	0.030	0.012	
				0								
	2	modified homopolymer	1	2.10-2.12	100-199	15	200-210	2.70	2.50	0.030	0.012	
			2	2.10-2.12	200-299	15	200-210	2.70	2.50	0.030	0.012	
			0									
	3	copolymer	1	2.08-2.10	100-199	20	190-200	2.70	2.50	0.035	0.015	
			2	2.07-2.10	200-299	25	190-200	2.70	2.50	0.035	0.015	
			0									
	0	other										

^ASee 10.1.7.

^BSee 10.1.3.

^CSee 10.1.4.

^DMaximum at 1112 N (250 lbf), 24 h, 70°C, %.

^ESee 10.1.5.

^FSee 10.1.6.

^GSee 10.1.6.

ISO 12086-2 (1995) Plastics—Fluoropolymer Dispersions and Moulding and Extrusion Materials, Part 2

3. Terminology

3.1 Definitions:

3.1.1 Definitions of terms used in this classification system shall be in accordance with Terminology **D883**.

3.1.2 *lot, n*—one production run or uniform blend of two or more production runs.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *preforming, n*—a process to compress the material under pressure in a mold to form a preform.

3.2.2 *zero strength time (ZST), n*—time measured in accordance with Section 10 of this classification system to check the relative molecular weight of PCTFE material.

3.3 Abbreviations:

3.3.1 Abbreviated terms are in accordance with Terminology **D1600**.

4. Classification

4.1 PCTFE materials in powders and pellets are classified into one group. The group is subdivided into classes based on chemical composition. These classes are subdivided into grades as shown in the Basic Property Table (**Table 1**). An example of this classification system is given as follows:

Group 01 = PCTFE

Class 1 = homopolymer

Grade 2 = having properties per **Table 1** (Grade 2)

4.1.1 To facilitate incorporation of future material the “other” category for group (01), class (0), and grade (0) are shown in **Table 1**.

5. General Requirements

5.1 The molding or extrusion material shall be of uniform composition and so compounded as to conform to the requirements of this classification system.

6. Detail Requirements

6.1 Test specimens prepared in accordance with Section 9 shall conform to the requirements prescribed for the particular type and grade in **Table 1**.

6.2 For finished PCTFE parts made from resin meeting Group 01, Class 1, Grade 3 requirements, and intended for aerospace use, detail requirements given in Specification **D7194** shall be followed.

6.3 For finished PCTFE parts made from resin Group 01, Class 1, Grade 0, 1, 2, or 3 requirements, and intended for general use, detail requirements given in Specification **D7211** shall be followed.

7. Sampling

7.1 Sampling shall be statistically adequate to satisfy the requirements of **11.4**.

8. Number of Tests

8.1 One set of test specimens as prescribed in Section 9 shall be considered sufficient for testing each batch. The average result for the specimens tested shall conform to the requirements prescribed in this classification system.

9. Specimen Preparation

9.1 Test specimens shall be cut from compression-molded sheets 1.58 ± 0.08 mm (0.062 ± 0.003 in.) thick, prepared from the resins in the following manner:

9.1.1 *Preforming*—Powder resin shall be preformed prior to molding in the following way: Place 30 ± 0.5 g of resin into a 57-mm (2.25-in.) diameter positive-pressure compression mold and compress the material at room temperature into a preform having a density of 1.4 to 1.5 g/cm³. A pressure of 68.9 MPa (10 000 psi) will satisfactorily accomplish the densification.

9.1.2 *Molding*—Pelletized resin, granular resin, and preforms of powder resin shall be molded in the following way: Place the preform prepared in accordance with 9.1.1 or 30 ± 0.5 g of pelletized or granular resin on a 0.63-mm (0.025-in.) thick chrome-plated metal plate and cover with a similar plate. Place spacers, 1.91 ± 0.03 mm (0.075 ± 0.001 in.) thick, between the chrome-plated metal plates and far enough apart so that they do not interfere with the flow of the resin during molding. Place the plates, with spacers and resin in place, between the platens of the press, the platens having been heated to a surface temperature of $265 \pm 5^\circ\text{C}$. Close and continuously load the platens, following the rate of melting so that the plates reach the stops within 3 min after closing the press. Then apply sufficient pressure for 3 min more to mold a sheet of the required thickness. Immediately after completion of the pressing, relieve the load, remove the plates and plastic sheet together, and at once quench them in cold water ($15 \pm 5^\circ\text{C}$) for 5 min, supporting the sandwich in a vertical position in the water. Then strip the 1.58 ± 0.08 -mm (0.062 ± 0.003 -in.) thick sheet from the metal plates. This sheet will be approximately 75 cm². Cut specimens from the center section of each sheet, discarding any imperfectly molded edges.

10. Test Methods

10.1 The properties enumerated in this classification system shall be determined in accordance with the following test methods:

10.1.1 *Conditioning*—For those tests where conditioning is required, the molded test specimens shall be conditioned in accordance with Procedure A of Practice D618.

10.1.2 *Test Conditions*—Tests shall be conducted in the standard laboratory atmosphere of $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and $50 \pm 5\%$ relative humidity unless otherwise specified in the test methods or in this classification system.

10.1.3 *Zero Strength Time (ZST)*—The zero strength time of PCTFE plastics shall be determined in accordance with the procedure described in the following paragraphs:

10.1.3.1 *Significance and Use*—Control of molecular weight of these polymers is necessary because the fabricating temperatures are very high and close to the point of rapid thermal degradation. The test for zero strength time is well suited to this type of control, as it is rapid, simple, and adaptable to semiautomatic operation, and for specific PCTFE resins correlates with molecular weight.

10.1.3.2 *Apparatus*—Cylindrical brass thermostat and accessory equipment as specified in Annex A1.

10.1.3.3 *Test Strip*—From the molded sheet prepared in accordance with Section 9 cut two strips 50 mm (2 in.) long, 4.8 mm ($\frac{3}{16}$ in.) wide, and 1.58 ± 0.08 mm (0.062 ± 0.003 in.) thick, using the sample cutter. With the notching punch make a V-notch in both sides of the strips approximately at the center

line (equally distant from the ends of the 50-mm length) so that the notches are directly opposite each other. The cross-sectional width between the notches shall be 1.19 ± 0.03 mm (0.047 ± 0.001 in.), and the sides of each notch shall form an angle of $90 \pm 0.5^\circ$ with each other. Alternatively, cut and notch the test strips in one operation with a test specimen punch mounted in an arbor press. Dimensions of the finished test strip are shown in Fig. A1.1.

10.1.3.4 *Procedure*—Insert one end of each notched strip into a specimen holder (Fig. A1.1) and clip a weight of 7.5 ± 0.1 g on the other end of the strip. The specimen holder and weight shall be at or near room temperature ($23 \pm 10^\circ\text{C}$). Insert the weighted specimens into the furnaces, which shall be at a temperature of $250 \pm 1^\circ\text{C}$, and start the timers at the moment of insertion. As each specimen breaks and the attached weight drops through the bottom of the furnace, stop the corresponding timer. Record the time in seconds indicated on each timer. Take the average of these two readings as the zero strength time for the duplicate specimens. If the difference between the two measurements exceeds 10 % of the average, reject these readings and test a second pair of specimens.

10.1.3.5 *Precision and Bias*—The precision and bias data for this test method is to be determined.

10.1.4 *Deformation Under Load*—Test Method A of Test Methods D621. With 1112-N (250-lbf) load at $70 \pm 1^\circ\text{C}$, except that it is acceptable for deformations to exceed 25 %.

NOTE 2—Experimental data have shown that at 1112-N (250-lbf) load and 70°C , the test for deformation under load is applicable for the purpose of classification to the materials described in this specification beyond 25 % deformation.

10.1.5 *Melting Point*—The melting point shall be determined by differential scanning calorimetry (DSC) (see Test Method D4591).

10.1.5.1 For DSC measurements, the test procedure shall follow that of the procedure section of Test Method D4591, with the exception that the reported melt temperature is that obtained upon reheating the sample after an initial melting and recrystallization.

10.1.6 *Dissipation Factor and Dielectric Constant*—Test Methods D150.

NOTE 3—A disk of approximately 50-mm (2-in.) diameter has been found satisfactory for the test.

10.1.7 *Specific Gravity*—Test Method A of Test Methods D792. The liquid used shall be *n*-heptane. The average of the specific gravity of three test specimens shall be reported.

11. Inspection and Certification

11.1 Inspection and certification of the material supplied with reference to a specification based on this classification system shall be for conformance to the requirements specified herein.

11.2 Lot-acceptance shall be the basis on which acceptance or rejection of the lot is made. The lot-acceptance inspection shall consist of particle size determination.

11.3 Periodic check inspection with reference to a specification based on this classification system shall consist of the