Designation: D3368 – 17 (Reapproved 2022)

Standard Specification for FEP Sheet and Film[1]

This standard is issued under the fixed designation D3368; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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

1. Scope

1.1 This specification covers unfilled, unpigmented FEP resin sheet and film less than 3.175 mm (0.125 in.) thick. Recycled materials are allowed in accordance with 6.2.

1.2 The values stated in SI units as detailed in IEEE/ASTM SI 10 are to be regarded as standard and the practices of IEEE/ASTM SI 10 incorporated herein.

1.3 The following safety hazards caveat pertains only to the test methods portion, Section 14, of this specification: *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

D374/D374M Test Methods for Thickness of Solid Electrical Insulation

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D882 Test Method for Tensile Properties of Thin Plastic Sheeting

D883 Terminology Relating to Plastics

D2116 Specification for FEP Resin Molding and Extrusion Materials

D3892 Practice for Packaging/Packing of Plastics

D5740 Guide for Writing Material Standards in the Classification Format

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI)

2.2 *Other Standard:*

TAPPI 411 Standard Thickness (Caliper) of Paper and Paper Products[3]

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this specification, see Terminology D883.

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

4. Classification

4.1 This specification covers four types of FEP sheet and film:

4.1.1 *Type I*—General purpose.

4.1.2 *Type II*—Cementable film. Type II materials can be subdivided into two grades:

4.1.2.1 *Grade 1*—One side cementable, and

4.1.2.2 *Grade 2*—Two sides cementable.

4.1.3 *Type III*—Special film for applications requiring unusual flexural endurance or extreme thermal and chemical service.

4.1.4 *Type IV*—Film for mold release applications.

4.2 A line callout system is used to specify materials in this standard. The system uses predefined cells to refer to specific aspects of this specification, which are illustrated as follows:

[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 (D20.15.12 on Fluoropolymers).

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[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 Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.

TABLE 1 Detail Requirements for Property Values

	Type I	Type II	Type III	Type IV
Tensile Strength, min, MPa (psi), at nominal thickness, mm (in.):				
0.0127 (0.0005)	13.8 (2000)	13.8 (2000)	...	11.0 (1600)
0.025 to 3.175 (0.001 to 0.125)	17.2 (2500)	17.2 (2500)	17.2 (2500)	14.5 (2100)
Elongation at Break, min, %, at nominal thickness, mm (in.):				
0.0127 to 0.025 (0.0005 to 0.001)	175	175	...	150
0.051 to 3.175 (0.002 to 0.125)	250	250	250	250
Dimensional Change on Heating, max, %, at nominal thickness, mm (in.):				
0.0127 to 0.025 (0.0005 to 0.001)	±5	±5	...	±5
0.051 (0.002)	±3	±3	±4	±3
0.076 to 0.508 (0.003 to 0.020)	±2	±2	±3	...
0.762 to 1.524 (0.030 to 0.060)	...	...	±4	...
2.285 to 3.175 (0.090 to 0.125)	...	...	±5	...
Cementability, min, peel strength, kg/m (g/in.), at nominal thickness, mm (in.):				
0.0127 (0.0005)	...	6.69 (170)	...	...
0.025 (0.001)	...	11.8 (300)	...	...
0.051 (0.002)	...	29.5 (750)	...	...
0.076 (0.003)	...	31.5 (800)	...	...
0.102 (0.004)	...	47.2 (1200)	...	...
0.127 (0.005)	...	78.7 (2000)	...	...
0.254 (0.010)	...	94.5 (2400)	...	...
0.508 (0.020)	...	94.5 (2400)	...	...
Dielectric Strength, min, kV/mm (V/mil), at nominal thickness, mm (in.):				
0.0127 to 0.025 (0.0005 to 0.001)	157 (4000)	157 (4000)	...	...
0.051 (0.002)	138 (3500)	138 (3500)	...	...
0.076 (0.003)	118 (3000)	118 (3000)	...	...
0.102 (0.004)	108 (2750)	108 (2750)	...	...
0.127 (0.005)	98 (2500)	98 (2500)	...	...
0.254 (0.010)	71 (1800)	71 (1800)	...	...
0.356 (0.014)	63 (1600)	63 (1600)	...	...
0.508 (0.020)	55 (1400)	55 (1400)	...	...
Density at 23°C, g/cm^3	2.13 to 2.17	2.13 to 2.17	2.13 to 2.17	2.13 to 2.17

Specification				
Standard Number Block	Type	Grade	Class	Special Notes
Example: Specification D3368 – XX,	II	1		, 0.051 mm thick

For this example, the line callout would be Specification D3368 – XX, II 1, 0.051 mm thick. This callout specifies a film of FEP that is cementable on one side and that has all of the properties listed for that type and grade in the appropriate specified properties or tables, or both, in this specification. Inclusion of a class is provided for in the system, but is not used in this particular specification. A comma is used as the separator between the standard number and the type. Separators are not needed between the type, grade, and class.[4] Provision for special notes is included in the system so that other information can be provided when required, in this case, the thickness of the film. When special notes are used, they shall be preceded by a comma.

5. Ordering Information

5.1 The sheet and film shall be furnished in the form of sheets or rolls in accordance with good commercial practice. Rolls shall be wound evenly and tightly on substantial cores suitably restrained to prevent unwinding.

5.2 Dimensions of sheet and film with respect to length, width, and core diameter shall be upon agreement between the purchaser and the manufacturer. The agreement shall apply also to the maximum number of splices per roll and tolerances for length and core.

5.3 Requests for certification or test results shall be made at the time of order placement.

6. Materials and Manufacture

6.1 The sheet and film shall be made from FEP resin as specified in Specification D2116 without filler or plasticizer.

6.2 This specification allows for the use of recycled, reprocessed, and reworked FEP materials provided the following:

6.2.1 The final physical, mechanical, and performance requirements as stated in this specification are met.

6.2.2 The toxicological characteristics are essentially unaltered from that of virgin material.

7. Other Requirements

7.1 The sheet and film shall conform to the physical, mechanical, and performance property requirements specified in Table 1. The nominal thickness of sheet or film and thickness tolerances shall be in accordance with Table 2.

7.2 The film and sheet shall be uniform in appearance and shall be sufficiently free of contamination, wrinkles, holes, scratches, and other imperfections so as to be functionally acceptable. The color shall be uniform and be characteristic of unpigmented sheet or film that ranges from clear to translucent and is dependent upon the thickness.

[4] See the ASTM *Form and Style Manual*. Available from ASTM Headquarters.

TABLE 2 Thickness and Tolerance Requirements

Nominal Thickness, mm (in.)	Applicable Types	Thickness, mm (in.)			
		min		max	
0.0127 (0.0005)	I, II, IV	0.0089	(0.00035)	0.0165	(0.00065)
0.025 (0.001)	I, II, IV	0.018	(0.0007)	0.033	(0.0013
0.051 (0.002)	I, II, III	0.038	(0.0015)	0.064	(0.0025)
0.076 (0.003)	I, II, III	0.057	(0.00225)	0.095	(0.00375)
0.102 (0.004)	I, II, III	0.080	(0.00315)	0.123	(0.00485)
0.127 (0.005)	I, II, III	0.102	(0.004)	0.152	(0.006)
0.254 (0.010)	I, II, III	0.216	(0.0085)	0.292	(0.0115)
0.356 (0.014)	I	0.320	(0.0126)	0.391	(0.0154)
0.508 (0.020)	I, II, III	0.432	(0.017)	0.584	(0.023)
0.762 (0.030)	I, III	0.648	(0.0255)	0.876	(0.0345)
1.016 (0.040)	III	0.889	(0.0350)	1.143	(0.0450)
1.524 (0.060)	III	1.372	(0.054)	1.676	(0.0660)
2.413 (0.095)	III	2.172	(0.0855)	2.654	(0.1045)
3.175 (0.125)	III	2.870	(0.113)	3.480	(0.137)

7.3 Tolerances for width of rolls shall be ±1.6 mm (±0.0625 in.) for film or sheet thickness less than 0.508 mm (0.020 in.) and ±3.2 mm (±0.125 in.) for sheet thickness equal to or greater than 0.508 mm.

8. Sampling

8.1 Sampling shall be statistically adequate to satisfy the requirements of 15.4.

9. Number of Tests

9.1 One set of test specimens as prescribed in Section 10 shall be considered sufficient for testing each batch. The average result of the specimens tested shall conform to the requirements of this specification.

10. Specimen Preparation

10.1 Take test specimens across the width of film excluding areas of wrinkles, folds, gel, and other obvious, visually determined, imperfections.

11. Conditioning

11.1 For those tests where conditioning is required and unless otherwise specified in the test method, condition the test specimens in accordance with Procedure A of Practice D618 for a period of at least 4 h prior to test.

12. Apparatus

12.1 *Heat Sealer,*[5] single heated jaw with silicone rubber pad, temperature range from 150 to 275°C (300 to 525°F), pressure 138 kPa (20 psi), and dwell time 10 s.

12.2 *Rod,*[6] or other means for coating aluminum evenly with adhesive.

13. Reagents and Materials

13.1 *Methyl Ethyl Ketone.*

13.2 *Acrylic Adhesive.*[7]

13.3 *Anodized Aluminum,*[8] 0.5 mm (0.019 in.) thick. Other sheet aluminum, either plain or anodized, should be satisfactory if it can be shown that the peel failure of the seal is between the treated film surface and the adhesive, and not between the adhesive and the aluminum.

14. Test Methods

14.1 *Test Conditions*—Unless otherwise specified, conduct tests at the standard laboratory temperature of 23 ± 2°C (70 to 77°F). Since this film and sheeting does not absorb water, the importance of constant humidity during testing is not important.

14.2 *Specific Gravity*—Determine the specific gravity on two specimens in accordance with Method A of Test Methods D792. Add two drops of a wetting agent (liquid detergent)[9] to the water in order to reduce the surface tension and insure complete wetting of the sample.

14.3 *Tensile Properties:*

14.3.1 Film 0.254 mm (0.010 in.) or less in nominal thickness.

14.3.1.1 Determine the tensile strength and elongation in accordance with Method A of Test Methods D882.

14.3.2 Sheet greater than 0.254 mm (0.010 in.) in nominal thickness.

14.3.2.1 Cut five bars with the microtensile die shown in Fig. 1. If the die is the steel rule type it shall have a curvature of 5 ± 0.8 mm (5⁄32 ± 1⁄32 in.). Tabs at each end of the die longer than specified in Fig. 1 are allowed.

[5] Sentinel Model 12AS or 12-12AS, available from Packaging Industries Group, Inc., 130 North St., Hyannis, MA 02601, or equivalent, has been found satisfactory for this purpose.

[6] No. 24 "Draw Down" rod, available from R. D. Specialities, Inc., P.O. Box 206, Webster, NY 14580, has been found satisfactory for this purpose.

[7] No. 68040 acrylic adhesive from E. I. DuPont de Nemours & Co., Inc., Polymers, Wilmington, DE 19898, has been found satisfactory for this purpose. Alternative adhesive is allowed, if it leads to the same result.

[8] "Aldine" No. 1200, available from Alsco, Inc., 225 S. Forge St., Akron, OH 44308, or equivalent, has been found satisfactory for this purpose.

[9] Examples of suitable wetting agents are "Glim" detergent, B. J. Babitt, Inc.; "Joy" detergent, Proctor and Gamble, Inc.; and "Triton" X-100, Rohm and Haas Co.

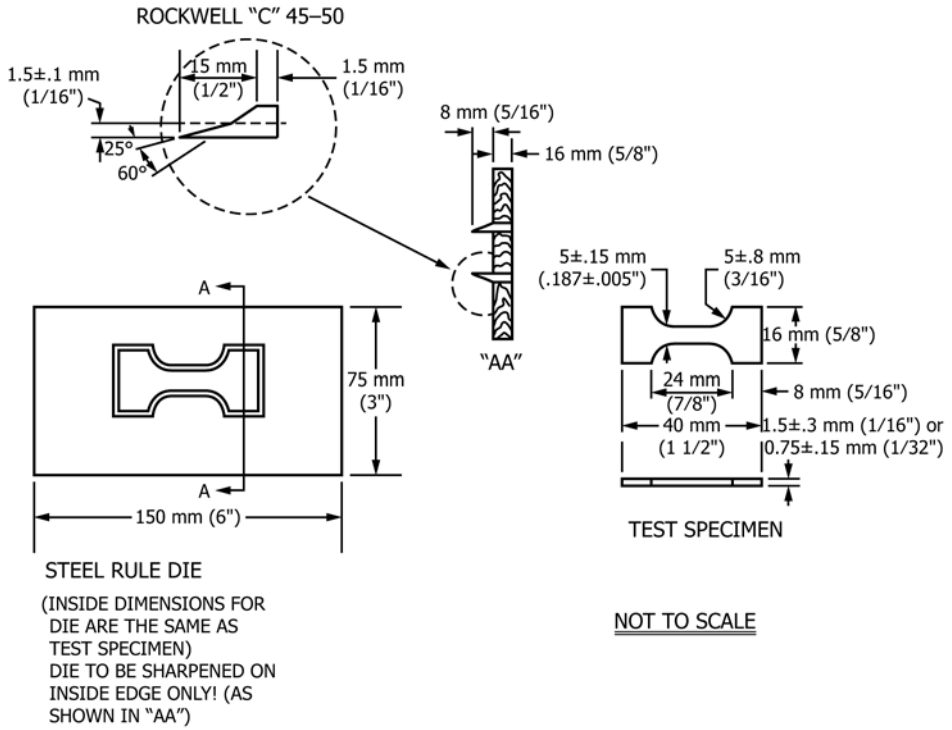

FIG. 1 Test Specimen and Die

14.3.2.2 Determine the tensile properties in accordance with the procedures described in Test Method D638, except that the specimens shall be as detailed in 14.3.1 – 14.3.2.1, the initial jaw separation shall be 22.2 ± 0.13 mm (0.875 ± 0.005 in.), and the speed of testing shall be 51 mm/min (2 in./min). Clamp the specimen with essentially equal lengths of the tabs in each jaw. If an extensiometer is not available, the elongation at break is determined from the chart record, expressing the value as a percentage of the initial jaw separation. Average the test results. In making the test for tensile properties, a full-scale load of 22.5 kg (50 lb) has been found suitable. If the specimens break quickly, increase the chart speed so that the chart record for each specimen covers at least 51 mm (2 in.) on the time axis of the chart.

NOTE 2—In determining elongation from the chart record, draw a perpendicular from the break point to the time axis. Measure the distance along the time axis from the intersection of this perpendicular with the axis to the intersection of an extension of the linear part of the load-time curve and the time axis. Then, calculate percent elongation as follows:

$$\text{Elongation} = 100d/(22.2 \text{ or } 0.875)m \quad (1)$$

where:

d = distance on chart, mm (in.),
m = hart speed magnification,
= chart speed/crosshead speed (both in same units), and
22.2 = factor when d is in millimetres, or
0.875 = factor when d is in inches.

14.4 *Dielectric Strength*—Determine the dielectric strength in accordance with Test Methods D149, using the short-time test and a 6.35-mm (¼-in.) brass electrode with a 0.79-mm (1/32-in.) radius.

14.5 *Dimensional Change on Heating*—Determine lengthwise change in dimensions by averaging five measurements on specimens immediately before and after oven heating. Each specimen shall be 101.6 ± 1.6 by 101.6 ± 1.6 mm (4 ± 1/16 by 4 ± 1/16 in.) and be freely suspended in an oven controlled at 200 ± 3°C (392 ± 5.4°F) for a minimum of 30 min. After the heating period, cool the specimens to 23 ± 2°C (73.4 ± 3.6°F), and remeasure them.

14.6 *Cementability*—Seal the treated surface of the material by the application of controlled heat, pressure, and time of dwell to an adhesive-coated strip of aluminum sheet. Measure the peel strength at a peel angle of 180°, and a speed of 30.5 cm/min (12 in./min).

14.6.1 *Procedure for Preparation of Adhesive-Coated Aluminum:*

14.6.2 Coat sheets of aluminum 254 by 254 mm (10 by 10 in.) evenly with No. 68040 adhesive[7] using a No. 24 "Draw Down" rod and allow to dry in air for 8 h. The thickness of coating is not critical but it is important that the coating be smooth and bubble-free. Use methyl ethyl ketone to thin the adhesive if necessary, and for cleaning the equipment.

14.6.3 Cut the coated sheets into strips 38.1 by 127 mm (1.5 by 5 in.) and store in a desiccator. It is not advisable to prepare more than a 2 or 3-month supply of coated aluminum at one time, as the adhesive slowly crosslinks in time and seal strength values are lowered.

14.6.4 Cut five 25.4 by 127-mm (1 by 5-in.) sample strips evenly spaced across the width of the film sample. The film must be free of fingerprints and contamination.

14.6.5 Place each film specimen on a strip of the coated aluminum with the treated surface facing the adhesive. Seal the strips in the heat sealer with the aluminum strip facing the heated jaw and the film facing the silicone rubber pad. Set the