

**ETHYLENE TETRAFLUOROETHYLENE SHEET, MOLDED
Stress-Relieved**

1. SCOPE:

1.1 **Form:** This specification covers a melt-processible, copolymer resin of ethylene and tetrafluoroethylene (ETFE) in the form of molded sheet.

1.2 **Application:** Primarily for parts such as seals, insulators, back-up rings, valve liners, and bearings requiring good mechanical, chemical, electrical, environmental (including radiation resistance), and elevated-temperature properties. ETFE offers improved mechanical properties compared to both polytetrafluoroethylene and polyfluoroethylene propylene, while offering essentially the same outstanding chemical, electrical, and environmental performance of these other materials. It is capable of continuous operations up to 150°C (300°F) and, depending on exposure time, load, and environment can be used intermittently up to 200°C (390°F).

2. **APPLICABLE DOCUMENTS:** The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 **SAE Publications:** Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 **Aerospace Material Specifications:**

AMS 2350 - Standards and Test Methods

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2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D149 - Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

ASTM D638 - Tensile Properties of Plastics

ASTM D792 - Specific Gravity and Density of Plastics by Displacement

ASTM D1708 - Tensile Properties of Plastics by Use of Microtensile Specimens

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Material: Shall be molded from ethylene tetrafluoroethylene copolymer resin pellets without admixture of fillers, pigments, or adulterants.

3.1.1 Sheet shall be stress-relief annealed after molding for dimensional stability.

3.2 Color: Shall be translucent white. Minor discoloration will be acceptable.

3.3 Properties: Sheet shall conform to the following requirements; tests shall be performed on the sheet supplied and in accordance with specified test methods, insofar as practicable:

3.3.1 Tensile Strength at 23°C \pm 1 (73°F \pm 2), min	5500 psi (38 MPa)	4.5.1
3.3.2 Elongation at 23°C \pm 1 (73°F \pm 2), min	225%	4.5.1
3.3.3 Specific Gravity at 23°/23°C (73°/73°F)	1.68 - 1.73	ASTM D792: add 2 drops of wetting agent to the water

3.3.4 Dielectric Strength, Short Time Test, min	1200 V per mil (47,250 V/mm)	4.5.2
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3.3.5 Dimensional Stability: Sheet 2.000 in. (50.00 mm) and under in nominal thickness shall not change in length, width, or thickness by more than 0.5%, determined as in 4.5.3. Dimensional stability of sheet over 2.000 in. (50.00 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.4 Quality: Sheet, as received by purchaser, shall be uniform in quality and condition, smooth, and free from foreign materials and from imperfections detrimental to usage of the sheet.

3.5 Tolerances: Shall be as follows, determined at 23° - 30°C (73° - 86°F):

3.5.1 Thickness:

TABLE I

Nominal Thickness (T) Inches	Tolerance, Inch	
	plus	minus
0.0312 to 0.0625, incl	0.015	0.005
Over 0.0625 to 0.0938, incl	0.020	0.005
Over 0.0938 to 0.125, incl	0.016	0.008
Over 0.125 to 0.1563, incl	0.018	0.009
Over 0.1563 to 0.1875, incl	0.022	0.011
Over 0.1875 to 0.250, incl	0.030	0.015
Over 0.250 to 0.375, incl	0.038	0.019
Over 0.375 to 0.500, incl	0.046	0.022
Over 0.500 to 0.625, incl	0.054	0.027
Over 0.625 to 0.750, incl	0.070	0.035
Over 0.750 to 1.000, incl	0.087	0.043
Over 1.000 to 1.250, incl	0.102	0.051
Over 1.250 to 1.500, incl	0.118	0.059
Over 1.500 to 1.750, incl	0.134	0.067
Over 1.750 to 2.000, incl	0.150	0.075
Over 2.000	0.10T	0.10T

TABLE I (SI)

Nominal Thickness (T) Millimetres	Tolerance, Millimetres	
	plus	minus
0.78 to 1.56, incl	0.38	0.12
Over 1.56 to 2.34, incl	0.50	0.12
Over 2.34 to 3.12, incl	0.40	0.20
Over 3.12 to 3.90, incl	0.45	0.22
Over 3.90 to 4.70, incl	0.55	0.28
Over 4.70 to 6.25, incl	0.75	0.38
Over 6.25 to 9.50, incl	0.95	0.48
Over 9.50 to 12.50, incl	1.15	0.55
Over 12.50 to 15.50, incl	1.35	0.68
Over 15.50 to 18.75, incl	1.75	0.88
Over 18.75 to 25.00, incl	2.20	1.08
Over 25.00 to 31.25, incl	2.55	1.28
Over 31.25 to 37.50, incl	2.95	1.48
Over 37.50 to 43.75, incl	3.35	1.68
Over 43.75 to 50.00, incl	3.75	1.88
Over 50.00	0.10T	0.10T

3.5.2 Width and Length: Shall not vary more than +0.250 in. (+6.25 mm), -0.

4. QUALITY ASSURANCE PROVISIONS:

- 4.1 Responsibility for Inspection: The vendor of sheet shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.6. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the sheet conforms to the requirements of this specification.
- 4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and as preproduction tests and shall be performed prior to or on the initial shipment of sheet to a purchaser, on each lot, when a change in material, processing, or both requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.
- 4.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.
- 4.3 Sampling: Shall be as follows:
- 4.3.1 For Acceptance Tests: Sufficient sheet shall be taken at random from each lot to perform all required tests. The number of determinations for each requirement shall be as specified in the applicable test procedure or, if not specified therein, not less than three.
- 4.3.1.1 A lot shall be all sheet produced in a single production run from the same batch of raw material and presented for vendor's inspection at one time but shall not exceed 200 lb (90 kg); a lot may be packaged and delivered in smaller quantities under the basic lot approval provided lot identification is maintained.
- 4.3.1.2 When a statistical sampling plan and acceptance quality level (AQL) have been agreed upon by purchaser and vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.6.1 shall state that such plan was used.
- 4.3.2 For Preproduction Tests: As agreed upon by purchaser and vendor.
- 4.4 Approval:
- 4.4.1 Sample sheet shall be approved by purchaser before sheet for production use is supplied, unless such approval be waived by purchaser. Results of tests on production sheet shall be essentially equivalent to those on the approved sample sheet.

4.4.2 Vendor shall use ingredients, manufacturing procedures, processes, and methods of inspection on production sheet which are essentially the same as those used on the approved sample sheet. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in material, processing, or both and, when requested, sample sheet. Production sheet made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Tensile Strength and Elongation: Shall be determined in accordance with ASTM D638, using the microtensile specimen of ASTM D1708. The initial jaw separation shall be 0.875 in. + 0.005 (22.00 mm + 0.12) and the speed of testing shall be 2 in. (50 mm) per minute. Sheet over 0.062 to 0.625 in. (1.55 to 15.50 mm), excl, in nominal thickness shall be machined to 0.062 in. + 0.010 (1.55 mm + 0.25) thick before cutting specimens. From sheet 0.625 in. (15.50 mm) and over in nominal thickness, a slice somewhat thicker than 0.062 in. (1.55 mm) shall be cut in a plane parallel to, and not less than 0.5 in. (12 mm) from, the plane of one end of the sheet; this slice shall be machined on both faces to 0.062 in. + 0.010 (1.55 mm + 0.25) thick and the specimens cut from the machined slice. In all cases of specimens reduced to specified thickness by machining, tool marks shall be removed by light sanding in a longitudinal direction.

4.5.2 Dielectric Strength: Shall be determined in accordance with ASTM D149 on specimens 0.060 in. + 0.010 (1.50 mm + 0.25) thick. Tests shall be conducted under oil using electrodes of corrosion-resistant steel, nominally 0.25 in. (6.25 mm) in diameter with 0.031 in. (0.75 mm) radius at the edges.

4.5.3 Dimensional Stability: Cut specimens from the product with both a length and width of 1.000 in. + 0.005 (25.00 mm + 0.12). Measure length, width, and thickness to the nearest 0.001 in. (0.025 mm). Mark the points of original measurement so that measurements after heating and cooling can be made at the same points. Place the specimens in a heating chamber which is at approximately 23°C (75°F) and raise the temperature of the chamber to 220°C + 3 (430°F + 5). The heating medium may be either oil or air. Hold the specimens at 220°C + 3 (430°F + 5) for 120 min. + 5. Lower the temperature at a rate not greater than 30 C (55 F) deg per hr to approximately 23°C (73°F). Measure the length, width, and thickness of the specimens to the nearest 0.001 in. (0.025 mm) at the same points as used for the original measurements. Calculate the changes in dimensions by the following equation and average the results for each dimension:

$$D = \frac{L_n - L_i}{L_i} \times 100$$

where, D = dimensional change in %
L_n = dimension of section after heating
L_i = dimension of section before heating