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Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing[1]

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1. Scope

1.1 This specification covers flexible sheet made from thermoplastic polyolefin (TPO) as the principal polymer, intended for use in single-ply roofing membranes exposed to the weather. The sheet shall contain reinforcing fabrics or scrims.

1.2 The tests and property limits used to characterize the sheet are values intended to ensure minimum quality for the intended purpose. In-place roof system design criteria, such as fire resistance, field seaming strength, material compatibility, and uplift resistance, among others, are factors which should be considered but are beyond the scope of this specification.

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

1.4 *This standard may involve hazardous materials, operations, and equipment. 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 requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 471 Test Method for Rubber Property—Effect of Liquids[2]

D 573 Test Method for Rubber—Deterioration in an Air Oven[2]

D 751 Test Methods for Coated Fabrics[3]

D 1149 Test Method for Rubber Deterioration—Surface Ozone Cracking in a Chamber[2]

D 1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature[4]

D 2137 Test Methods for Rubber Property—Brittleness Point of Flexible Polymers and Coated Fabrics[2]

D 5538 Practice for Thermoplastic Elastomers—Terminology and Abbreviations[2]

G 151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources[5]

G 155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials[5]

3. Materials and Manufacture

3.1 The sheet shall be formulated from ethylene and higher alpha-olefin polymers, copolymers, and mixtures thereof, in amounts greater than 50 %, by weight of the total polymer content suitably compounded to satisfy the physical requirements in the specification (see Practice D 5538).

3.2 The sheet shall be capable of being heat welded, fused, or adhesively bonded to itself for making watertight field splices and repairs, and the supplier or fabricator shall recommend suitable methods and materials.

3.3 Sheet shall be reinforced with fabric or scrim.

4. Physical Properties and Tolerances

4.1 Each sheet specimen shall meet or exceed the physical requirements prescribed in Table 1.

4.2 The tolerance for time conditions (aging, weathering, and so forth) is ±15 min or ±1 % of the period, whichever is greater, unless otherwise specified.

4.3 The tolerance for temperature conditions (aging, weathering, and so forth) is ±2°C (±4°F) of the specified temperature, unless otherwise specified.

5. Dimensions and Permissible Variations

5.1 The width and length of the sheet shall be agreed upon between the purchaser and the supplier.

5.1.1 The width and length tolerance shall be +3 %, −0 %.

5.1.2 The thickness tolerance shall be +15 %, –10 % of thickness agreed upon by the purchaser and supplier, but in no case shall it be less than the minimum in Table 1.

6. Workmanship, Finish, and Appearance

6.1 The sheet, including factory seams, if present, shall be watertight and free of pinholes, particles of foreign matter,

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[2] *Annual Book of ASTM Standards*, Vol 09.01.

[3] *Annual Book of ASTM Standards*, Vol 09.02.

[4] *Annual Book of ASTM Standards*, Vol 08.03.

[5] *Annual Book of ASTM Standards*, Vol 14.04.

TABLE 1 Physical Requirements for TPO Sheet

Thickness, min, mm (in)	
Sheet-overall	1.0 (0.039)
Coating over fabric or scrim, weathering side only	0.305 (0.012)
Breaking strength, min, N (lbf)	976 (220)
Elongation at reinforcement break, min, %	15
Tearing strength, min, N (lbf)	245 (55)
Brittleness point, max, °C (°F)	-40 (-40)
Ozone resistance, no cracks	Pass
Properties after heat aging: (retained values)	
Breaking strength, % min	90
Elongation at reinforcement break, % min	90
Tearing strength, % min	60
Weight change (mass), max %	±1
Linear dimensional change, max, %	±1
Water absorption, max, mass %	±3.0[A]
Factory seam strength, min, N (lbf)	290 (66)
Weather resistance: (retained values)	
Visual inspection	Pass
Breaking strength, % min	90
Elongation at reinforcement break, min, %	90

[A] Test performed on top coating material only. (Use Test Method D 471, Testing only one side Section.)

protruding fibers or reinforcement, undispersed raw material, nicks and cuts, voids, thin areas, delaminations or other manufacturing defects that might adversely affect serviceability.

6.2 Edges of the sheet shall be capable of being seamed to one another without fishmouthing.

7. Test Methods

7.1 *Dimensions*—Test Methods D 751, after permitting the sheet to relax at 23°C (73°F) for 1 h.

7.2 *Thickness, Sheet Overall*—Refer to Test Methods D 751 for Type I.

7.3 *Thickness of Coating Over Scrim (Reinforcing Fabric)*—Optical Method described in Annex A1.

7.4 *Breaking Strength*—Test Methods D 751, Grab Method.

7.5 *Elongation at Break*—Test Methods D 751, Grab Method.

7.6 *Tearing Strength*—Test Methods D 751, 2 in./min jaw speed. (8 by 8 in. sample size).

7.7 *Brittleness Point*—Test Methods D 2137, Method B.

7.8 *Ozone Resistance*—Test Method D 1149. Inspect at 7× magnification on specimens exposed to 100 mPa (1×10^{-5} psi) ozone in air at 40°C (104°F). Specimens shall be wrapped around a 75-mm (3-in.) diameter mandrel for 166 h exposure. Specimen shall be wrapped around the same size mandrel for inspection. The required specimen width is 25 mm (1.0 in.).

7.9 *Heat Aging*—Test Method D 573. Age sheet specimens for 670 h at 116°C (240°F). Specimens are then cut from the aged sheet for testing of breaking strength, elongation, and so forth.

7.10 *Linear Dimensional Change*—Test Method D 1204. Age specimen for 6 h at 70°C (158°F) or 1 h at 100°C (212°F).

7.11 *Water Absorption*—Test Method D 471 for 166 h at 70°C (158°F). Test performed on top coating material only. (Use Test Method D 471, Testing One Surface Only Section.)

7.12 *Factory Seam Strength*—Test Methods D 751, Grab Method. Modify procedure by cutting a 25 mm (1.0 in.) wide by 300 mm (12 in.) long sample across the lap seam. Place in jaws approximately 50 mm (2.0 in.) from edges of the overlap area and test at a jaw separation rate of 5 cm/min (2 in./min).

7.13 *Weather Resistance*—Accelerated weathering tests shall be performed using Practice G 155.

7.13.1 *Practice G 151 and G 155*—Xenon-arc apparatus shall be operated in accordance with the following conditions:

Filter Type	Daylight
Irradiance	0.35 to 0.70 W/m^2 at 340 nm (42 to 84 W/m^2 at 300 to 400 nm)
Cycle	690 min light, 30 min light plus water spray
Black Panel Temperature	80 ± 3°C
Relative Humidity	50 ± 5 %
Spray Water	Deionized
Specimen Rotation	Refer to Practice G 155
Radiant Exposure	5040 kJ/m^2 at 340 nm (604.8 MJ/m^2 at 300 to 400 nm) Inspect at 7× magnification for aging.

7.13.2 Perform the weathering tests on the intact sheet with the weathering side facing the lamps. Mount specimens for exposure under no strain. After exposure, the specimens shall be removed, wrapped around a 75 mm (3 in.) mandrel, and inspected for cracks and crazing. A specimen is rated "pass" if no cracks or crazing is observed. Determine physical properties as specified by Table 1.

8. Inspection

8.1 Inspection of the material shall be agreed upon between involved parties.

9. Rejection and Resubmittal

9.1 Failure to conform to any one of the requirements prescribed in this specification shall constitute grounds for rejection. Rejection shall be reported to the supplier promptly and in writing. The seller shall have the right to reinspect the rejected shipment and resubmit the lot after removal of those packages not conforming to the specified requirements.

10. Product Marking

10.1 The sheet shall be identified on the side intended to be exposed to the weather with this ASTM designation, the name of the manufacturer or supplier, and TPO. The type of identification is at the manufacturer's option. Such identification shall occur at intervals not to exceed 3 m (9 ft, 10 in.) in the long direction. The identification shall be applied in such a manner as to be legible five years from installation. Identification shall not be required when so specified by the purchaser.

11. Packaging and Package Marking

11.1 The material shall be packaged in a standard commercial manner, unless otherwise specified, so as to be acceptable by commercial or other carriers for safe transportation to the point of delivery.

11.2 Shipping containers shall be marked with:

11.2.1 The name of the material,

11.2.2 Product code,

11.2.3 ASTM number,

11.2.4 Size or quantity, and

11.2.5 Name of manufacturer or supplier.

12. Keywords

12.1 flexible sheet; roofing; roofing material; single-ply roofing membrane; thermoplastic polyolefin; TPO

ANNEX

(Mandatory Information)

A1. OPTICAL METHOD FOR MEASUREMENT OF THICKNESS OF COATING OVER SCRIM (REINFORCING FABRIC) FOR TYPE I SHEET

A1.1 Scope

A1.1.1 This method measures the thickness of the coating over reinforcing fabric.

A1.2 Measurement Method

A1.2.1 *Principle*—The thickness of coating material over fiber, fabric, or scrim can be observed with a standard reflectance microscope. Measurement is made with a calibrated eyepiece.

A1.2.2 *Apparatus*:

A1.2.2.1 *Microscope*, 60× with reticle.

A1.2.2.2 *Light Source*—If light source on the microscope is not adequate, use a small high-intensity lamp.

A1.2.2.3 *Stage Micrometer*, 0.0254 mm (0.001 in.) divisions.

A1.2.3 *Calibration Procedure*:

A1.2.3.1 Place a standard reflectance stage micrometer in place of the specimen.

A1.2.3.2 Turn on the microscope light source.

A1.2.3.3 Position the reticle eyepiece and the micrometer such that the scales are superimposed. Focus the reticle by turning the eyepiece. Focus the specimen and reticle by turning the vertical adjustment knob.

A1.2.3.4 Locate a point at which both scales line up. Count the number of micrometer divisions away. Measure to the nearest 0.0125 mm (0.0005 in. or 0.5 mil). The calibration may be optimized by increasing the number of divisions measured.

A1.2.3.5 Repeat the calibration three times and average the results. A calibration example is given below.

A1.2.3.6 If four reticle divisions (RD) are found equal to 4.5 micrometer divisions (MD), then:

$$1(RD) = 4.5/4(MD) \text{ or } 1\ (RD) = 1.125\ (MD)$$

Since 1 micrometer division is also equal to 25.4 μm (0.001 in. or 1.0 mil); therefore, 1(RD) = 28.6 μm (0.001125 in. or 1.125 mils) or the calibration factor.

A1.2.4 *Specimen Analysis*:

A1.2.4.1 Carefully center a sharp single-edge razor or equivalent over the fiber intersections along the *x-x* axis.

A1.2.4.2 Make a clean bias cut completely through the sheet.

A1.2.4.3 Remove the razor-cut section and mount in common putty with the cut surface facing upward.

A1.2.4.4 Observe the cut surface with the eyepiece reticle. Measure the thickness of the coating on either side of the thread intersection by counting the number of reticle divisions (to the nearest one-half division).

A1.2.4.5 Sample three areas of the coatings and average the results.

A1.3 Calculation and Report

A1.3.1 Multiply the number or reticle divisions representing the thickness of the coating by the calibration factor. Report the average results from the three areas of the coating to the nearest 12.7 μm (0.0005 in. or 0.5 mils).

A1.4 Precision and Bias

A1.4.1 *Precision*—Measurements are accurate to ±12.7 m (0.005 in. or 5.0 mils) when the thickness is about 0.05 mm (0.020 in. or 20 mils).

A1.4.2 *Bias*—Since there is no accepted reference material suitable for determining the bias for measuring coating thickness, no statement on bias is being made.