Designation: D2103 – 15

Standard Specification for Polyethylene Film and Sheeting[1]

This standard is issued under the fixed designation D2103; 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 the classification of polyethylene film and sheeting up to 0.3 mm (0.012 in.) in thickness, inclusive. The film or sheeting may contain additives for the improvement of the surface properties, pigments, or stabilizers, or combinations thereof.

NOTE 1—Film is defined in Terminology D883 as an optional term for sheeting having a nominal thickness no greater than 0.254 mm (0.010 in.).

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

1.3 The following precautionary caveat pertains only to the test method portion, Section 8, 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 and health practices and determine the applicability of regulatory limitations prior to use.*

1.4 This specification allows for the use of recycled polyethylene film or resin as feedstock, in whole or in part, as long as all the requirements as governed by the producer and end user are also met (see Note 2).

NOTE 2—Guide D7209 describes terminology and definitions related to recycled plastics.

NOTE 3—There is no known ISO equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

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

D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics

D1004 Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting

D1434 Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting

D1505 Test Method for Density of Plastics by the Density-Gradient Technique

D1709 Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method

D1746 Test Method for Transparency of Plastic Sheeting

D1894 Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting

D1922 Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method

D1938 Test Method for Tear-Propagation Resistance (Trouser Tear) of Plastic Film and Thin Sheeting by a Single-Tear Method

D2457 Test Method for Specular Gloss of Plastic Films and Solid Plastics

D2578 Test Method for Wetting Tension of Polyethylene and Polypropylene Films

D2839 Practice for Use of a Melt Index Strand for Determining Density of Polyethylene

D3892 Practice for Packaging/Packing of Plastics

D4321 Test Method for Package Yield of Plastic Film

D4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets

D4976 Specification for Polyethylene Plastics Molding and Extrusion Materials

D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens

D6988 Guide for Determination of Thickness of Plastic Film Test Specimens

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.19 on Film, Sheeting, and Molded Products.

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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.

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

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D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products (Withdrawn 2015)[3]

E96/E96M Test Methods for Water Vapor Transmission of Materials

F1249 Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor

3. Terminology

3.1 *Definitions:*

3.1.1 Unless otherwise specified, the definitions of plastics used in this specification are in accordance with Terminology D883.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *treated*—surface characteristics of the sheet or film have been modified by flame, corona discharge, or other means to promote the adhesion of inks, etc.

3.2.2 *yield*—the area provided by a given weight of film or sheeting of specified thickness.

4. Classification

4.1 The film and sheeting covered in this specification shall be designated by a type number, composed by listing the desired cell limit for each of the five properties, in the order shown in Table 1.

NOTE 4—Examples of this classification system are as follows:

(*1*) A high-clarity packaging film might be described as follows:

Type Number	2	1	1	1	2
Density (0.926 to 0.940)	⌊				
Impact strength (<40)		⌊			
Coefficient of friction (<0.20)			⌊		
Haze (<5.0)				⌊	
Nominal Thickness 0.0254–<0.0508 mm (0.0010–<0.0020 in.)					⌊

(*2*) A thin garment bag film might be described as follows:

Type Number	2	1	1	2	2
Density (0.926 to 0.940)	⌊				
Impact strength (<40)		⌊			
Coefficient of friction (<0.20)			⌊		
Haze (5.0 to 9.0)				⌊	
Nominal Thickness 0.0254–<0.0508 mm (0.0010–<0.0020 in.)					⌊

(*3*) A tough, thick, pigmented industrial film might be described as follows:

Type Number	1	4	3	3	5
Density (0.910 to 0.925)	⌊				
Impact strength (151–300)		⌊			
Coefficient of friction (0.41 to 0.70)			⌊		
Haze (>9.0)				⌊	
Nominal Thickness 0.1778–≤0.3048 mm (0.0070–≤0.0120 in.)					⌊

With this type of classification it is possible to assemble on paper a combination of properties that is impossible to obtain with the present state of technology. A purchaser using this specification for the first time will probably find it necessary to contact material suppliers to learn what materials are commercially available.

4.2 In cases where surface treatment is specified by the purchaser, the test method must be agreed upon between the purchaser and the seller. The recommended test to measure the degree of surface treatment is Test Method D2578.

5. General Requirements

5.1 *Appearance*—The material shall have appearance qualities conforming with those produced by good commercial

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

TABLE 1 Type Numbers

Property Order Number	Property	0	1	2	3	4	5	Units
1	Density[A]	unspecified	0.910–<0.926	0.926–<0.941	0.941–0.965	<0.910	...	g/cm^3
2	Impact strength	unspecified	<40	40–70	71–150	151–300	>300	grams
3	Coefficient of friction[G]	unspecified	<0.20	0.20–0.40	0.41–0.70	>0.70	...	...
4	Haze	unspecified	<5.0	5.0–9.0	>9.0	...	...	...
5	Nominal thickness	unspecified	[B]	[C]	[D]	[E]	[F]	mm (in.)

[A] Annealed density of molded plaques or Melt Index extrudates.
[B] <0.0254 (<0.0010).
[C] 0.0254–<0.0508 (0.0010–<0.0020)
[D] 0.0508–<0.1016 (0.0020–<0.0040)
[E] 0.1016–<0.1778 (0.0040–<0.0070)
[F] 0.1778–≤0.3048 (0.0070–≤0.0120)
[G] Coefficient of friction listed in this table is based on the kinetic coefficient of friction.

practice. It shall be as free as commercially possible of gels, streaks, pinholes, particles of foreign matter, and undispersed raw material. Gels need to be kept as minimal as possible when recycled materials are used in the films. There shall be no other visible defects such as holes, tears, or blisters. The edges shall be free of nicks and cuts visible to the unaided eye. There shall be no visible evidence of damage from shipping.

5.2 *Thickness Tolerances*——The point-to-point thickness tolerances of the film or sheeting covered in this specification shall be nominal ±20 %.

5.3 *Yield Tolerances*—The actual yield of film or sheeting covered in this specification shall be within the tolerance limits of the nominal yield as prescribed in Table 2. In cases where each roll, blanket, or unit of production is packaged and marked by the producer as the ultimate consumer sales unit with stated dimensions, the single-roll tolerances for yield shall apply.

5.4 *Width Tolerances*——The tolerance for width shall be ±3.3 mm (0.13 in.)/ft of nominal width except that the tolerance shall be not less than ±3.3 mm (0.13 in.).

5.5 *Length*—For unit consumption the length of film or sheeting per roll shall be within +4, -0 % of the length as marked, or as agreed upon between the purchaser and the seller. Each roll shall be in one piece, except that it is permissible for no more than 20 % of the rolls in any one shipment to contain a maximum of three pieces. Such rolls shall be clearly labeled.

6. Detail Requirements

6.1 The film or sheeting shall conform to the requirements of Table 1 as indicated by the type designation.

6.2 The film and sheeting shall not be blocked excessively as agreed upon between the purchaser and the seller.

7. Sampling

7.1 Samples of film or sheeting sufficient to determine conformance to this specification shall be taken at random.

8. Test Methods

8.1 *Conditioning*—Condition the test specimens at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D618 unless otherwise specified by agreement or the relevant ASTM material specification. In cases of disagreement, the tolerances shall be ±1°C (±1.8°F) and ±5 % relative humidity.

8.2 *Test Conditions*—Conduct the tests at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity unless otherwise specified by agreement or the relevant ASTM material specification. In cases of disagreement, the tolerances shall be ±1°C (±1.8°F) and ±5 % relative humidity.

TABLE 2 Yield Tolerances

Number of Rolls	Tolerance, %
Single rolls and lots up to and including 25 rolls	±10
Lots over 25 rolls and up to and including 100 rolls	±5
Lots over 100 rolls	±3

8.3 *Density*—Determine the annealed density of the molded plaques or melt index extrudate as specified in Specification D4976. Plaques shall be compression molded in accordance with Practice D4703, Annex A1, Procedure C. If melt index extrudate is used, it shall be prepared in accordance with Practice D2839.

8.4 *Impact Strength*—Test the film or sheeting for impact strength in accordance with Test Methods D1709, Test Method A, reporting the results in grams. This test method is not applicable to impact strengths greater than 2,000 g. Run impact strengths of greater than 2,000 g in accordance with Test Method B of Test Methods D1709.

NOTE 5—The impact resistance of polyethylene film, while partly dependent on thickness, has no simple correlation with sample thickness. Hence, impact values expressed in grams cannot be normalized over a range of thicknesses without producing misleading data as to the actual impact resistance of the material. Data from these methods are comparable only for comparing specimens that vary in thickness by no more than ±25 % from the nominal or average thickness of the specimens tested.

8.5 *Coefficient of Friction, Kinetic*—Determine the kinetic coefficient of friction in accordance with Test Method D1894.

8.6 *Haze*—Determine the haze of the film or sheeting in accordance with Test Method D1003.

8.7 *Treatment*—Designate the film or sheeting simply as untreated or treated in accordance with 3.2.1.

8.8 *Thickness*—The thickness of the film and sheeting shall be determined in Test Methods D5947 or Guide D6988.

8.8.1 *Test Specimens*—Five specimens, at least 5 by 5 cm (2 by 2 in.) in area, taken randomly across the width of the roll shall be tested. At least one set of specimens shall be measured from each roll being tested.

8.9 *Yield*—Calculate the actual yield using Test Method D4321.

8.9.1 Calculate the nominal yield using Test Method D4321 and the unannealed film density. Determine the unannealed film density in accordance with Test Method D1505, using three specimens after conditioning in accordance with Procedure A of Practice D618.

8.9.2 Calculate the deviation of the actual yield from the nominal yield as follows:

$$D = [(Y_a - Y_n)/Y_n] \times 100 \quad (1)$$

where:

D = deviation from the nominal yield, %,
Y_a = measured yield, m^2/kg ($in.^2/lb$), and
Y_n = nominal yield, m^2/kg ($in.^2/lb$).

9. Packaging and Package Marking

9.1 *Packaging*—The material shall be packaged in standard commercial containers, so constructed as to ensure acceptance by common or other carriers for transportation at the lowest rate to the point of delivery, unless otherwise specified in the contract or order.

9.2 *Marking*—Shipping containers shall be marked with the name, ASTM type in accordance with this specification,

thickness, width, and weight of the film or sheeting contained therein, as defined by the contract or order under which the shipment is made, the name of the manufacturer, and the contract order number.

9.3 All packing, packaging, and marking provisions of Practice D3892 shall apply to this specification.

10. Keywords

10.1 ethylene plastics; polyethylene film; polyethylene plastics; polyethylene sheeting; recycling

APPENDIXES

(Nonmandatory Information)

X1. OTHER PROPERTIES (OPTIONAL)

X1.1 Other properties that may be used to characterize polyethylene film and sheeting are as follows:

X1.1.1 *Tensile Strength and Elongation*—When tensile strength and elongation are to be measured, test in accordance with Test Method D882. It is important that these properties be measured in both the transverse and longitudinal directions.

X1.1.2 *Tear Strength*—When required, determine the tear strength in accordance with Test Method D1938, Test Method D1922, or Test Method D1004, as agreed upon between the purchaser and the seller.

X1.1.3 *Water Vapor Transmission*—Determine the water vapor transmission of polyethylene film and sheeting, when necessary, in accordance with Test Methods E96/E96M, Procedure E or Test Method F1249, as agreed upon between the purchaser and the seller.

X1.1.4 *Gas Transmission*—Determine the gas transmission through polyethylene film and sheeting, when necessary, in accordance with Test Method D1434 or specific methods for the gases of interest, as agreed upon between the purchaser and seller.

X1.1.5 *Odor*—When required, rate the film and sheeting odor as satisfactory or unsatisfactory when compared to an odor standard. The odor standard and test method shall be agreed upon between the purchaser and the seller.

X1.1.6 *Gloss*—Determine the gloss of polyethylene film and sheeting, when necessary, in accordance with Test Method D2457. Sample preparation and test method shall be agreed upon between the purchaser and the seller.

X1.1.7 *Transparency*—Determine the transparency, when required, in accordance with Test Method D1746. These specular transmittance data correlate with “see-through” clarity.

X1.1.8 *Flatness*—When required, rate the film or sheeting for degree of flatness. The test method and the degree of flatness shall be agreed upon between the purchaser and the seller.

X2. ALTERNATIVE TECHNIQUES FOR DETERMINATION OF AVERAGE THICKNESS

X2.1 *Thickness*—This method for thickness determination is to be used as a referee method for average thickness and is especially suitable for use in determining the average thickness for embossed film and sheeting. For routine testing or specification, standard dead weight methods shall be used.

X2.1.1 *Apparatus*—The apparatus shall consist of the following:

(1) Analytical Balance, equipped with pan straddle or other stationary support, sensitive to 0.0005 g,

(2) Class S Weights,

(3) Beaker, 250-mL,

(4) Fine Thread or Wire, nonabsorbent,

(5) Thermometer, 0 to 100°C, graduated in 1°C divisions,

(6) Die or Template, for cutting test specimens, 10 by 10 cm (3.9 by 3.9 in.), with dimensional tolerance of ±0.01 cm/side, and

(7) Sharp knife or Razor.

X2.1.2 *Test Specimens*—Test five 10 by 10-cm (3.9 by 3.9 in.) specimens taken uniformly across the width of the sheet.

X2.1.3 *Procedure*—By means of the die or template and the sharp knife or razor, cut five specimens from the sample of material. Weigh each specimen to the nearest 0.5 mg on the analytical balance. Record the weight as W. Determine the density of each specimen in accordance with Method A of Test Methods D792 or Test Method D1505, and record as D. Use of a wetting agent is recommended.

X2.1.4 *Calculation*—Calculate the average thickness of each test specimen, using the following formula, and average the five values:

$$T = 394W/100D = 3.94W/D \quad \text{(X2.1)}$$

where:

T = average thickness of test specimen, mils,

W = weight of test specimen, g,
D = density of test specimen, g/cm^3,
394 = conversion factor, cm to mils, and
100 = area of specimen, cm^2.

X2.2 *Average Thickness Based on Yield per Roll*—Calculate the average thickness based on yield per roll as follows:

$$\text{average thickness, mils} = \frac{2307 \times \text{net weight (lb)}}{\text{density} \times \text{length (ft)} \times \text{width (in.)}} \quad \text{(X2.2)}$$

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue, D2103 - 10, that may impact the use of this standard. (April 1, 2015)

(1) Removed withdrawn standard D374 from 2.1 and 8.8.
(2) Inserted Test Methods D5947 and Guide D6988 in 8.8.
(3) Included in Referenced Documents D1004, D5947, and D6988.
(4) Revised 8.1 and 8.2.
(5) Changed measurements in 8.4 (Impact Strength): 300 g changed to 2,000 g.
(6) Updated 8.5.
(7) Metric and English units were adjusted throughout the standard.

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