



Designation: D 5203 – 9802

Standard Specification for Polyethylene Plastics Molding and Extrusion Materials from Recycled Post-Consumer (HDPE) Sources¹

This standard is issued under the fixed designation D 5203; 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.

INTRODUCTION

This specification provides for the identification of post-consumer recycled high-density polyethylene plastics (HDPE) plastics molding and extrusion materials derived from specified sources. It provides for the identification of resin characteristics and certification so that the user and the supplier can agree on the acceptability of shipments of the plastic materials. This specification provides that the source of the materials be listed as an aid in identifying the material. The tests described in this specification are intended to provide additional information for identifying these materials.

¹ This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.125 on ~~Olefin Plastics~~. Thermoplastic Materials (Section D20.15.01).

Current edition approved April 10, 1998; 2002. Published December 1998; January 2003. Originally published as D 5203 – 91; approved in 1991. Last previous edition approved in 1998 as D 5203 – 938.

1. Scope *

1.1 This specification provides for the identification of recycled post-consumer HDPE molding and extrusion materials, from specified sources, in pellet or chip form so that the supplier and the user can agree on the acceptability of lots or shipments. This specification covers post-consumer HDPE materials from the following: (1) blow molded household chemical containers, (2) blow molded milk, juice, and water containers, (3) materials from the spunbonded process, (4) thermoformed packaged food containers and personal care packages, (5) injection molded packaged food containers and beverage bottle base cups, and (6) injection molded housewares and industrial articles such as pails, crates, totes, and pallets. Other post-consumer HDPE materials may be added to this specification when such material streams are characterized.

1.1.1 The tests described in this specification are intended to provide information for identifying these materials. The separation by sources improves the usefulness of the materials.

1.1.2 It is not the function of this specification to provide specific data for design purposes.

1.2 This specification provides a procedure to certify that the materials are from post-consumer sources.

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

1.4 The following precautionary caveat pertains only to the test method portion, Section 10, 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.*

NOTE 1—There are no ISO standards covering the primary subject matter of this specification.

2. Referenced Documents

2.1 ASTM Standards:

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing²

D 638 Test Method for Tensile Properties of Plastics²

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials²

D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement²

D 883 Terminology Relating to Plastics²

D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer²

² Annual Book of ASTM Standards, Vol 08.01.

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

- D 1505 Test Method for Density of Plastic by the Density-Gradient Technique²
- ~~D 1898 Practice for Sampling Plastics²~~
- ~~D 1928 Test Method for Preparation of Compression-Molded Polyethylene Test Sheets and Test Specimens²~~
- ~~D 2839 Practice for Use of Melt Index Strand for Determining Density of Polyethylene³~~
- D 3892 Practice for Packaging/Packing of Plastics³
- ~~D 4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets²~~
- D 4883 Test Method for Density of Polyethylene by the Ultrasound Technique⁴
- D 5033 Guide for Development of Standards Relating to the Proper Use of Recycled Plastics⁴
- ~~D 5577 Guide for Techniques to Separate and Identify Contaminants in Recycled Plastics⁴~~
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁵

3. Terminology

3.1 Definitions—The definitions of terms used in this specification are in accordance with Terminology D 883 and Guide D 5033.

3.2 *Descriptions of Terms Specific to This Standard:*

3.2.1 *nominal density*—the density of the unpigmented high-density polyethylene resin, which may differ from the apparent density of the material due to the addition of fillers or pigments to the resin.

3.2.2 *source*—the original end use of the HDPE materials described in this specification.

3.2.3 *spunbonded*—a method of fabrication wherein a material is bonded to form a sheet-like structure during the spinning process.

4. Ordering Information

4.1 The purchase order or inquiry for these materials shall state the specification number, date of issue and desired values for the items listed in Table 1.

4.2 Further definition as may be required for the items listed in Table 1 shall be on agreement between the user and the supplier.

4.3 It is recognized that some contaminants may result in an odor being present in the recycled material. The acceptability of the type and level of odor shall be as agreed upon by the user and supplier. Methods to evaluate odors in recycled materials are being developed elsewhere in the plastics industry.

5. General Requirements

5.1 The material shall be in the form of pellets or chips.

5.2 The material shall be as free of contamination as can be achieved by good manufacturing practice. If necessary, the level of contamination may be agreed upon between the user and the supplier. ~~NOTE 2—Tests~~

~~5.2.1 Guidance for measurement the separation and identification of contamination are under development. contaminants may be found in Guide D 5577.~~

5.3 The materials described in this specification are limited to high-density polyethylene from the sources indicated. Different end uses can be categorized as from the same source provided the physical properties of the HDPE meet the requirements specified in Table 1.

³ Annual Book of ASTM Standards, Vol 08.02.

⁴ Annual Book of ASTM Standards, Vol 08.03.

⁵ Annual Book of ASTM Standards, Vol 14.02.

TABLE 1 Specification Values

Property	Specification Value				
	Source A ^A	Source B ^A	Source C ^A	Source D ^A	Source E ^A
Melt Index ^B g/10 min	0.2 to 0.6	0.4 to 1.0	0.4 to 0.9	>20	4 to 20
Density (unpigmented) ^C g/cm ³	≤0.959	>0.958	≥0.955	0.956 to 0.962	0.956 to 0.962
Added antioxidant ^D or other stabilizer	Specify level	Specify level	Specify level	Specify level	Specify level
Tensile strength ^E MPa (psi)	14 (2030) min	20 (2900) min	20 (2900) min	17 (2500) min	17 (2500) min
Secant modulus ^F MPa (psi)	620 (89 900) min	670 (97 150) min	670 (97 150) min	620 (90 000) min	~R550 (80 000) min
Secant modulus ^F MPa (psi)	620 (90 000) min	670 (97 000) min	670 (97 000) min	620 (90 000) min	550 (80 000) min

^A See 5.3.

^B Melt index measured at condition 190/2.16 (see Test Method D 1238).

^C The apparent density of the pigmented resin may be different (usually higher) than the density of the unpigmented resin. Only the unpigmented density is listed in Table 1.

^D Test Method D 4883 may be useful as a measure of the base resin density of pigmented recycled HDPE material.

^E The seller must specify the amount of antioxidant or other stabilizer added, if any, to repelletized material.

^F Type IV tensile bars tested at 50.8 mm/min (2 in./min) (see Test Method D 638).

^F Secant modulus at approximately 2 % strain using Method 1, Procedure B with 50.8-mm (2-in.) span on 3.2 by 12.7-mm (0.125 by 0.5-in.) specimens. (See Test Method D 790.)

5.3.1 *Source A*—Post-consumer blow molded or thermoformed HDPE containers, usually from household chemicals, packaged food, or personal care packages.

5.3.2 *Source B*—Post-consumer blow molded HDPE containers usually from milk, juice, and water containers.

5.3.3 *Source C*—Post-consumer HDPE items that have been fabricated from spunbonded materials.

5.3.4 *Source D*—Post-consumer injection molded articles, usually from packaged food containers and beverage base cups.

5.3.5 *Source E*—Post-consumer injection molded articles, usually from housewares and industrial articles such as pails, crates, totes, and pallets.

6. Physical Properties

6.1 Test specimens of the materials shall conform to the requirements prescribed in Section 8 and tested as described in Section 10.

6.2 Observed or calculated values obtained from analysis, measurement or test, shall be rounded as specified in Practice E 29. Round to the nearest unit in the last right-hand place of figures used in expressing the specified limiting value. The value obtained is compared directly with the specified limiting value. Conformance or nonconformance with the specification is based on this comparison.

7. Sampling

7.1 The materials shall be sampled ~~in accordance with Practice D 1898~~, using adequate statistical sampling techniques. Adequate statistical sampling shall be considered as an acceptable alternative. Procedures to ensure sample homogeneity should be part of the sampling plan. A batch or lot of resin shall be considered as a unit of manufacture as prepared for shipment and may consist of a blend of two or more production runs of material.

8. Specimen Preparation

8.1 Test specimens shall be molded in accordance with Procedure C of ~~Test Method D 1928~~, Annex A1 of Practice D 4703. If the material is known to be homogenous or has been melt blended, milling, prior to compression molding, is not required except in reference situations.

8.2 The molded sheet thickness shall be 1.9 ± 0.2 mm (0.075 ± 0.008 in.) for tensile testing or 3.2 ± 0.3 mm (0.125 ± 0.012 in.) for flexural modulus testing.

8.3 The mechanical test specimen shall be prepared in accordance with requirements in Test Methods D 638 and D 790.

9. Conditioning

9.1 ~~Conditioning—Once specimens are molded, they shall be moved to a standard laboratory atmosphere or a controlled laboratory atmosphere. For natural unfilled polyethylene plastics the test methods controlled laboratory atmosphere shall be $23 \pm 2^\circ\text{C}$. Test specimens, 7 mm or under in this specification, thickness, shall be conditioned for a minimum of 40 h immediately prior to testing. Test specimens over 7 mm in thickness shall be conditioned for 88 h. For filled and reinforced polyethylene plastics or polyethylene plastic blends, which contain a hydrophilic co-monomer, pigment, or modifier the molded test specimens shall be conditioned in accordance with Procedure A a standard laboratory atmosphere of $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ relative humidity (see Practice D 618, Procedure A). For all materials to be conditioned for electrical testing, conditioning shall comply with the requirements of the standard test methods for electrical testing. In all cases the laboratory shall report both the temperature and humidity conditions during the conditioning period.~~

9.2 ~~Test Conditions—Conduct all tests following the standard laboratory atmosphere of $23 \pm 2^\circ\text{C}$ same criteria for temperature and $50 \pm 5\%$ relative humidity. humidity as specified for conditioning in 9.1.~~

10. Test Methods

10.1 Determine the properties enumerated in this specification in accordance with the ASTM test methods as they apply, unless otherwise stated herein.

10.1.1 *Melt Index*—Use Test Method D 1238, Condition 190/2.16. Make duplicate determinations on the material.

NOTE 32—Although the flow rate of polyethylene plastics may be measured under any of the conditions listed for it in Table 1 of Test Method D 1238, only Condition 190/2.16 may be identified as “melt index.”

10.1.2 *Nominal Density*—Test Method D 1505 or alternative test methods of suitable accuracy as described in Test Method D 792. Make duplicate determinations using two separate portions of the same or two different moldings.

10.1.3 *Tensile Strength*—Use Test Method 638, except that the speed-of-grip separation shall be 50.8 mm (2 in.)/min. Specimens shall conform to dimensions given for Type IV in Test Method D 638. Their thicknesses shall be 1.9 ± 0.2 mm (0.075 ± 0.008 in.). Specimens shall be either die cut or machined to the specified dimensions. Gage-length shall be 25.40 ± 0.38 mm (1.000 ± 0.015 in.) and initial-grip-separation shall be 62.5 ± 5 mm (2.5 ± 0.2 in.). Test results for specimens that break outside the gage marks need not be discarded unless the break occurs between the contact surfaces of a grip.

10.1.4 *Secant Modulus of Elasticity in Bending*—Use Test Method D 790, Method I Procedure B with a 50.8-mm (2-in.) span, and using a testing speed of 12.7 mm/min. (0.5 in./min.). Test specimens each 3.2 by 12.7 mm (0.125 by 0.5 in.) flatwise and calculate the average value of the secant modulus at 2 % strain in the outer fibers.

10.1.4.1 Calculate the deflection of the test specimen corresponding to 2 % strain (0.02 mm/mm) as follows:

$$D = rL^2/6d \quad (1)$$

where:

D = deflection of the center of the beam test specimen at 2 % strain,

r = strain in the outer fiber = 0.02 mm/mm,

L = test span = 50.8 mm (2 in.), and

d = measured specimen depth.

10.1.4.2 Calculate the stress corresponding to 2 % strain as follows:

$$S = 3PL/2bd^2 \quad (2)$$

where:

S = stress in the outer fiber at 2 % strain, MPa, (psi),

P = load corresponding to 2 % strain, N, (lb),

L = test span = 50.8 mm (2 in.),

d = measured specimen depth, and

b = measured specimen width.

The secant modulus at 2 % strain is the ratio of stress to strain or $S/0.02$.

NOTE 43—The tangent modulus of elasticity in bending approximates the secant modulus of elasticity in bending. Generally, however, the secant modulus is lower. The tangent modulus is considered less reproducible due to the inability to construct consistent tangents to the steepest initial straight-line portions of the stress-strain curves.

11. Inspection and Certification

11.1 Inspection and certification of the material shall be made for conformance to the requirements specified herein.

11.2 The supplier shall provide a written certification with each shipment that the chips or pellets are derived from post-post-consumer sources. The source of these materials, as specified in 5.3, shall be identified in the certification.

11.3 Certification shall be that the material was processed, sampled, tested, and inspected in accordance with this specification and that the average values meet the requirements at a confidence level of 95 %.

11.4 Lot acceptance inspection shall be the basis on which acceptance or rejection of the lot is made. The lot acceptance inspection shall consist of those tests that ensure process control as well as those necessary to ensure certifiability in accordance with 11.3.

11.5 Periodic check/inspection shall consist of the tests specified for all material requirements under this specification.

12. Packaging and Package Marking

12.1 For packing and packaging, the provisions of Practice D 3892 shall apply.

13. Keywords

13.1 blow-molding; HDPE; injection molding; molding and extrusion materials; polyethylene; post-consumer material; recovered material; recycled; spunbonded; thermoforming

SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification. For the convenience of the user, Committee D-20 has highlighted those changes that may impact the use of this specification. This section may also include descriptions of the changes or reasons for the changes, or both.

D 5205 – 02:

(1) Changed subcommittee jurisdiction.

(2) Updated the referenced documents, and made appropriate corrections throughout the specification to reflect these changes.

(3) Section 9 was changed to reflect recent changes in Specification D 4976.

(4) Table 1 was updated.

D 5205 – 98:

(1) Inclusion of Practice D 2839 in the Referenced Documents section.

(2) Clarification of odor level statement.

(3) The current wording describing Source A in 5.3.1 is somewhat restrictive as blow molded containers meeting the requirements are available from sources other than household chemical containers, that is, food and personal care containers. The proposed wording intends to better define and broaden the available sources.

(4) As written, 8.1, specimen preparation, requires samples to be milled and references Test Method D 1928. In Test Method D 1928, the need for milling is treated as a footnote as pressing directly from pellets is acceptable. An addition is proposed to allow pressing directly from pellets if it is known the samples are homogeneous.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).