Designation: D 2581 – 02

Standard Classification System for Polybutylene (PB) Plastics Molding and Extrusion Materials[1]

This standard is issued under the fixed designation D 2581; 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.

1. Scope *

1.1 This classification system covers polybutylene plastics materials suitable for molding and extrusion.

1.2 This classification system allows for the use of those polybutylene plastic materials that can be recycled, reconstituted, and reground, provided the following conditions are met:

1.2.1 The requirements as stated in this classification system and other guideline pertaining to these materials are met, and

1.2.2 The material has not been modified in any way to alter its conformance to water contact regulations or other similar requirements.

1.3 The proportions of recycled, reconstituted, and regrind material used, as well as the nature and the amount of any contaminant, cannot be practically covered in this classification system. It is the responsibility of the supplier and buyer of recycled, reconstituted, and regrind materials to ensure compliance.

1.4 The properties included in this classification system are those required to characterize and classify the specific product. Other properties may be necessary to identify particular characteristics important to specialized applications. These may be specified by using suffixes as given in Section 5. Properties shall be selected in such a manner that consistency of different lots or shipments is assured. The tests involved in this classification system are intended to provide information for identifying materials in accordance with types and categories. It is not the function of this classification system to provide specific engineering data for design purposes.

1.5 This classification system and subsequent line callout (specification) are intended to provide a means of calling out plastic materials used in the fabrication of end items or parts. It is not intended for the selection of materials. Material selection should be made by those having expertise in the plastic field after careful consideration of the design and the performance required of the part, the environment to which it will be exposed, the fabrication process to be employed, the costs involved, and the inherent properties of the material other than those covered by this standard.

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

NOTE 1—ISO 8986 Parts 1 and 2 resemble this standard in title, but their content is significantly different.

1.7 The following precautionary caveat pertains only to the test methods portion, Section 11, of this classification system: *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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 618 Practice for Conditioning Plastics for Testing[2]
D 638 Test Method for Tensile Properties of Plastics[2]
D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement[2]
D 883 Terminology Relating to Plastics[2]
D 1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer[2]
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique[2]
D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]
D 1603 Test Method for Carbon Black in Olefin Plastics[2]
D 3892 Practice for Packaging/Packing of Plastics[3]
D 4000 Classification System for Specifying Plastic Materials[3]
D 5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics[4]
E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[5]
E 105 Practice for Probability Sampling of Materials[5]

[1] This classification system is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.12 on Olefin Plastics.

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[2] *Annual Book of ASTM Standards*, Vol 08.01.
[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.

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

F 699 Practice for Accelerated Conditioning of Polybutylene Pipe and Tubing for Subsequent Quality Control Testing[6]

2.2 *Military Standard:*

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes[7]

3. Terminology

3.1 Except for the terms defined below, the terminology used in this classification system is in accordance with Terminologies D 883 and D 1600.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *internal recycled material*—clean rework material generated from the manufacturer's own resin production.

3.2.2 *polybutylene plastics*—plastics prepared by the polymerization of no less than 85 % butene-1 and no less than 95 % of total olefins by weight.

4. Classification

4.1 This classification system recognizes that polybutylene plastics are identified on the basis of two characteristics, that is, density and flow rate. The former is the criterion for assignment as to type, the latter for designation as to category.

4.2 *Types*—This classification system provides for three types of polybutylene molding and extrusion materials in accordance with the requirements in Table 1. Material supplied under these types shall be of such nominal density, within the ranges given.

4.3 *Categories*—This classification system provides for six grades of polybutylene on the basis of flow rate ranges in accordance with the requirements of Table 2. Material supplied under these grades shall be of such nominal flow rate, within the ranges given.

4.4 *Classes*—Each of the three types is subdivided into three classes, in accordance with use and composition, as follows:

4.4.1 *Class A*—General-purpose and dielectric, unpigmented.

4.4.2 *Class B*—General-purpose and dielectric, in colors (including black and white).

4.4.3 *Class C*—Weather-resistant (black) containing not less than 2 % carbon black. The carbon black shall be of a kind and particle size (Note 2), and dispersed by such means and to such degree, as agreed upon between the manufacturer and the purchaser.

[6] *Annual Book of ASTM Standards*, Vol 08.04.

[7] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

TABLE 1 Classification of Polybutylene Molding and Extrusion Materials According to Type

Type	Density Range, (kg/m^3) g/cm^3
I	0.905 to 0.909
II	> 0.909 to 0.920
II, colored and filled	0.920 to 0.950

TABLE 2 Classification of Polybutylene Molding and Extrusion Materials According to Category

Category	Flow Rate, g/10 min
0	< 0.25
1	≥ 0.25 to 0.75
2	> 0.75 to 2.5
3	> 2.5 to 10
4	> 10 to 25
5	> 25

NOTE 2—Carbon black, 20 nm or less in average particle diameter, is used, as required, in black electrical and jacketing materials to impart maximum weather resistance.

4.5 Material in any of the preceding three classes may be supplied with or without any antioxidant or other additive as appropriate.

5. Suffixes

5.1 When additional requirements are needed that are not covered by the basic requirements or cell-table requirements, they shall be indicated through the use of suffixes.

5.2 A list of suffixes can be found in Classification System D 4000 (Table 3) and may be used for additional requirements as appropriate. Additional suffixes will be added to that standard as test methods and requirements are developed and requested.

6. General Requirements

6.1 Basic requirements from the property tables are always in effect unless superseded by specific suffix requirements, which always take precedence.

6.2 The compound, in the form of molding powder, granules, or pellets, shall be of uniform composition and so formulated as to conform to the requirements of this classification system.

6.3 The compound shall be as free of foreign matter as can be achieved by good manufacturing practice and as appropriate for the application.

7. Detail Requirements

7.1 *Extrusion and Molding Compound*—Molded test specimens shall conform to the requirements prescribed for the particular type and category in Table 1, Table 2, and Table 3 and suffix requirements as they apply.

7.2 For purposes of determining conformance, all specified limits for the specification (line callout) based on this classification system are absolute limits, as defined in Practice E 29.

7.2.1 With the absolute method, an observed value or a calculated value is not rounded, but is compared directly with the limiting value. Conformance or nonconformance is based on this comparison.

8. Sampling

8.1 The compound shall be sampled in accordance with the sampling procedure described in Practice E 105. Adequate statistical sampling prior to packaging shall be considered an acceptable alternative. Sampling shall be statistically adequate to satisfy the requirements of 12.4.

TABLE 3 Detail Requirements for Polybutylene Molded Test Specimens

Property	Type I	Type II	Type II, Colored and Filled
Tensile strength, min, MPa (psi)	20.7 (3000)	20.7 (3000)	20.7 (3000)
Yield strength, min, MPa (psi)	10.3 (1500)	13.8 (2000)	13.8 (2000)
Elongation at break, min, %	300	300	280

8.2 A batch or lot of molding material 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.

9. Specimen Preparation and Number of Tests

9.1 Unless otherwise specified, test specimens shall be compression-molded under conditions recommended by the manufacturer.

9.2 One set of test specimens, as prescribed in the test methods cited in Section 11, shall be considered sufficient for testing each batch or lot. The average result for the specimens tested shall conform to the requirements prescribed in this classification system.

10. Conditioning

10.1 *Conditioning*—240/23/50-molded test sheets shall be held at 23 ± 20°C (73.4 ± 3.60°F) and 50 ± 5 % relative humidity for 10 days prior to the performance of any test. Test specimens shall be cut after this aging period.

NOTE 3—For pipe and tubing applications an accelerated conditioning technique may be applied to bring the polybutylene to a stable state for quality control testing. Applying hydrostatic pressure transforms the polybutylene from the unstable Type II crystalline structure to the stable Type I crystalline structure. Details of this conditioning technique are addressed in Practice F 699.

10.2 *Test Conditions*—Tests shall be conducted in the standard laboratory atmosphere of 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity as defined by Practice D 618.

11. Test Methods

11.1 The properties enumerated in this classification system shall be determined in accordance with the following test methods:

11.1.1 *Density*—Test Method D 1505 or Test Methods D 792.

11.1.2 *Flow Rate*—Test Method D 1238, using Condition 190/2.16. It may be necessary to dry samples containing carbon black before running this test, if reproducible results are to be obtained. The manufacturer's recommendation should be followed.

11.1.3 *Tensile Properties*—Test Method D 638, 500 mm (20 in.)/min. Specimens shall conform to the dimensions given for Type IV in Test Method D 638, with their thicknesses to be 1.9 ± 0.2 mm (0.075 ± 0.008 in.). Bench mark separation shall be 25.40 ± 0.38 mm (1.000 ± 0.015 in.). Percentage elongation at break shall include the cold drawing distance. Test results for specimens that break outside the gage marks after extensive cold drawing need not be discarded unless the break occurs between the contact surfaces of a grip.

11.1.4 *Carbon Black Content*—Test Method D 1603.

12. Inspection

12.1 Inspection and certification of the material supplied with reference to a specification based on this classification system shall be for conformance to the requirements specified herein.

12.2 Lot-acceptance inspection shall be on the basis on which acceptance or rejection of the lot is made. The lot-acceptance inspection shall consist of:

12.2.1 Density
12.2.2 Melt Flow Rate
12.2.3 Tensile Strength
12.2.4 Tensile Stress at Yield
12.2.5 Tensile Elongation at Break

12.3 Periodic check inspection with reference to a specification based on this classification system shall consist of the tests for all requirements of the material under the specification. Inspection frequency shall be adequate to ensure the material is certifiable in accordance with 12.4.

12.4 Certification shall be that the material was manufactured by a process in statistical control, sampled, tested, and inspected in accordance with this classification system, and that the average values for the lot meet the requirements of the specification (line callout).

12.5 A report of test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment and the percent by weight of recycled plastic, as defined in 3.1 of Guide D 5033, if requested.

13. Packaging and Package Marking

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

13.2 *Marking*—Unless otherwise agreed upon between the manufacturer and the purchaser, shipping containers shall be marked with the name of the material and its manufacturer, type, quantity contained, the manufacturer's lot number, and the number of the order.

13.3 The provisions of Practice D 3892 apply to packaging, packing, and marking of containers for plastic materials.

14. Keywords

14.1 classification system; line callout; polybutylene; recycled; specification

QUALITY ASSURANCE PROVISIONS FOR GOVERNMENT/MILITARY PROCUREMENT

SUPPLEMENTARY REQUIREMENTS

These requirements apply *only* to federal/military procurement, not domestic sales or transfers.

S2. Selection of Acceptable Quality Level (AQL) and of Inspection Level (IL) shall be made, with consideration of the specific use requirements. This is discussed in the sections on Means and Standard Deviations and Comparison of Sampling Plans of the above document, with reference to MIL-STD-105.

S3. In the absence of contrary requirements, the following values shall apply:

	IL	AQL
Defects of appearance and workmanship	II	2.5
Defects of preparation for delivery	S-2	2.5
Testing (products)	S-1	1.5
Testing (polymer, unfabricated)	S-1[A]	...

[A] Samples shall be drawn from the required number of units and pooled for preparation of molded samples for mechanical properties evaluation.

SUMMARY OF CHANGES

This section identifies the location of selected changes to this classification system. For the convenience of the user, Committee D20 has highlighted those changes that may impact the use of this classification system. This section may also include descriptions of the changes or reasons for the changes, or both.

D 2581 – 02:
(*1*) Revised 1.1.
(*2*) Added 1.2, 1.2.1, 1.2.2, 1.3, 1.4, and 1.5.
(*3*) Renumbered 1.2 to 1.6.
(*4*) Edited Note 1.
(*5*) Renumbered 1.3 to 1.7.
(*6*) Added D 883, D 1600, D 4000, E 29, and F 699 to Section 2.
(*7*) Added 3.1.
(*8*) Renumbered 3.1 to 3.2.
(*9*) Reworded 4.2, 4.3, and 4.5.
(*10*) Added Section 5 Suffixes.
(*11*) Renumbered Section 5 to Section 6.
(*12*) Added 6.1.
(*13*) Renumbered 5.1 to 6.2.
(*14*) Renumbered 5.2 to 6.3.
(*15*) Reworded 6.3.
(*16*) Renumbered Section 6 to Section 7.
(*17*) Renumbered 6.1 to 7.1.
(*18*) Moved 6.2 to 9.1.
(*19*) Added 7.2 and 7.2.1.
(*20*) Renumbered Section 7 to Section 8.
(*21*) Renumbered 7.1 to 8.1 and revised.
(*22*) Renumbered Section 8 to Section 9.
(*23*) Added 9.1.
(*24*) Renumbered 8.1 to 9.2.
(*25*) Renumbered Section 9 to Section 10, as well as changed title fro Test Methods to Conditioning.
(*26*) Added Note 3 to Section 10.
(*27*) Moved 9.1 to 11.1.
(*28*) Renumbered 9.1.1 to 10.1.
(*29*) Renumbered 9.1.2 to 10.2.
(*30*) Renumbered Section 9 to Section 11.
(*31*) Renumbered 9.1.3 to 11.1.1, 9.1.4 to 11.1.2, 9.1.5 to 11.1.3, and 9.1.6 to 11.1.4.
(*32*) Renumbered Section 10 to Section 12.
(*33*) Deleted 10.1.
(*34*) Added 12.1 to 12.5.
(*35*) Renumbered Section 11 to Section 13.
(*36*) Renumbered 11.1 to 13.1 and 11.2 to 13.2.
(*37*) Renumbered 11.3 to 13.3 and revised the wording.
(*38*) Renumbered Section 12 to Section 14.
(*39*) Added two additional keywords to Section 14.
D 2581 – 01:
(*1*) Revised ISO equivalency statement.
(*2*) Deleted all references to Practice D 1898 and replaced it with Practice E 105.
(*3*) Deleted S1 in the Quality Assurance Provisions for Government/Military Procurement section.
(*4*) Revised density values and units in Table 1 and Table 3.