Designation: D2581 – 09

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

This standard is issued under the fixed designation D2581; 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 is applicable to all butene homopolymers and to copolymers of butene with a maximum content of other 1-olefinic monomers of less than 50 % and with a content of non-olefinic monomers with functional groups up to a maximum of 1 %.

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

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

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

1.4 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.

1.5 The properties included in this classification system are those required to characterize and classify the specific product. Other properties are necessary to identify particular characteristics important to specialized applications. These are 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.

1.6 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 is to 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.

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

NOTE 1—This standard, ISO 8986-1, and ISO 8986-2 address the same subject matter, but differ in technical content.

1.8 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:*[2]

C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

D495 Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation

D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents

D570 Test Method for Water Absorption of Plastics

[1] This classification system is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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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**

D618 Practice for Conditioning Plastics for Testing
D635 Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
D638 Test Method for Tensile Properties of Plastics
D648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
D696 Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer
D732 Test Method for Shear Strength of Plastics by Punch Tool
D746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D883 Terminology Relating to Plastics
D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
D1505 Test Method for Density of Plastics by the Density-Gradient Technique
D1525 Test Method for Vicat Softening Temperature of Plastics
D1600 Terminology for Abbreviated Terms Relating to Plastics
D1603 Test Method for Carbon Black Content in Olefin Plastics
D2240 Test Method for Rubber Property—Durometer Hardness
D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
D2990 Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
D3418 Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry
D3801 Test Method for Measuring the Comparative Burning Characteristics of Solid Plastics in a Vertical Position
D3892 Practice for Packaging/Packing of Plastics
D3895 Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
D4000 Classification System for Specifying Plastic Materials
D4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
D5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics (Withdrawn 2007)[3]
D5279 Test Method for Plastics: Dynamic Mechanical Properties: In Torsion
D5630 Test Method for Ash Content in Plastics
D6110 Test Method for Determining the Charpy Impact Resistance of Notched Specimens of Plastics
D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products (Withdrawn 2015)[3]
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E105 Practice for Probability Sampling of Materials
E831 Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis
F699 Practice for Accelerated Conditioning of Polybutylene Pipe and Tubing for Subsequent Quality Control Testing (Withdrawn 2005)[3]

2.2 *ISO Standards:*
ISO 62 Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis
ISO 75-1 Plastics—Determination of Temperature of Deflection under Load—Part 1: General Test Method
ISO 75-2 Plastics—Determination of Temperature of Deflection under Load—Part 2: Plastics and Ebonite
ISO 178 Plastics—Determination of Flexural Properties
ISO 179 Plastics—Determination of Charpy Impact Properties—Part 2: Instrumented Impact Test
ISO 293 Plastics Compression Moulding of Test Specimens of Thermoplastic Materials
ISO 527-1 Plastics—Determination of tensile properties—Part 1: General Principles
ISO 527-2 Plastics—Determination of Tensile Properties—Part 2: Test Conditions for Moulding and Extrusion Plastics
ISO 604 Plastics—Determination of Compressive Properties
ISO 868 Plastics and Ebonite—Determination of Indentation Hardness by Means of a Durometer (Shore Hardness)
ISO 899-1 Plastics—Determination of Creep Behaviour—Part 1: Tensile Creep
ISO 899-2 Plastics—Determination of Creep Behaviour—Part 2: Flexural Creep by Three-Point Loading
ISO 1133 Plastics—Determination of The Melt Mass-Flow Rate (MFR) and The Melt Volume-Flow Rate (MVR) of Thermoplastics
ISO 1183-1 Plastics Methods for Determining the Density of Non-Cellular Plastics Part 1: Immersion Method, Liquid Pyknometer Method and Titration Method
ISO 1183-2 Plastics Methods for Determining the Density of Non-Cellular Plastics Part 2: Density Gradient Column Method
ISO 1628-3 Plastics—Determination of the Viscosity of Polymers in Dilute Solution Using Capillary Viscometers—Part 3: Polyethylenes and Polypropylenes-Second Edition
ISO 3451-1 Plastics—Determination of Ash—Part 1: General Methods
ISO 4589-2 Plastics—Determination of Ash—Part 1: General Methods
ISO 8256 Plastics—Determination of Tensile-Impact Strength
ISO 8986-1 Plastics—Polybutene (Pb) Moulding and Extrusion Materials—Part 1: Designation System and Basis for Specifications

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

ISO 8986-2 Plastics—Polybutene (Pb) Moulding and Extrusion Materials—Part 1: Preparation of Test Specimens and Determination of Properties
ISO 10350 Plastics—Acquisition and Presentation of Comparable Single-Point Data—Part 1: Moulding Materials
ISO 11357-2 Plastics—Differential Scanning Calorimetry (DSC)—Part 2: Determination of Glass Transition Temperature crystallization
ISO 11403-1 Plastics—Acquisition and Presentation of Comparable Multipoint Data—Part 1: Mechanical Properties
ISO 15876 Plastics Piping Systems for Hot and Cold Water Installations—Polybutylene (Pb)—Part 1: General

2.3 *IEC Standards:*
IEC 60093 Methods of Test for Volume Resistivity and Surface Resistivity of Solid Electrical Insulating Materials
IEC 60112 Method for Determining the Comparative and the Proof Tracking Indices of Solid Insulating Materials under Moist Conditions
IEC 60243-1 Electrical Strength of Insulating Materials—Test Methods—Part 1: Tests at Power Frequencies
IEC 60250 Recommended Methods for the Determination of the Permittivity and Dielectric Dissipation Factor of Electrical Insulating Materials at Power, Audio and Radio Frequencies Including Metre Wavelengths
IEC 60695-11-10 Fire hazard testing Part 11-10: Test flames 50 W horizontal and vertical flame test methods

2.4 *Military Standard:*
MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes[4]

3. Terminology

3.1 Except for the terms defined below, the terminology used in this classification system is in accordance with Terminologies D883 and D1600.

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.

3.2.3 *polybutene-1 plastics*—plastics prepared by the polymerization of isobutene using Zeigler-Natta catalyst

3.2.4 *thermoplastic butene block copolymer*—plastic having not more than 50% of another olefinic monomer (or monomers) dispersed in discreet, linear sequences along the polymer chain and having no functional group other than the olefinic group, copolymerized with butane

3.2.5 *thermoplastic butane random copolymer*—plastic having not more than 50% of another olefinic monomer (or monomers) dispersed randomly along the polymer chain and having no functional group other than the olefinic group, copolymerized with butene.

[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

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

Type	Density Range, (kg/m^3) g/cm^3
I	0.890 to 0.909
II	> 0.909 to 0.950
II, filled	dependent on type and amount of filler

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.

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 are to 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 are found in Classification System D4000 (Table 3) and are to 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.

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

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 E29.

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 E105. Adequate statistical sampling prior to packaging shall be considered an acceptable alternative. Sampling shall be statistically adequate to satisfy the requirements of 12.4.

8.2 A batch or lot of molding material shall be considered as a unit of manufacture as prepared for shipment. A blend of two or more production runs of material is also considered a unit of manufacture.

9. Specimen Preparation and Number of Tests

9.1 The material shall be kept in moisture-proof containers until it is required for molding.

9.2 Test specimens shall be compression-molded in accordance with D4703 or ISO 293 using the conditions specified in Table 4. It is essential that the specimens are always prepared by the same procedure using the same processing conditions to ensure consistent mechanical property test results. Molding conditions are dependent on the type of mold design used, either a frame mold or a positive mould.

9.3 The preheating time of the material in the mold depends on the type of mold and the type of heating. For frame molds, 5 min. is usually sufficient, but for positive molds, due to the larger mass, a preheating time of up to 15 min is necessary, especially if electric heating is used.

9.4 The average cooling rate of the mold is 30°C/min.

NOTE 3—Since only the average cooling rate is defined the actual cooling rate during crystallization is not fixed. This can lead to significant deviations in properties related to crystallinity such as density and mechanical properties and must be considered when comparing data from different sources.

9.5 When a frame mold is used it is necessary to start cooling while simultaneously applying full pressure. This avoids the melt being pressed out of the frame and minimizes sink marks.

9.6 Test specimens required for the determination of the properties shall be machined or punched out of the compression molded sheet only after the conditioning step has been completed.

9.7 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*—Molded test sheets shall be held at 23 ± 2°C (73.4 ± 3.60°F) and 50 ± 10 % relative humidity for the period of time necessary to observe no further change of properties.

NOTE 4—The use of accelerated aging at elevated pressure is allowed if it is demonstrated that the test results are reproducible and equivalent to those obtained on specimens aged at atmospheric pressure.

NOTE 5—In some cases for pipe and tubing applications an accelerated conditioning technique is 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 F699 - 00.

NOTE 6—Because of the slow crystallization, transformation, and shrinkage which takes place after polybutene-1 plastics are cooled from the melt, it is necessary to delay mechanical testing after extrusion or molding until the morphological transition in crystalline structure is completed.

10.2 *Test Conditions*—Tests shall be conducted in the standard laboratory atmosphere of 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity as defined by Practice D618.

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 D1505 or Test Methods D792.

11.1.2 *Flow Rate*—Test Method D1238, using Condition 190/2.16. It will be necessary to dry samples containing carbon black before running this test, if reproducible results cannot be obtained. The manufacturer's recommendation are to be followed.

11.1.3 *Tensile Properties*—Test Method D638, 500 mm (20 in.)/min. Specimens shall conform to the dimensions given for Type IV in Test Method D638, 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

TABLE 3 Detail Requirements for Polybutylene Molded Test Specimens

Property	Type I	Type II	Type II, 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

TABLE 4 Conditions for Compression Molding of Test Specimens

Material	Molding Temperature (°C)	Average Cooling Rate (°C/min)	Demoulding Temperature (°C)	Full Pressure (MPa)	Full Pressure Time (min)	Preheating Pressure (MPa)	Preheating Time (min)
All Grades	200	30	30 ± 5	5/10[A]	5 ± 1	Contact	5 to 15

[A]Use 5 MPa for frame mold and 10 MPa for positive mold.

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 D1603.

11.2 Tables 5 and 6 list additional properties, ASTM and ISO test method and test conditions for testing polybutylene plastics.

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 D5033, 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 D3892 apply to packaging, packing, and marking of containers for plastic materials.

14. Keywords

14.1 classification system; line callout; polybutylene; polybutene-1; recycled; specification

TABLE 5 ASTM General Properties and Test Conditions for Testing of Polybutylene

Number	Property	Standard Test Method	Specimen Type Dimensions, mm	Processing Method	Units	Test Conditions and Supplementary Instructions
1.	Rheological properties					
1.1	Melt flow rate	D1238	Granules or powder		g/10 min	Test temperature 190°C, 2.16 kg load
2.	Mechanical properties					
2.1	Tensile stress at yield	D638	Type IV, thickness = 1.9	Compression	MPa	Test at 500 mm/
2.2	Tensile elongation at yield				%	
2.3	Tensile modulus				MPa	Speed of 5 mm/min with Class B-2 or better extensometer

TABLE 5 *Continued*

Number	Property	Standard Test Method	Specimen Type Dimensions, mm	Processing Method	Units	Test Conditions and Supplementary Instructions
2.4	Tensile creep modulus	D2990	Type I, thickness = 3.2	Compression	MPa	At room temperature and at least two elevated temperatures for 1000 h at three stress levels
2.5	Flexural modulus	D790	Center of Type I bar, 63.5 by 12.7 by 3.2	Compression	MPa	1 % secant, 50 mm span, 1.3 mm/min speed 5 ± 0.1 mm radius support rods and loading nose at yield, if yield occurs at less than 5 % strain, otherwise report value at 5 %
2.6	Flexural strength				MPa	
2.7	Flexural creep modulus	D2990	Center of Type I bar, 63.5 by 12.7 by 3.2	Compression	MPa	At room temperature and at least two elevated temperatures for 1000 h at three stress levels
2.8	Shear strength	D732	50 disk or 50 by 50 by 50 square with thickness of 3.2	Compression	MPa	Speed 1.3 mm/min
2.9	Shear modulus	D5279	76 by 13 by 3.2	Compression	Pa	-150°C to Tg+20°C or Tm+10°C @ 1 Hz
2.10	Charpy impact resistance	D6110	127 by 12.7 by 3.2	Compression	PaJ/m	
2.11	Shore A or D hardness	D2240	Minimum 25 by 25 square by 6 or 25 diameter disk by 6 thick	Compression	Shore A or D	Shore A or D scale (thickness of specimen is achieved by plying specimens or thinner specimens is used if hardness is shown not to be changed). Values at 1 s.
3.	Thermal properties					
3.1	Melting temperature	D3418	Any material form		°C	DSC/DTA at 10/°C
3.2	Heat deflection temperature	D648	127 by 13 by 3.2	Compression	°C	1820 kPa stress.
3.3	Vicat softening temperature	D1525	Minimum 12 by 12 by 3 square or 12 diameter disk	Compression	°C	455 kPa stress. Rate A, 50°C/h
3.4	Coefficient of linear thermal expansion	D696	Between 50 and 120 length, other dimensions depend on test apparatus	Compression	mm/(m·°C)	Dilatometer, between -30° and +30°C (use E228 for temperatures other than -30 and +30°C)
		E831	Between 2 and 10 length and less than 10 lateral dimension	Compression	mm/(m·°C)	Report over ranges from -30 to 0°C, 0 to +30°C, and +30 to +60°C
3.5	Thermal conductivity	C177	Depends on test apparatus	Compression	cal/s/cm^2/°C/cm	
3.6	Brittleness temperature	D746	Length minimum 20 + minimum 5 in clamp by 6.35 by 1.91	Compression	°C	Procedure A
3.7	Flammability	D635	127 by 12.7 by 3.2	Compression	mm/min	
		D2863	127 by 6.5 by 3.2	Compression	%	
		D3801	127 by 12.7 by 3.2	Compression	s	Generate rating based on burning time and glow time
4.	Electrical properties					
4.1	Volume resistivity	D257	100 by 100 by 3.2 square or 100 diameter disk by 3.2	Compression	Ohm·cm	Electrification for 60 s with applied voltage of 500 V

TABLE 5 *Continued*

Number	Property	Standard Test Method	Specimen Type Dimensions, mm	Processing Method	Units	Test Conditions and Supplementary Instructions
4.2	Dielectric strength	D149	100 by 100 by 3.2 square or	Compression	kV/mm	Method A—short time
			100 diameter disk by 3.2			Method B—step by step
4.3	Dielectric constant	D150	100 by 100 by 3.2 square or 100 diameter disk by 3.2	Compression		Test at 1 MHz
4.4	Dissipation factor					
4.5	Arc resistance	D495	Dependent on test apparatus, thickness 3.2	Compression	s	
5.	Other					
5.1	Water absorption	D570	50.8 by 3.2 disk	Compression	%	24 h immersion at ambient temperature
		D543	50.8 by 3.2 thick disk or	Compression	%	Disk for weight and dimensional changes
5.2	Chemical resistance		Type I bar, 3.2 thickness	Compression	%	Type IV for mechanical properties retention, 7 day immersion
5.3	Density	D792	37 by 12.7 by 3.2	Compression	kg/m^3	
		D1505	Extrudate from MFR test		kg/m^3	
5.4	Ash	D5630	Granules or pellets		%	
5.5	Oxidative Induction Time	D3895	Granuales or pellets		Min	Isothermal method at 220°C
5.6	Carbon Black Content	D1603	Granuales or Pellets		%	

TABLE 6 ISO General Properties and Test Conditions for Testing of Polybutylene

Number	Properties	Standard	Specimen Type, Dimensions, mm	Processing Method	Unit	Test Conditions and Supplementary Instructions
1.0	Rheological properties					
1.1	Melt flow rate—mass	ISO 1133	granule or powder		g/10 min	190°C, 2160 g, use a value of 776.5 kg/m^3 to calculate MFR by timed method
						190°C, 5 kg is used for pipe products in accordance with ISO 15876.
						190°C, 10 kg is used for materials with MFR below 0.1 g/10 min
1.2	Melt flow rate—volume		granule or powder		mL/10 min	190°C, 2160 g
2.0	Mechanical Properties					
2.1	Tensile modulus	ISO 527-1	As specified by standard	Compression	MPa	For modulus, speed is 1 % of gauge length/min. Tensile yield stress and strain measured at 500 mm/min For breakproperties use test speed of 50 mm/min.
2.2	Tensile yield stress	ISO 527-2			MPa	
2.3	Tensile yield strain				%	
2.4	Tensile break stress				MPa	
2.5	Tensile break strain				%	
2.6	Nominal strain at break				%	
2.7	Tensile creep modulus	ISO 899-1 ISO 11403- 1	20 by 2.5 by 1.6	Compression	MPa	Determine the creep modulus at 1 h and 1000 h at strain level less than 0.5 %.

TABLE 6 *Continued*

Number	Properties	Standard	Specimen Type, Dimensions, mm	Processing Method	Unit	Test Conditions and Supplementary Instructions
2.8	Flexural modulus	ISO 178	80 by 10 by 4	Compression	MPa	Test speed 2 mm/min, 64-mm span, and chord modulus between 0.0005 and 0.0025 mm/mm strain, and results corrected for machine compliance
2.9	Flexural strength	ISO 178	80 by 10 by 4	Compression	MPa	
2.10	Flexural creep modulus	ISO 899-2	80 by 10 by 4	Compression	MPa	Same requirements as tensile creep (2.7)
2.11	Compressive strength and modulus	ISO 604	for strength 10 by 10 by 4, for modulus 50 by 10 by 4	Compression	MPa	Speed of test 0.02 mm/min for modulus, 0.1 mm/min for brittle materials, and 0.5 mm/min for ductile materials
2.12	Charpy impact strength	ISO 179	80 by 10 by 4	Compression	kJ/m^2	Method 1 unnotched (edgewise)
2.13	Charpy notched impact strength	ISO 179	80 by 10 by 4	Compression	kJ/m^2	Method 1A (edgewise), V- notch, r=0.25
2.14	Tensile impact strength	ISO 8256	80 by 10 by 4 Double-V notch, r = 1	Compression	kJ/m^2	Determined only when fracture cannot be achieved in the Izod or Charpy test
2.15	Shore A or D hardness	ISO 868	min 50 by 50 by 6 (min)	Compression	Value A or D	Value at 1 s, durometer A or D, thickness can be achieved by plying
3.0	Thermal Properties					
3.1	Peak melting temperature	ISO 11357– 3	powder, granules, sheet		°C	Heating rate 10°C/min, to be measured after aging
3.2	Glass Transition Temperature	ISO 11357-2	powder, granules, sheet		°C	Heating rate 20°C
3.3	Temperature of deflection under load	ISO 75-1 ISO 75-2	120 by 10 by 4	Compression	°C	Stress level 0.45 MPa or 1.80 MPa, span 100 mm for specimens in edgewise position, 64 mm for specimens positioned flatwise
3.4	Coefficient of linear thermal expansion	TMA, ISO 10350	ISO 3167	Compression	1/K	Secant value over temperature range of 23 to 55°C in both parallel and normal directions
3.5	Flammability	IEC 60695-11-10	125 by 10 by 4	Compression	mm/s, or s, or extent of burn	Horizontal burn, either time or length of burn, 20 mm flame, 30 s exposure to the flame
3.76	Ignitability	ISO 4589-2	80 by 10 by 4	Compression	%	Procedure A—top surface ignition
4.0	Electrical Properties					
4.1	Relative permittivity	IEC 60250	80 by 80 by 1	Compression		Frequencies 100Hz and 1 MHz
4.2	Dissipation factor	IEC 60250	80 by 80 by 1	Compression		Frequencies 100Hz and 1 MHz

TABLE 6 *Continued*

Number	Properties	Standard	Specimen Type, Dimensions, mm	Processing Method	Unit	Test Conditions and Supplementary Instructions
4.3	Volume resistivity	IEC 60093	80 by 80 by 1	Compression	ohm-m	Voltage 100 V
4.4	Surface resistivity	IEC 60093	80 by 80 by 1	Compression	ohm	
4.5	Dielectric strength	IEC 60243-	80 by 80 by 1 and 80 by 80 by 3	Compression	kv/mm	Use electrode configuration 25 mm/ 75 mm coaxial cylinders; immersion in transformer oil IEC 296; use short time (rapid rise) test
4.6	Comparative tracking index	IEC 60112	100 by 100 by 3 (min) or 100 mm diameter disk by 3 (min) thickness	Compression		Use solution A, at 50 Hz
5.0	Other Properties					
5.1	Water absorption	ISO 62	50 mm square or disk by 3 mm	Compression	%	24 h immersion at 23°C
5.2	Density	ISO 1183-1		Compression	kg/m^3	Specimen to be taken from molded sheet or from extrudate from MFR determination
5.3	Viscosity number	ISO 1628-3	granules or powder		mL/g	
5.4	Ash	ISO 3451-1	any form		%	

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

Committee D20 has identified the location of selected changes to this standard since the last issue (D2581 - 02) that may impact the use of this standard. (August 1, 2009)

(1) Added 1.2, and renumbered subsequent subsections.
(2) Revised ISO statement in Note 1.
(3) Updated Section 2.
(4) Added 3.2.3, 3.2.4, and 3.2.5.
(5) Added 9.1, 9.2, 9.3, 9.4, Note 3, 9.5, and 9.6. Renumbered subsequent subsections.
(6) Revised 10.1. Added Note 4 and Note 6. Renumbered Note 3 to Note 5.
(7) Revised 10.2 tolerance on relative humidity
(8) Added 11.2.
(9) Revised Table 1 ranges of density.
(10) Added Polybutene-1 to keywords.
(11) Added new Table 4.
(12) Added new Table 6.
(13) Added new Table 6.