



Designation: D4067 – 23

Standard Classification System and Basis for Specification for Reinforced and Filled Poly(Phenylene Sulfide) (PPS) Injection Molding and Extrusion Materials Using ASTM Methods¹

This standard is issued under the fixed designation D4067; 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 classification system covers reinforced and filled poly(phenylene sulfide) materials suitable for injection molding and extrusion.

1.2 This classification system is not intended for the selection of materials, but only as a means to call out plastic materials to be used for the manufacture of parts. The selection of these materials shall be made by personnel with expertise in the plastics field where the environment, inherent properties of the materials, performance of the parts, part design, manufacturing process, and economics are considered.

1.3 The properties included in this classification system are those required to identify the compositions covered. If necessary, other requirements identifying particular characteristics important to specific applications shall be designated by using the suffixes given in Section 5 or Classification System D4000.

1.4 The values stated in SI units are to be regarded as the standard.

NOTE 1—There is no known ISO equivalent to this standard.

NOTE 2—ASTM Standard D6358 provides a classification system for the same materials covered in this standard, along with additional PPS materials, with the major difference being its use of ISO test methods, versus the use of ASTM test methods in this standard. The user of this standard is encouraged to evaluate switching to the use of Standard D6358 as it is more up to date with current practices.

1.5 This precautionary statement pertains only to the test method portion of this classification system, Section 12. *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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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1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
- D618 Practice for Conditioning Plastics for Testing
- D638 Test Method for Tensile Properties of Plastics
- D648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
- 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
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D3418 Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry
- D3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials
- D3835 Test Method for Determination of Properties of Polymeric Materials by Means of a Capillary Rheometer
- D3892 Practice for Packaging/Packing of Plastics
- D4000 Classification System for Specifying Plastic Materials

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

- D5630 Test Method for Ash Content in Plastics
- D5740 Guide for Writing Material Standards in the Classification Format
- D6358 Classification System and Basis for Specification for Poly (Phenylene Sulfide) (PPS) Injection Molding, Extrusion and Blow Molding Materials Using ISO Methods
- 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
- E595 Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
- E662 Test Method for Specific Optical Density of Smoke Generated by Solid Materials
- 2.2 Military Standards:⁴
 - MIL-P-46174 (MR) Plastic Molding Material, Polyphenylene Sulfide, Glass Fiber Reinforced
 - MIL-M-24519 Molding Plastics, Electrical, Thermoplastic
- 2.3 ISO Standard:⁵
 - ISO 527–2 Plastics—Determination of Tensile Properties—Part 2: Test Conditions for Moulding and Extrusion Plastics
 - ISO 3451 Plastics—Determination of Ash

3. Terminology

3.1 Definitions:

3.1.1 The definitions used in this classification system are in accordance with Terminology D883 and Terminology D1600.

4. Classification

4.1 There is currently no group, class, or grade distinction and no basic property table is given.

NOTE 3—Where no basic property table exists, the generic family designation will be followed by four zeros, for example: PPS 0000.

4.1.1 Table A shall be used to specify the physical property requirements that shall be shown by a six-character designation. The designation shall consist of the letter A and the five digits comprising the cell numbers for the property requirements in the order as they appear in Table A.

4.1.1.1 The values listed are necessary to include the range of properties available in existing materials. However, this does not imply that every possible combination of properties exists or can be obtained with the current state of technology.

4.2 A single letter shall be used to indicate the major category of the reinforcement, along with two numbers that indicate the percentage of additive(s) by mass, with the tolerances as tabulated in Table 1:

TABLE 1 Reinforcement-Filler Symbols and Tolerances

Category	Material	Tolerance (Based on the total mass)
C	Carbon and graphite fiber-reinforced	±2 percentage points
G	Glass-reinforced ≤15 % glass content >15 % glass content	±2 percentage points ±3 percentage points
L	Lubricants (such as PTFE, graphite, silicone, and molybdenum disulfide) or lubricants with fillers/reinforcements	Depends upon the material and process—to be specified.
M	Mineral-reinforced	±2 percentage points
R	Reinforced-combination/mixtures of reinforcements or other fillers/reinforcements.	±3 percentage points based on the total reinforcement.

NOTE 4—This part of the system uses the type and percentage of additive to designate the modification of the basic material. To facilitate this designation, the type and percentage of additive can be shown on the supplier’s technical data sheet unless it is proprietary in nature. If necessary, additional requirements shall be indicated by the use of the suffix part of the system, as given in Section 5. Special agreements on tolerances may be needed below 5 % levels.

NOTE 5—An example of this classification system for a poly(phenylene sulfide) material is as follows: The designation ASTM D4067 PPS0000G40A42043 would indicate the following material requirements from Table A:

- PPS0000 = poly(phenylene sulfide) material,
- G40 = glass-reinforced at 40 % nominal level,
- A = Table A physical property requirements,
- 4 = tensile strength, min 120 MPa,
- 2 = flexural modulus, min 10 000 MPa,
- 0 = Izod impact strength, unspecified,
- 4 = flexural strength, min 165 MPa, and
- 3 = density, min 1.60 g/cm³.

If no properties are specified, the designation would be ASTM D4067 PPS0000G40A00000.

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. Electrical, flammability or other requirements shall be designated by the appropriate suffix from Table 3 of Classification System D4000.

NOTE 6—The denotation of electrical property requirements changed from an independent table of electrical properties in the 1996 version of this standard with its own nomenclature for suffixes, to referring to ASTM Standard D4000 electrical property suffix requirements in 2011 and subsequent revisions. Where the older suffix nomenclature such as E00, E01, E02, etc have been used on engineering drawings, these suffixes are not consistent with suffixes used in Table 3 of D4000. The material classification used in such cases should refer to the 1996 version of this standard, as for example, “ASTM D4067-96 PPS0000G40A42043E01” or as “ASTM D4067 PPS0000G40A42043E01 per ASTM D4067-96”. The table of electrical properties from ASTM D4096-96 is included as Appendix X2 in this standard.

5.1.1 If applicable, heat deflection temperature shall be designated using the following suffix:

Y = Heat deflection temperature as designated by the following digits:

- First Digit
- 1 = Test Method D648, 1820 kPa
- Second Digit
- 1 = minimum of 260°C
- 2 = other minimum temperature (°C) - specify

NOTE 7—Heat treating the test specimens at 260°C for 4 h is permitted to achieve high heat deflection temperatures.

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

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

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

6. Basic Requirements

6.1 Basic requirements from Table A, as they apply, are always in effect unless superseded by specific suffix requirements, which always take precedence.

TABLE A Physical Property Requirements

Designation Order	Property/ASTM Test Method	Units	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, min D638^A	MPa ^B	^C	60	80	110	120	130	160	180	200	^D
2	Flexural modulus, min D790^E	MPa ^B	^C	7 000	10 000	12 000	14 000	17 000	20 000	23 000	26 000	^D
3	Izod impact strength, min D256^F	J/m ^G	^C	28	40	52	70	80	90	100	110	^D
4	Flexural strength, min D790^E	MPa ^B	^C	85	105	135	165	195	225	255	285	^D
5	Density, min D792	g/cm ³	^C	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	^D

^A Type I specimens, 3.18 mm thickness, crosshead speed of 5 mm/min.

^B MPa × 145 = psi.

^C Unspecified.

^D Specific value (must be shown).

^E Tangent modulus of elasticity. Test specimens are 3.18 by 12.7 mm and tested with a crosshead speed of 1.3 mm/min ± 50 % with a span to depth ratio of 16:1.

^F Test specimens are 3.18 mm thick with a notch radius of 0.25 mm and tested by Method A.

^G J/m × 18.73 × 10⁻³ = ft-lbf/in.

7. General Requirements

7.1 The plastics composition shall be uniform and shall conform to the requirements specified herein. The color and form of the material shall be as agreed upon between the supplier and the user.

8. Detail Requirements

8.1 Test specimens for the various materials shall conform to the requirements prescribed in Table A and suffix requirements as they apply.

8.2 For the purpose of determining conformance with this classification system, all specified limits in this classification system are absolute limits, as defined in Practice **E29**.

8.2.1 In the absolute method, an observed value or a calculated value is not rounded off, but is to be compared directly to the specified limiting value. Conformance or non-conformance with the specification is based on this comparison.

9. Sampling

9.1 Sampling shall be statistically adequate to satisfy the requirements of **13.4**.

9.2 A batch or lot is construed as a unit of manufacture as prepared for shipment and can consist of a blend of two or more “production runs.”

10. Specimen Preparation

10.1 The test specimens shall be prepared by injection molding in accordance with Practice **D3641**. Processing conditions are:

Drying	2 h at 135°C
Plastic melt temperature	305 - 335°C
Mold temperature	140°C minimum
Average injection velocity	200 ± 100 mm/s
Plastic Hold Pressure	600 bar minimum

11. Conditioning

11.1 *Conditioning*—Before performing the required tests, condition test specimens for a minimum of 4 h in the standard

laboratory atmosphere of 23°C and 50 % relative humidity with standard tolerances as specified in Section 7 of Practice **D618**.

11.2 *Test Conditions*—Conduct those tests influenced by the ambient conditions in the standard laboratory atmosphere of 23°C and 50 % relative humidity as defined in 3.1.2 of Practice **D618**.

12. Test Methods

12.1 Determine the properties of the material according to the test methods in 2.1, using the specimens and protocols specified in Table A and applicable Suffixes, as required.

NOTE 8—For a large proportion of the PPS materials covered by this standard, there has been a switch from ASTM test methods to ISO test methods as exemplified by the classification system in Standard **D6358**. The ISO test methods specified in Standard **D6358** may be used in lieu of the ASTM test methods referenced if acceptable to the purchaser. Test reports using ISO methods must clearly state that testing was modified to use ISO methods instead of the ASTM methods specified by ASTM D4067.

12.1.1 The number of tests shall be consistent with the requirements of Section 9 and paragraph **13.4**.

12.2 *Reinforcement Concentrations*—Test Method **D5630** or ISO 3451, using a temperature of 815°C for inorganic fillers/reinforcements. Carbon fiber, graphite fiber, and other organic reinforcements require special methods that shall be agreed upon between the supplier and the user.

13. Inspection and Certification

13.1 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.

13.2 Lot-acceptance inspection shall be the basis on which acceptance or rejection of the lot is made. The lot-acceptance inspection shall consist of apparent shear viscosity (Test Method **D3835**) or flow rate (Test Method **D1238**, 315/5.0); reinforcement or filler content at 815°C (Test Method **D5630** or ISO 3451); and, tensile strength (Test Method **D638**, Type 1 bar or ISO 527-2, Type 1A bar).

13.3 Periodic check inspection with reference to a specification based upon 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 13.4.

NOTE 9—The ISO test methods specified in Standard D6358 may be used in lieu of the ASTM test methods referenced if acceptable to the purchaser. Test reports using ISO methods must clearly state that testing was modified to use ISO methods instead of the ASTM methods specified by ASTM D4067.

13.4 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).

13.5 A report of test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment; the results of the most recent periodic-check inspection; and the percent by weight of recycled plastic, as defined in 3.1.47 of Guide D7209, if requested.

14. Packaging and Marking

14.1 Provisions of Practice D3892 apply for packaging, packing, and marking of containers for plastic materials. Other packaging or marking, or both, is acceptable when agreed upon by the purchaser and the supplier.

15. Keywords

15.1 plastic materials; poly(phenylene sulfide)

SUPPLEMENTARY REQUIREMENTS

The following supplementary items shall become part of this classification system when applicable, as agreed upon between the user and the supplier.

S1. *Approval*—Material submitted by a new supplier shall be approved by the user. Material or test specimens submitted by the supplier and intended for evaluation, shall be accompanied by the supplier’s laboratory test report.

S1.1 *New Sources*—The user can elect to accept shipment temporarily on the supplier’s certification.

S2. *Infrared Spectrophotometry or Thermal Analysis, or Both*—If requested by the user, infrared or thermal analysis, or both, shall be conducted on materials supplied to this classification system. The curves established for initial approval shall constitute the reference standard and shall be kept on file at the user’s laboratory. All samples shall produce curves that correspond to the reference standard when tested under the same conditions as those specified on the master set of curves.

S2.1 In the event such analyses are to be designated as required of the supplier, this must appear on the part drawing or purchase contract, or both, as agreed upon between user and supplier.

NOTE S7—Melting characteristics of PPS materials shall be determined by Test Method D3418 with reference standards agreed upon by the user and supplier. Appropriate Suffix Designations consistent with Classification System D4000 shall be used to define requirements for Melting Point.

S3. *Outgassing and Smoke Generation:*

S3.1 In aircraft and aerospace applications that require specification of outgassing, or in combustion modes the amount of smoke generated, these requirements shall be agreed upon by the user and supplier with limiting values clearly defined using the Standard D4000 Suffix System.

S3.1.1 *Specific Optical Density*—If required, shall be determined by Test Method E662 in both the flaming and smoldering modes. Maxima, D_{max} shall be stipulated using the Suffix System of Classification System D4000.

S3.1.2 *Outgassing*—If required for aerospace applications, shall be determined in accordance with Test Method E595. Requirements shall be defined using an appropriate Suffix designation.

APPENDICES

(Nonmandatory Information)

X1. CROSS REFERENCE FROM MIL-P-46174 (MR) TO ASTM CLASSIFICATION SYSTEM D4067

X1.1 This classification system contains pertinent specification items from MIL-P-46174 (MR) and MIL-M-24519, for plastic molding material, poly(phenylene sulfide), glass reinforced. (MIL-P-46174(MR) has been cancelled, replaced with Classification System D4067. The MIL-P-46174(MR) information included here is for historical reference only.)

X1.2 The following cross reference designations are believed to accurately provide comparable callout information relative to the intent of the designated military specifications. It

is recommended that someone knowledgeable in the requirements of the military specifications review this information before use.