Designation: D4067 – 16

Standard Classification System and Basis for Specification for Reinforced and Filled Poly(Phenylene Sulfide) (PPS) Injection Molding and Extrusion Materials Using ASTM Methods[1]

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.

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 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 is no known ISO equivalent to this standard.

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
D5630 Test Method for Ash Content in Plastics
D5740 Guide for Writing Material Standards in the Classification Format

[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**

D6358 Classification System and Basis for Specification for Poly (Phenylene Sulfide) (PPS) Injection Molding and Extrusion Materials Using ISO Methods
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:*[3]
MIL-P-46174 (MR) Plastic Molding Material, Polyphenylene Sulfide, Glass Fiber Reinforced
MIL-M-24519 Molding Plastics, Electrical, Thermoplastic

2.3 *ISO Standard:*[4]
ISO 527–2 Plastics—Determination of Tensile Properties—Part 2: Test Conditions for Moulding and Extrusion Plastics

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 2—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	±2 percentage points
	>15 % glass content	±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 3—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 4—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/cm^3.

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.

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

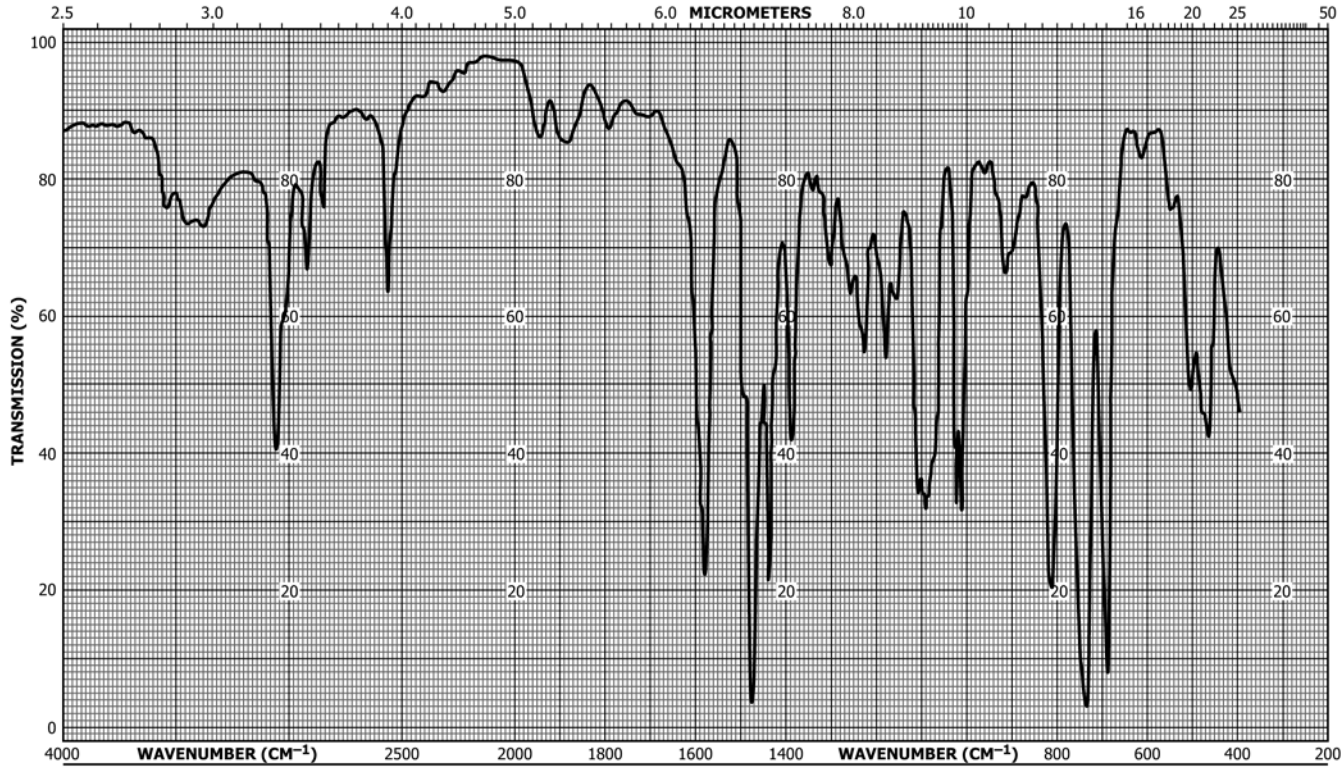
NOTE 5—Heat treating the test specimens at 260°C for 4 h is permitted to achieve high heat deflection temperatures.

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.

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

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



Phase—Liquid
Cell thickness—0.025 mm
Sample—Pyrolyzate
Prism—NaCl

FIG. 1 Infrared Spectrum of Poly(phenylene sulfide) Pyrolyzate

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 nonconformance 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.

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, 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 (Test Method D5630); 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.

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 D 7209, 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 S6—A useful procedure for IR is to place approximately 0.5 g of finely divided sample into a test tube and rapidly apply heat in order to pyrolyze the sample. Pyrolysis vapors that condense on the cooler portions of the tube can then be removed for appropriate IR analysis.

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.

APPENDIX

(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.

ASTM D4067	MIL-P-46174 (MR)
PPS000G15A21221	Class 15 Grade A
PPS000G15A21221 EA117ED041EE020	Class 15 Grade E

ASTM D4067	MIL-P-46174 (MR)
PPS000G30A32332	Class 30 Grade A
PPS000G30A32332 EA117ED041EE020	Class 30 Grade E
PPS000G40A43443	Class 40 Grade A
PPS000G40A43443 EA117ED041EE020	Class 40 Grade E
PPS000G50A54454	Class 50 Grade A
PPS000G50A54454 EA117ED041EE020	Class 50 Grade E

ASTM D4067	MIL-M-24519
PPS000A00330E01EA124	GST-40F

X1.3 If additional property requirements need to be specified, appropriate suffixes are to be used as needed.

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D4067 - 10) that may impact the use of this standard. (September 1, 2016)

(1) Added Guide D5740 and Standard D6358 to 2.1.
(2) Revised Table 1 to be consistent with Table 1 in Guide D5740.
(3) Changed the minimum conditioning time in 11.1 to be in agreement with D6358.
(4) Changed the conditioning statements in 11.1 and 11.2 to be consistent with D5740.