



Designation: D 4067 – 96

Standard Specification for Reinforced and Filled Polyphenylene Sulfide (PPS) Injection Molding and Extrusion Materials¹

This standard is issued under the fixed designation D 4067; 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 Department of Defense.

1. Scope

1.1 This specification covers reinforced and filled polyphenylene sulfide materials suitable for injection molding and extrusion.

1.2 This specification 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 is to 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 specification are those required to identify the compositions covered. There may be other requirements necessary to identify particular characteristics important to specific applications. These will be agreed upon between the user and the supplier by using the suffixes as given in Section 5.

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 specification, section 13. *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.*

2. Referenced Documents

2.1 ASTM Standards:

D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies²

D 150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials²

D 256 Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials³

D 257 Test Methods for DC Resistance or Conductance of Insulating Materials²

D 495 Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation²

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing³

D 638 Test Method for Tensile Properties of Plastics³

D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load³

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials³

D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement³

D 883 Terminology Relating to Plastics³

D 1600 Terminology for Abbreviated Terms Relating to Plastics³

D 1897 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials³

D 1898 Practice for Sampling of Plastics³

D 3418 Test Method for Transition Temperatures of Polymers by Thermal Analysis⁴

D 3892 Practice for Packaging/Packing of Plastics⁴

D 4000 Classification System for Specifying Plastic Materials⁴

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specification⁵

E 595 Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment⁶

E 662 Test Method for Specific Optical Density of Smoke Generated by Solid Materials⁷

F 814 Test Method for Specific Optical Density of Smoke Generated by Solid Materials for Aerospace Applications⁶

¹ This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials (Section D20.15.17).

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² *Annual Book of ASTM Standards*, Vol 10.01.

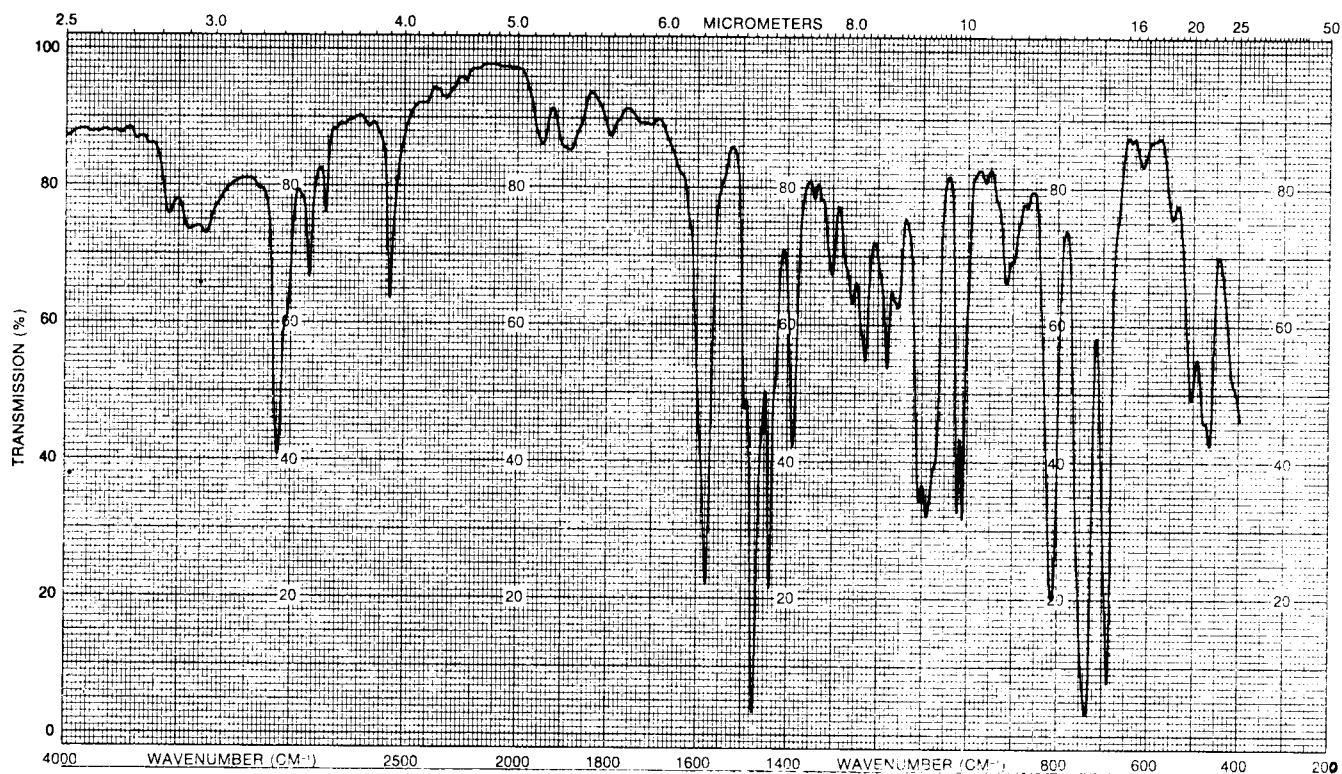
³ *Annual Book of ASTM Standards*, Vol 08.01.

⁴ *Annual Book of ASTM Standards*, Vol 08.02.

⁵ *Annual Book of ASTM Standards*, Vol 14.02.

⁶ *Annual Book of ASTM Standards*, Vol 15.03.

⁷ *Annual Book of ASTM Standards*, Vol 04.07.



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

FIG. 1 Infrared Spectrum of Polyphenylene Sulfide Pyrolyzate

TABLE 1 Detail Requirements

Property	Condition ^A	Units	A	B	C	D	E	F	G	H	I
Dielectric constant ^B max	E-48/50 + D24/23										
1 KHz	E-48/50 + D24/23		4.0	4.0	4.2	4.5	4.8	5.3	6.8	5.8	9.0
1 MHz	E-48/50 + D24/23		4.0	4.0	4.1	4.4	4.5	4.8	6.3	6.3	9.0
Dissipation factor ^B max	E-48/50 + D24/23										
1 KHz	E-48/50 + D24/23		0.002	0.002	0.004	0.008	0.02	0.08	0.10	0.10	0.10
1 MHz	E-48/50 + D24/23		0.007	0.007	0.007	0.010	0.02	0.01	0.03	0.03	0.10
Volume resistivity ^C , min	C-24/23/50	ohm-cm	1×10^{16}	1×10^{14}	1×10^{16}	1×10^{14}	1×10^{15}	1×10^{15}	1×10^{15}	1×10^{15}	1×10^{14}
Dielectric strength ^D , min	E-48/50 + 96/23/50	KV/mm (Y/mil)	14.6 (375)	14.6 (375)	13.6 (350)	11.7 (300)	11.7 (300)	11.7 (300)	11.7 (300)	11.7 (300)	11.7 (300)
Arc resistance ^E , min		second	30	10	30	0	150	150	150	180	150
Comparative tracking index ^A		Y	130	130	130	130	200	200	150	230	200
^F min											

^A In accordance with Methods D 618.

^B ASTM Test Method D 150.

^C ASTM Test Method D 257.

^D ASTM Test Method D 149.

^E ASTM Test Method D 495.

^F UL Method 746A.

2.2 Military Standards:⁸

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

MIL-P-46174 (MR) Plastic Molding Material, Polyphenylene Sulfide, Glass Fiber Reinforced

MIL-M-24519 Molding Plastics, Electrical, Thermoplastic

2.3 Underwriters Laboratories:⁹

UL Standard 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL Standard 746A Polymeric Materials—Short-Term Property Evaluation

⁸ Available from Standardization Documents, Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁹ Available from Underwriters Laboratories, Inc. Publications Stock, 333 Pfingsten Road, Northbrook, IL 60062.



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 D 638 ^A	MPa ^B	C	60	80	110	120	130	160	180	200	D
2	Flexural modulus, min D 790 ^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 D 256 ^F	J/m ^G	C	28	40	52	70	80	90	100	110	D
4	Flexural strength, min D 790 ^E	MPa ^B	C	85	105	135	165	195	225	255	285	D
5	Density, min D 792	g/cm ³	C	1.40	1.50	1.60	1.70	1.80	1.90	2.0	2.10	D

^A Type I or type IV specimens, 3.18 mm thickness, crosshead speed of 5 mm/min. Values in Table A were generated using type IV specimens.
^B MPa × 145 = psi.
^C Unspecified.
^D Specific value (must be shown).
^E Test specimens are 3.18 by 12.7 mm and tested by Method I, Procedure A (Tangent) with 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.

3. Terminology

3.1 Definitions:

3.1.1 The definitions used in this specification are in accordance with Terminology D 883 and Terminology D 1600.

4. Classification

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

NOTE 1—Where no basic property table exists, the generic family designation will be followed by three zeros, for example: PPS 000.

4.1.1 Table A shall be used to specify the physical property requirements which 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 Although the values listed are necessary to include the range of properties available in existing materials, users should not infer that every possible combination of the properties exists or can be obtained.

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 below:

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 ±3 percentage points
L	Lubricants (such as PTFE, graphite, silicone, and molybdenum disulfide)	By agreement between the supplier and the user.
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 2—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 suppliers 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 3—An example of this classification system for a polyphenylene sulfide material is as follows: The designation PPS000G40A42043 would indicate the following material requirements from Table A:

- PPS000 = polyphenylene 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 = unspecified,
- 4 = flexural strength, min 165 MPa, and
- 3 = density, min 1.60 g/cm³.

If no properties are specified, the designation would be PPS000G40A00000.

5. Suffixes

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

E = Electrical requirements as designated by the following digits:

First Digit

0 = Specimen to be specified by user

Second Digit

- 0 = To be specified by user
- 1 = Meets Requirements, Table 1, Column A
- 2 = Meets Requirements, Table 1, Column B
- 3 = Meets Requirements, Table 1, Column C
- 4 = Meets Requirements, Table 1, Column D
- 5 = Meets Requirements, Table 1, Column E
- 6 = Meets Requirements, Table 1, Column F
- 7 = Meets Requirements, Table 1, Column G
- 8 = Meets Requirements, Table 1, Column H
- 9 = Meets Requirements, Table 1, Column I
- F = Flammability requirements as designated by the following digits:

First Digit

- 0 = to be specified by user
- 1 = product is tested according to UL 94 at 3.05 mm minimum thickness
- 2 = product is tested according to UL 94 at 1.47 mm minimum thickness
- 3 = product is tested according to UL 94 at 0.71 mm minimum thickness

Second Digit

- 0 = to be specified by user
- 1 = UL 94V-0 flammability class
- 2 = UL 94V-1 flammability class
- 3 = UL 94V-2 flammability class
- 4 = UL 94-5V flammability class

NOTE 4—**Precaution:** By publication of this specification and its use of flammability ratings, ASTM does not intend that their use in any way reflects hazards presented under actual fire conditions.

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

First Digit

1 = Test Method D 648, 1820 kPa

Second Digit

1 = minimum of 260°C—High heat deflection temperatures may be



obtained by heat treating the test specimens at 260°C for 4 h.

5.1.1 Additional suffixes will be added to this specification as required. See Table 3 of Classification D 4000.

NOTE 5—If the requirements for the polyphenylene sulfide material in Note 3 also included electrical requirements, the following example indicates the call-out: PPS000G40A42043E12

PPS000G40A42043E12	=	Same as Note 3
E	=	electrical requirements
0	=	Specimen to be specified by user
2	=	property requirements of Table 1, Column B

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.

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 specification, all specified limits in this specification are absolute limits, as defined in Practice E 29.

8.2.1 With 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 Unless otherwise agreed upon between the user and the supplier, the materials shall be sampled in accordance with the sampling procedure prescribed in Practice D 1898. Adequate statistical sampling shall be considered an acceptable alternative. 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 or batches.

10. Number of Tests

10.1 The number of tests shall be conducted as agreed upon between the user and the supplier.

11. Specimen Preparation

11.1 Unless otherwise specified, test specimens shall be prepared by injection molding in accordance with Practice D 1897. Unless otherwise recommended, minimum mold temperature shall be 121°C and stock temperature shall be 316 ± 6°C.

12. Conditioning

12.1 *Conditioning*—Condition test specimens at 23 ± 2°C and 50 ± 5 % relative humidity for not less than 40 h prior to testing in accordance with Procedure A of Practice D 618, where conditioning is specified.

12.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity unless otherwise specified.

13. Test Methods

13.1 *Reinforcement and Additive Concentrations*—Method to be agreed upon between the supplier and the user.

14. Rejection and Rehearing

14.1 Material that fails to conform to the requirements as agreed upon between the user and the supplier may be rejected. If any failure occurs, the materials may be retested to establish conformity in accordance with the agreement between the user and supplier. Rejection should be reported to the supplier promptly and in writing. In case of dissatisfaction with the results of the test, the supplier may make claim for a rehearing.

15. Certification and Inspection

15.1 *Certification and Lot Acceptance Inspection*—Certification and lot acceptance of the material shall be made as agreed upon between the user and the supplier or as part of the purchase order or contract.

15.2 *Periodic Check Inspection*—The periodic check inspection shall consist of the tests specified for all requirements of the material under this specification or as agreed upon between the user and the supplier.

15.3 *Reports*—When specified in the purchase order or contract, a report of the test results shall be furnished at a frequency agreed upon between the user and the supplier.

16. Packaging and Marking

16.1 Provisions of Practice D 3892 apply for packaging, packing, and marking of containers for plastic materials.



SUPPLEMENTARY REQUIREMENTS

The following supplementary items may become part of this specification 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 may elect to accept shipment temporarily on the supplier’s certification.

S2. *Infrared Spectrophotometry or Thermal Analysis, or Both*—At the option of the user, infrared or thermal analysis, or both, may be conducted on materials supplied to this specification. The curves established for initial approval shall constitute the reference standard and shall be kept on file at the user’s laboratory. All samples should 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.

NOTE S00006—A useful procedure for IR is to place approximately 0.5 g of finely divided sample into a pyrex test tube and to rapidly apply heat in order to pyrolyze the sample. Pyrolysis vapors will condense on the cooler portions of the tube and can then be removed for appropriate IR analysis.

NOTE S00007—Melting characteristics of PPS materials shall be determined by Test Method D 3418 with reference standards agreed upon by the user and supplier. Appropriate Suffix Designations consistent with Standard D 4000 shall be used to define requirements for Melting Point.

S3. *Outgassing and Smoke Generation:*

S3.1 Aircraft and Aerospace applications may 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 D 4000 Suffix System.

S3.1.1 *Specific Optical Density*—When required, shall be determined by Test Method E 662 in both the flaming and smoldering modes. Maxima, D_{max} shall be stipulated using the Suffix System of Standard D 4000.

S3.1.2 *Outgassing*—When required for space, applications shall be determined in accordance with Test Method E 595. Requirements shall be defined using an appropriate Suffix designation.

S3.1.3 *Smoke Density*—When required for aerospace applications, the maximum specific optical smoke density shall be determined according to Test Method F 814. Requirements shall be defined using an appropriate Suffix designation.

S4 Quality Assurance Provisions for Government/Military Procurement

S4.1 Selection of acceptance quality level (AQL) and of inspection level (IL) shall be made with consideration of the specific use requirements. This is discussed in the section on Comparison of Sampling Plans and the Scope section of the General Sampling Procedures of Practice D 1898, with reference to MIL-STD-105. In the absence of contrary requirements the following values shall apply.

	IL	AQL
Testing (polymer unfabricated)	S-1 ^A	As agreed between the purchaser and supplier

^A Samples shall be drawn from the required number of units and pooled for preparation of molded samples for property evaluation.

S5 Government/Military Packaging

S5.1 Materials shall be packaged and marked in accordance with Practice D 3892. Other packaging or marking, or both, may be used when agreed to by the purchaser and the supplier.

APPENDIX

(Nonmandatory Information)

X1. CROSS REFERENCE FROM MIL-P-46174 (MR) TO ASTM SPECIFICATION D 4067

X1.1 This specification contains pertinent specification items from MIL-P-46174 (MR) and MIL-M-24519, for plastic molding material, polyphenylene sulfide, glass reinforced.

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.

PPS000G15A21221	EA117ED041EE020	Class 15 Grade E
	ASTM D4067	MIL-P-46174 (MR)
PPS000G30A32332	EA117ED041EE020	Class 30 Grade A
PPS000G30A32332	EA117ED041EE020	Class 30 Grade E
PPS000G40A43443	EA117ED041EE020	Class 40 Grade A
PPS000G40A43443	EA117ED041EE020	Class 40 Grade E
PPS000G50A54454	EA117ED041EE020	Class 50 Grade A
PPS000G50A54454	EA117ED041EE020	Class 50 Grade E
	ASTM D4067	MIL-M-24519
PPS000A00330E01EA124		GST-40F

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

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

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