



Designation: D 6339 – 9804

Standard Specification for Syndiotactic Polystyrene Molding and Extrusion (SPS)¹

This standard is issued under the fixed designation D 6339; 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 specification covers syndiotactic polystyrene materials including homopolymer, copolymers, blends, and impact modified, suitable for molding and extrusion. Recycled product will be addressed in a separate standard.

1.2 This specification is intended to be a means of calling out plastic materials used in fabrication of end use items or parts. Material selection should be made by those having expertise in the plastics 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 inherent properties of the material other than those covered by this specification, and the economics.

1.3 The properties included in this specification are those required to identify the compositions covered. Other requirements necessary to identify particular characteristics important to specialized applications can be called out using the suffixes given in Section 5.

NOTE 1—There is no ISO equivalent.

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

Current edition approved ~~Dec. 10, 1998~~; February 1, 2004. Published March 2004. Originally approved in 1998. Last previous edition approved in 1998 as D 6339 - 98.

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

2. Referenced Documents

2.1 *ASTM Standards:*²

- D 256 Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials
- ~~D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing~~
- D 638 Test Method for Tensile Properties of Plastics
- D 648 Test Method for Deflection Temperature of Plastics under Flexural Load
- D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- D 792 Test Methods for Specific Gravity (Relative Density) of Plastic by Displacement
- D 883 Terminology Relating to Plastics
- D 1238 Test Methods for Flow Rate of Thermoplastics by Extrusion Plastometer
- D 1525 Test Method for Vicat Softening Temperature of Plastics
- D 1898 Practice for Sampling of Plastics
- D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials
- D 3892 Practice for Packaging/Packing of Plastic
- D 4000 Classification System for Specifying Plastic Materials
- D 5630 Test Method for Ash Content in Thermoplastics

2.2 *Military Standard:*³

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

2.3 *ISO Standards:*⁴

- ISO 75–1 and 2 Plastics: Determination of Temperature of Deflection Under Load
- ISO 178 Plastics: Determination of Flexural Properties
- ISO 180 Plastics: Determination of Izod Impact Strength
- ISO 306 Plastics: Thermoplastic Materials-Determination of Vicat Softening Temperature (VST)
- ISO 527–2 Plastics: Determination of Tensile Properties-Part 2: Test Conditions for Moulding and Extrusion Plastics
- ISO 1133 Plastics—Determination of the Melt Mass-Flow Rate (MFR) and the Melt Volume-Flow Rate (MVR) of Thermoplastics
- ISO 1183 Plastics: Methods for Determining the Density and Relative Density of Non-Cellular Plastics
- ISO 3451 Plastics: Determination of Ash-Part 1 General Methods

3. Terminology

3.1 *Definitions*— For definitions of technical terms pertaining to plastics used in this specification, see Terminology D 883.

4. Classification

4.1 Syndiotactic polystyrene materials are classified into groups according to classes and grades shown in the basic properties table, Table SPS. Injection molded properties are the preferred standard and are used for the basis of call out examples. Call outs can be made in either ASTM or ISO properties where both are given using the same line callout.

NOTE 2—An example of this classification system for SPS is as follows: For SPS0111, the designation SPS would indicate SPS = syndiotactic polystyrene = homopolymer = general purpose, and 1 (grade) = minimum grade requirements as found in Table SPS.

4.1.1 To facilitate the incorporation of future or special materials the “Other/Unspecified” category (0) for group, class, and grade is shown in Table SPS. The basic properties can be obtained from Tables A or B as they apply (see 4.3).

4.2 Reinforced and filled syndiotactic polystyrene materials are classified in accordance with Table SPS as noted or with Table A.

4.2.1 *Reinforced and Additive Materials* —A single letter will be used for the major reinforcement or combination, or both, along with two digits that indicate the percentage of addition by mass with the tolerances as shown in Table 1.

NOTE 3—This part of the system uses the type and percentages of additive to designate the modification of the basic material. Percentage of additives can be shown on the supplier’s Technical Data Sheet unless it is proprietary. If necessary, additional requirements shall be indicated by the use of the suffix part of the system, as given in Section 5.

NOTE 4—~~A Determine~~ ash content of filled or reinforced materials ~~may be determined~~ using Test Method D 5630 or ISO 3451–1 where applicable.

4.2.2 *Table A, Detail Requirements*—An identifying number is made up of the letter A and five digits comprising the cell numbers for the new requirements in the designated order as they appear in Table A.

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*, Vol 08.01, volume information, refer to the standard’s Document Summary page on the ASTM website. *Annual Book of ASTM Standards*, Vol 08.02.

³ Available from Standardization Documents Order Desk, Bldg. 4 Section D, Philadelphia, PA, 199111-5094, Attn: PODS. *Annual Book of ASTM*

⁴ Available from American National Standards, Vol 08.03, Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

4.2.2.1 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.

NOTE 5—Using Table SPS and Table A, an example of a reinforced syndiotactic polystyrene of this classification system is as follows: The designation would indicate material requirements from Table A as:

SPS0110G15A12332

where:

- 0110 = Homopolymer, Table SPS,
- G15 = Glass-reinforced at 15 % nominal (see 4.2.1),
- A = Table A for property requirements,
- 1 = Tensile strength 50 MPa,
- 2 = Flexural modulus, 4000 MPa/min,
- 3 = Izod impact 80 J/m or 7 kJ/m²(ISO), minimum,
- 3 = Deflection temperature, 150°C, minimum, and
- 2 = Specific gravity, 1.2, minimum.

If no properties are specified, the designation would be SPS0110G15A00000.

4.3 Table B has been incorporated into this specification to facilitate the classification of special materials where neither Table SPS nor Table A reflect the required properties. Table B shall be used in the same manner as Table A.

NOTE 6—An example of a special material using this classification system is as follows: The following designation would indicate material requirements from Table B as:

SPS0110B76013

where:

- 0110 = homopolymer from Table SPS,
- B = Cell Table B for properties requirements,
- 7 = Tensile strength, 70 MPa, minimum,
- 6 = Tensile Modulus, 3600 MPa, minimum,
- 0 = Unspecified izod impact,
- 1 = Vicat softening temperature, 80°C, minimum, and
- 3 = Flow rate, 3.0, minimum.

5. Suffix Requirements

5.1 When requirements are needed that supersede or supplement the property table or cell table requirements they shall be specified through the use of suffixes. In general, the first suffix letter indicates the special requirements needed and the second letter indicates the condition or test method, or both, with a three-digit number indicating the specific requirement. The suffixes that may be used are listed in Table 3 of Classification D 4000.

NOTE 7—Properties of pigmented or colored SPS materials can differ from the properties of natural or unpigmented SPS material, depending on the choice of colorants and the concentration. The main property affected is ductility, as illustrated by a reduction in Izod impact strength. If specific properties of pigmented SPS materials are necessary, prior testing between the materials supplier and end user should be initiated.

6. Basic Requirements

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

7. General Requirements

7.1 The material composition shall be uniform and shall conform to the requirements specified herein.

8. Detail Requirements

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

8.2 For the purpose of determining conformance, all specified limits for a specification (line callout) based on this classification system are absolute limits.

9. Sampling

9.1 Sampling shall be in accordance with ~~the a sampling procedure prescribed in Practice D 1898~~ or statistically adequate to satisfy the requirements of 13.4. A lot of material shall be considered as a unit of manufacture as prepared for shipment, and may consist of two or more production runs or batches.

10. Sample Preparation—Injection

10.1 The test specimens shall be molded by an injection molding process in accordance with Practice D 3641 as follows:

10.1.1 Pre-drying of pellets is only required for blends of SPS. Four hours of drying at 200°C in a dryer with a dew point of -30°C is recommended for SPS/PA blends.

10.1.2 For injection-molded samples $290 \pm 10^\circ\text{C}$ ~~is~~ shall be the melt temperature, and $100 \pm 10^\circ\text{C}$ or $160 \pm 10^\circ\text{C}$ ~~when high crystallinity required, is~~ for filled or reinforced materials, shall be the mold temperature.

10.1.2.1 Average injection velocity ~~is~~ shall be 200 ± 100 mm/s, and can be calculated using the following equation:

$$AIV = \frac{\pi d^2 Va}{4ns} \quad (1)$$

where:

d = screw diameter,

Va = screw advance speed,

n = number of mold cavities, and

s = cross-sectional area of test specimen.

11. Conditioning

11.1 Test specimens shall be conditioned in the standard laboratory atmosphere in accordance with Procedure A of Practice D 618 before performing the required tests. Blends shall be tested dry as molded.

11.2 Conduct tests in the standard laboratory atmosphere of $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ relative humidity in accordance with Practice D 618.

12. Test Methods

12.1 Unless otherwise stated herein, determine the properties enumerated in this specification by means of the following Test Methods as applicable: D 256 or ISO 180; D 638 or ISO 527; D 648 or ISO 75; D 790 or ISO 178; D 792 or ISO 1183; D 1238 or ISO 1133; D 1525 or ISO 306.

13. Inspection and Certification

13.1 Inspection and certification of the material supplied under this standard specification 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 the following:

13.2.1 Tensile strength, and

13.2.2 Ash (filled products only).

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 this specification. Inspection frequency shall be adequate to ensure 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 line callout specified.

13.5 A report of the test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment and results of the most recent periodic-check inspection.

14. Packaging and Package Marking

14.1 For packing, packaging, and marking, the provisions of Practice D 3892 apply.

15. Keywords

15.1 plastics; syndiotactic polystyrene

TABLE SPS Materials, Detail Requirement, Natural Color Only

Group	Description	Class	Glass	Description	Grade	MFR ^A HLT		Tensile Strength, ^B MPa		Flexural Modulus, ^C MPa		DTUL, °C, 1.8 MPa ^D	Specific Gravity ^E	Izod, ^F		
						ASTM	ISO	ASTM	ISO	ASTM	ISO				ASTM	ISO
01	Homopolymer	1	General-purpose	4	7	5540	40	3900	3800	405	4-05	45	2.5			
				1	7	40	40	3900	3800	105	1.05	15				
				2	3	6040	40	3900	3800	405	4-05	45			25	
				2	3	40	40	3900	3800	105	1.05	15			2.5	
				0												
				G10		70	5500	475	4-12	42	4-25	95-70			7	
				G20		90	6500	200	4-18	60	1.25	70			7	
				G30		95	9200	95200	250240	245	440-85	85			8	
				G40		4310	440	4050	280220	240	1.32	120			10	
				G40		110	110	11400	13000	220	80-120	40				
02	Copolymer	1	General-purpose	4	5	4030	30	300	2500	-90	4-02	80-120	40			
				1	5	30	30	2600	2500	90	1.02	120				
				G10		60	4500	450	4-11	50	1.16	55			6	
				G20		80	85	66800	6500	200450	220	4-16			85-55	6
				G20		80	85	6800	6500	150	220	1.16			55	6
				G30		400-95	405	7000	8400	240490	230	4-24			445-100	8
				G30		95	105	8000	8100	190	230	1.21			100	8
				445		250	4-29	445								
				00												
				00												
03	Flame-retardant	1	General-purpose	4	4	60	65	3500	3400	-90-70	4-04	30	3			
				1	4	60	65	3500	3400	70	80	1.04			30	
				G10		5700	60	470	5000	470	4-18	55			5.5	
				General-purpose												
				G20		6700	490	4-26	35							
				G20		240	4-32	40								
				G40		405	41000	250	50							
				00												
				00												
				00												
03	Flame-retardant	2	General-purpose	4	70	5700	60	5600	5000	470	4-18	55	40			
				1	70	5700	60	5600	5000	470	4-18	55				
				G10		50	60	5500	5000	170	115	1.29			55	
				G20		7580	85	6500	7500	490	240	4-26			60-90	40
				G20		80	85	6500	7500	190	210	1.32			90	10
				00												
				00												
				00												
				00												
				00												

TABLE SPS Materials, Detail Requirement, Natural Color Only

Group	Description	Class	Glass	Description	Grade	MFR ^A HL4	Tensile Strength, ^B MPa	Flexural Modulus, ^C MPa	DTUL, °C, 1.8 MPa ^D	Specific Gravity ^E	Izod, ^F		
04	Blends	1	General Purpose	G30	---	85410-	9200	245	1-32	42			
				G30	---	110	9200	245	1.39	65-110-	12		
				G40	---	40-	41-500-	250200	4-40	75-140-	47		
				G40	---	110	11 500-	200	1.50	140	17		
				Other	---	---	---	---	---	---	---	---	
				Other	---	---	---	---	---	---	---	---	
				Other	---	---	---	---	---	---	---	---	
				Other	---	---	---	---	---	---	---	---	
				Other	---	---	---	---	---	---	---	---	
				Other	---	---	---	---	---	---	---	---	
00	Other	0	Impact Modified	G10	20	---	4200	---	---	3.5			
				G20	6	---	6700	---	---	6.6			
				G30	13	---	8500	---	---	8.5			
				G10	6	---	75	---	---	---	6		
				Other	---	---	---	---	---	---	---		
				Other	---	---	---	---	---	---	---		
				Other	---	---	---	---	---	---	---		
				Other	---	---	---	---	---	---	---		
				Other	---	---	---	---	---	---	---		
				Other	---	---	---	---	---	---	---		

^ATest Methods D-1238, 300/1.2 condition; ISO 1133, 300/1.2 condition.

^BTest Methods D-790, 3.2 by 12.7 mm specimen; 50 mm span; 1.3 mm/min cross-head rate; D 638, Type I specimen; ISO 527-2, Type 1A specimen.

^CTest Methods D-648, 1.82 MPa stress; D 790, 3.2 by 12.7 mm specimen, 50 mm span, 1.3 mm/min cross-head rate, tangent; ISO 178, 4 by 10 mm specimen, 64 mm span, (1.0mm/min cross-head rate, chord - all dimensions within allowed tolerances in standards.

^DTest Methods D-792; D 648, 1.82 MPa stress, 3.2 by 12.7 mm specimen, 100 mm support, edgewise; ISO 75-1 and 2, 1.8 MPa stress, 4 by 10 mm specimen, flat, 64 mm support - all dimensions within allowed tolerances in standards.

^ETest Methods D-256, 3.2 by 12.7 mm specimen; D 792; ISO 1183.

^FTest Methods D-25638, 1.3 by 12.7 mm specimen; ISO 180, 4 by 10 mm specimen - all dimensions within allowed tolerances in standards.

TABLE A Reinforced Materials—Detail Requirements

Designation Order Number	Injection Molded Properties	0	1	2	3	4	5	6	7	8	9
4	Tensile Strength, ^A min, —MPa	unspecified	–50	–70	–90	100	125	150	175	200	specify
1	Tensile Strength, ^A min, MPa	unspecified	50	70	90	100	125	150	175	200	specify
2	Flexural Modulus, ^B —min, —MPa	unspecified	3500	4000	5000	6000	7,000	8,000	10,000	13,000	specify
2	Flexural Modulus, ^B min, MPa	unspecified	3500	4000	5000	6000	7000	8000	10 000	13 000	specify
3	Izod Impact, ^C min, J/m	unspecified	40	60	80	100	150	200	400	600	specify
			3.5	6	7.5	10	15	18	35	50	
4	DTUL, ^D MPa, min °C	unspecified	100	125	150	175	200	220	240	260	specify
5	Specific Gravity, ^E min	unspecified	1.1	1.2	1.4	1.6	1.8	2.0	2.2	2.4	specify

^ATest Method D 638, Type I specimens; ISO 527-2, Type 1A specimen.

^BTest Methods D 790, 3.2 by 12.7 mm (within allowed tolerances) specimen, 50 mm span, 1.3 mm/min cross-head rate, tangent modulus; ISO 178, 4 by 10 mm (within allowed tolerances) specimen, 64 mm span, 1.0 mm/min cross-head rate, chord modulus.

^CTest Methods D 256, 3.2 by 12.7 mm (within allowed tolerances) specimen; ISO 180, 4 by 10 mm (within allowed tolerances) specimen.

^DTest Method D 648, deflection temperature under load, 1.82 MPa, 3.2 by 12.7 mm specimen (within allowed tolerances), 100 mm nominal support, edgewise orientation; ISO 75-1 and 2, 1.8 MPa, 64 mm support, flat orientation, 4 by 10 mm specimen (within allowed tolerances).

^ETest Methods D 792; ISO 1183.

TABLE B Unreinforced Materials—Detail Requirements

Designation Order Number	Injection Molded Properties	0	1	2	3	4	5	6	7	8	9
4	Tensile Strength, ^A min, —MPa	unspecified	–40	–20	–30	–40	–50	–60	–70	–80	specify
1	Tensile Strength, ^A min, MPa	unspecified	10	20	30	40	50	60	70	80	specify
2	Tensile Modulus, ^A min, —MPa	unspecified	2100	2400	2700	3000	3300	3600	3900	4200	specify
2	Tensile Modulus, ^A min, MPa	unspecified	2100	2400	2700	3000	3300	3600	3900	4200	specify
3	Izod Impact, ^B min, J/m	unspecified	10	25	50	100	150	200	250	300	specify
			1	2	5	10	15	18	22	27	
4	Vicat Softening Point, ^C —min, °C	unspecified	80	100	120	140	160	180	200	220	specify
4	Vicat Softening Point, ^C min, °C	unspecified	80	100	120	140	160	180	200	220	specify
5	Melt Flow Rate, ^D g/10 —min	unspecified	0.5	1.0	3.0	5.0	7.0	9.0	12.0	15.0	specify
5	Melt Flow Rate, ^D g/10 min	unspecified	0.5	1.0	3.0	5.0	7.0	9.0	12.0	15.0	specify

^ATest Method D 638, Type I specimen, tangent modulus; ISO 527-2, Type 1A specimen, chord modulus at 1.0 mm/min cross-head rate.

^BTest Method D 256, 3.2 by 12.7 mm (within allowed tolerances) specimen; ISO 180, 4 by 10 mm (within allowed tolerances) specimen.

^CTest Methods D 1525, rate B; ISO 306, rate B120.

^DTest Methods D 1238, 300/1.2 condition; ISO 1133, 300/1.2 condition.

TABLE 1 Reinforced and Additive Materials

Symbol	Material	Tolerance (Based on Total Mass)
C	Carbon and graphite fiber-reinforced	± 2 %
G	Glass	± 2 %
M	Mineral reinforced	± 2 %
L	Lubricants	depends upon material and process to be specified
R	Combination of reinforcement or fillers, or both	± 2 %

SUMMARY OF CHANGES

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

D 6339 - 04:

(1) Extensive changes made in Table SPS to update with current grades and performance and add ISO test data where available. Blends have also been added to this Table and the

drying requirements prior to molding of these grades.

(2) ISO references have been added.

(3) Tables A and B were modified to add ISO Izod numbers.

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