Designation: D 5676 – 99

Standard Specification for Recycled Polystyrene Molding and Extrusion Materials[1]

This standard is issued under the fixed designation D 5676; 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 only recycled post-consumer, or post-consumer or industrial/virgin blended polystyrene materials, both crystal and rubber modified, suitable for molding and extrusion.

1.2 This specification is intended as a means of calling out recycled plastic materials used in the fabrication of end items or parts. Material selection should be made by those having expertise in the plastics field after careful consideration of the design and performance required of the part, environment to which it will be exposed, fabrication process to be used, inherent properties to the material other than those covered by this specification, and economics.

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

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

NOTE 1—There is no equivalent ISO standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 256 Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics[2]

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[2]

D 638 Test Method for Tensile Properties of Plastics[2]

D 883 Terminology Relating of Plastics[2]

D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer[2]

D 1525 Test Method for Vicat Softening Temperature of Plastics[2]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins[3]

D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding Extrusion Materials[3]

D 3892 Practice for Packaging/Packing of Plastics[3]

D 4000 Classification System for Specifying Plastic Materials[3]

D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics[4]

D 5577 Guide for Techniques to Separate and Identify Contaminants in Recycled Plastics[4]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[5]

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of technical terms pertaining to plastics used in this specification, see Terminology D 883, and for terms related to recycle, see Guide D 5033.

3.1.2 RPS is an abbreviation chosen for use in this specification to represent recycled polystyrene materials. (See Terminology D 1600 for other abbreviated terms related to plastics.)

4. Classification

4.1 The RPS materials are classified into groups according to levels of recycled material and grade as shown in the basic property table (Table RPS).

4.1.1 To facilitate the incorporation of future or special materials, the "other/unspecified" category (0) for group, class, and grade is given in Table RPS. The basic properties can be obtained from Tables A or B as they apply (see 4.3).

NOTE 2—An example of this classification system for RPS0111 is as follows: The designation RPS0111 would indicate: RPS recycled polystyrene, 1 (group) = 100 % recycled, 1 class = post-consumer, and 1 (grade) = food service with requirements as found in Table RPS.

4.1.2 Although the values listed are necessary to include the range of properties available in existing materials, users should not infer that every possible combination on the properties exists or can be obtained.

[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.

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[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 08.02.

[4] *Annual Book of ASTM Standards*, Vol 08.03.

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

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

TABLE RPS Recycled Polystyrene Materials

Detail Requirements, Natural Color Only[A]				Melt Flow Rate, Test Method D 1238 200/ 5.0 min, g/10 min	Izod Impact[B] (12.7 × 3.2 mm) Test Method D 256, J/M, max	Tensile Strength at Yield, Test Method D 638, MPa, min,[CD]	Elongation at Break, Test Method D 638,% , min[C]	Visual Contamination, Guide D 5577, Method, max %	Vicat Softening Point, Test Method D 1525, Rate B, °C, min
Group	Description	Class	Description[E]						
1	100 % recycle	1	post-consumer			unspecified	unspecified		unspecified
			1 food service	4	30	unspecified	unspecified	0.025	unspecified
			2 EPS	17	25	unspecified	unspecified	0.025	unspecified
			3 FS/curbside	6	20	unspecified	unspecified	0.7	unspecified
			0 other	unspecified	unspecified	unspecified	unspecified	unspecified	unspecified
		2	industrial						
			1 GPPS	6	25	unspecified	unspecified	0.015	unspecified
			2 impact	4	50 (min)	unspecified	unspecified	0.025	unspecified
			3 EPS	6	25	unspecified	unspecified	0.025	unspecified
			0 other	unspecified	unspecified	unspecified	unspecified	unspecified	unspecified
		3	other						
2	blends	1	30 %						
			1	6	80 (min)	25	30	0.03	95
		0	other	unspecified	unspecified	unspecified	unspecified	unspecified	unspecified
		2	55 %						
			1	5	100 (min)	30	20	0.03	100
			2	5	50 (min)	25	30	0.04	95
			0 other	unspecified	unspecified	unspecified	unspecified	unspecified	unspecified
		3	other (% by weight)	unspecified	unspecified	unspecified	unspecified	unspecified	unspecified

[A] All properties determined on injection molded specimen, except visual contamination.
[B] Method A. Specimen taken from center portion of Type I (Test Method D 638) bar.
[C] Tensile properties determined at 5 mm/min strain rate.
[D] Values in this column may be break strength for those materials (that is, GPPS) that do not yield.
[E] Descriptions for 100 % recycled grades refer to sources of recycled material.

4.2 *Reinforcements 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 tolerance tabulated as follows:

Symbol	Material	Tolerance (Based on Total Mass)
C	carbon and graphite fiber-reinforced	±2 %
G	glass	±2 %
M	mineral-reinforced	±2 %
L	lubricants	depends on material and process to be specified
R	combination of reinforcement or fillers, or both	±3 %
Q	recycled material content in blends	±2 %

NOTE 3—This part of the system uses the type and percentages of additive to designate the modification of the basic material. The 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—No property requirements have been identified at this time, as no known sources exist for reinforced materials.

NOTE 5—Ash content of filled or reinforced material may be determined using Test Method D 2584 where applicable.

4.3 Tables A and B have been incorporated into this specification to facilitate the classification of special materials for which Table RPS does not reflect the required properties. Tables A and B shall be used in the same manner. The identifying number is composed of the letter A or letter B and five digits comprising the cell numbers for the new requirements in the designated order as they appear in Table A or B.

NOTE 6—An example of a 100 % RPS of this classification system is as follows. The designation RPS0110A14300 would indicate the following material requirements from Table A:

RPS0110	=	100 %, post-consumer RPS
A	=	Cell Table A for property requirements
1	=	melt flow rate, 3 min
4	=	visual contamination, 0.05 % max
3	=	izod impact, 20 J/m min
0	=	unspecified
0	=	unspecified

NOTE 7—An example of a blended recycled/virgin polystyrene of this classification system is as follows. The designation RPS023Q10 B330 RPS 023Q 10B33062 62 would indicate the following, with the material requirements from Table B:

RPS023(10)	=	RPS blend with 10 % recycle from Table RPS
Q	=	recycled material content 10 % by mass
B	=	Cell Table B for property requirements
3	=	melt flow rate, 5 min
3	=	visual contamination, 0.03 area, % max
0	=	unspecified izod impact
6	=	tensile elongation at break, 30 % min
2	=	vicat softening temperature, 90°C min

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 requirement 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 System D 4000.

NOTE 8—Properties of pigmented or colored RPS materials can differ from the properties of natural or unpigmented RPS material, depending on the choice of colorants and concentration. The main property affected is ductility, as illustrated by a reduction in izod impact strength. Prior testing between the materials supplier and end user should be initiated if specific properties of pigmented RPS materials are necessary.

TABLE A 100 % Recycled RPS Materials

Designation Order No.	Property	Detail Requirements[A] 0	1	2	3	4	5	6	7	8	9
1	Melt flow rate, Test Method D 1238, 200/5.0 g/10 min, min	unspecified	3	6	10	12	15	18	20	22	specify
2	Visual contamination, Guide D 5577, method area %, max	unspecified	0.01	0.02	0.03	0.05	0.1	0.3	0.5	0.8	specify
3	Izod impact 12.7 by 3.2 mm, Method A Test Method D 256, J/M, min	unspecified	50	65	85	100	130	150	200	250	specify
4	Unspecified										
5	Unspecified										

[A] Properties for Izod determined on injection molded specimen.

TABLE B Blends Recycled PS with Virgin PS Materials

Designation Order No.	Property	Detail Requirements[A] 0	1	2	3	4	5	6	7	8	9
1	Melt flow rate, Test Method D 1238, 200/5 g/10 min, min	unspecified	3	4	5	6	7	8	9	10	specify
2	Visual contamination, Guide D 5577 method area %, max	unspecified	0.01	0.02	0.03	0.04	0.05	0.08	0.1	0.15	specify
3	Izod impact 12.7 by 3.2 mm, Method A Test Method D 256, J/M, min	unspecified	50	65	85	100	130	150	200	250	specify
4	Tensile elongation at break, Test Method D 638, Type 1 specimen, 5 mm/min %, min	unspecified	5	10	15	20	25	30	35	40	specify
5	Vicat softening point, Test Method D 1525, Rate B,° C, min	unspecified	85	90	95	100	105	110	115	120	specify

[A] Tensile, vicat and izod properties determined on injection molded specimen.

6. Basic Requirements

6.1 As they apply, basic requirements from Table RPS 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 RPS, A, and B and suffix requirements, as they apply.

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

NOTE 9—See Practice E 29 for specified rounding limits.

9. Sampling

9.1 Statistically adequate sampling to meet the requirements of 13.4 shall be demonstrated. A lot of resin shall be considered to be a unit of manufacture as prepared for shipment and may consist of a blend of two or more production runs or batches of material.

10. Specimen Preparation Injection Compression Molding Process

10.1 The test specimens shall be molded by either an injection or compression molding process, as specified. Injection molding shall be in accordance with Practice D 3641, with the conditions given below:

Injection molded samples:
220 ± 10°C melt temperature
50 ± 10°C mold temperature
average injection velocity 200 nm/s ±100
Compression molded samples:
215 ± 10°C press temperature
2 to 3-mPa mold pressure

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.

11.2 Conduct tests in the standard laboratory atmospheres of 23 ± 2°C and 50 ± 5 % relative humidity in accordance with Practice D 618.

12. Test Method

12.1 Determine the properties enumerated in this specification by means of the ASTM test methods as they apply, unless otherwise stated herein.

13. Inspection and Certification

13.1 Inspection and certification of the material supplied with reference to a specification based on this specification shall be in accordance with 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 those tests that ensure process control during manufacture: melt flow rate and izod.

13.3 Periodic-check inspection shall consist of the tests specified for all requirements of the material under this specification. Inspection frequency shall be adequate to ensure that the material is certifiable in accordance with 13.4.

13.4 Certification shall be that the material was manufactured, sampled, tested, and inspected in accordance with this specification and that the average values meet the requirements at a confidence level of 95 %.

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 polystyrene; recycled; specification

SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification. For the convenience of the user, Committee D-20 has highlighted those changes that may impact the use of this specification. This section may include descriptions of the changes or the reasons for the changes, or both.

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(*1*) In 2.1, deleted reference to Practice D 1898.

(*2*) In Table RPS, added second sentence to Footnote B.

(*3*) In 9.1, deleted reference to Practice D 1898.

(*4*) In Section 15, deleted *line call out*.