



## Standard Specification for Styrene-Maleic Anhydride Materials (S/MA)<sup>1</sup>

This standard is issued under the fixed designation D 4634; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope \*

1.1 This specification covers styrene-maleic anhydride materials suitable for molding or extrusion. Styrene-maleic anhydride materials, being thermoplastic, are reprocessible and recyclable. This specification allows for the use of those materials provided that all the specific requirements of this specification are met.

1.2 The properties included in this standard are those required to identify the compositions covered. There may be other requirements necessary to identify particular characteristics important to specialized applications. These will be agreed upon between the user and the supplier, by using the suffixes as given in Section 5.

1.3 This classification system and subsequent line call out (specification) are intended to provide means of calling out properties of plastic materials used in the fabrication of end items or parts. It is not intended for the selection of materials. Materials should be selected 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, costs involved, and the inherent properties of the material other than those covered by this classification system.

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

1.5 The following precautionary caveat pertains only to the test methods portion, Section 11, of this specification. *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 and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no equivalent or similar ISO standard for S/MA.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

<sup>1</sup> 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 July 10, 1999. Published September 1999. Originally published as D 4634 – 86. Last previous edition D 4634 – 86(1993).

- D 256 Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials<sup>2</sup>
- D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing<sup>2</sup>
- D 638 Test Method for Tensile Properties of Plastics<sup>2</sup>
- D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load<sup>2</sup>
- D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials<sup>2</sup>
- D 883 Terminology Relating to Plastics<sup>2</sup>
- D 1525 Test Method for Vicat Softening Temperature of Plastics<sup>2</sup>
- D 1600 Terminology for Abbreviated Terms Relating to Plastics<sup>2</sup>
- D 1898 Practice for Sampling of Plastics<sup>2</sup>
- D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials<sup>3</sup>
- D 3892 Practice for Packaging/Packing of Plastics<sup>3</sup>
- D 4000 Classification System for Specifying Plastic Materials<sup>3</sup>
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>4</sup>
- 2.2 *Military Standard:*<sup>5</sup>
  - MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes
- 2.3 *Underwriters Laboratories Standard:*<sup>6</sup>
  - UL 94 Standard for Tests for Flammability for Parts in Devices and Appliances

### 3. Terminology

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

<sup>2</sup> Annual Book of ASTM Standards, Vol 08.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 08.02.

<sup>4</sup> Annual Book of ASTM Standards, Vol 14.02.

<sup>5</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

<sup>6</sup> Available from Underwriters Laboratories, Inc., Publications Stock, 333 Pfingsten Road, Northbrook, IL 60062.

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

#### 4. Classification

4.1 Styrene-maleic anhydride materials are classified into groups according to their use either for injection molding, or for extrusion. These groups are subdivided into classes and grades, as shown in Table S/MA.

NOTE 2—An example of this classification system is as follows: The designation S/MA 211 would indicate:

S/MA = Styrene-maleic anhydride,

- 2 = injection-molding resin (group),
- 1 = general purpose (class),
- 1 = requirements given in Table S/MA (grade).

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 S/MA. The basic properties can be obtained from Tables A and B as they apply (see 4.3).

**TABLE S/MA Requirements for Natural Color Only**

Group	Description	Class	Description	Grade	Description	Tensile Strength <sup>A</sup> (D 638) min, MPa	Flexural Modulus <sup>B</sup> (D 790) min, MPa	Izod Impact Strength <sup>C</sup> (D 256) min, J/m	Vicat Softening Point <sup>D</sup> (D 1525) min, °C		
1	Crystal	1	general purpose	1		45	3000	20	120		
				0	other	...	...	...	...		
		2	high-heat resistant	1		45	2900	20	130		
				0	other	...	...	...	...		
		0	other	0		...	...	...	...		
				0	other	...	...	...	...		
		2	Impact-modified, molding	1	general purpose	1		40	2200	140	115
						2		33	2100	170	115
						3		30	2000	200	115
				0	other	0		...	...	...	...
1						45	2200	500	115		
2						34	2200	300	120		
2	high-impact			0		...	...	...	...		
				1		45	2200	500	115		
				2		34	2200	300	120		
0	other			0		...	...	...	...		
				1		35	2500	120	135		
				2		33	2200	210	125		
3	high-heat resistant			0		30	2200	80	125		
				1		35	2500	120	135		
				2		33	2200	210	125		
0	other	0		...	...	...	...				
		1		30	2000	150	120				
		0		...	...	...	...				
5	FR	1		28	1900	130	115				
		2		22	1800	70	115				
		0		...	...	...	...				
0	other	0		...	...	...	...				
		0		...	...	...	...				
		0		...	...	...	...				
3	Impact modified, extrusion	1	general purpose	1		40	2500	140	115		
				2		35	2300	170	115		
				3		30	2200	200	115		
		0	other	0		...	...	...	...		
				1		33	2200	210	125		
				2		30	2200	80	125		
		2	high-heat resistant	0		...	...	...	...		
				1		33	2200	210	125		
				2		30	2200	80	125		
0	other	0		...	...	...	...				
		1		28	1900	130	115				
		2		22	1800	70	115				
0	other	0		...	...	...	...				
		0		...	...	...	...				
		0		...	...	...	...				
0	Other	0	other	0		...	...	...			
				0		...	...	...	...		

<sup>A</sup> Tensile strength determined on 3.2-mm thick injection-molded Type I specimen, tested at 5 mm/min.

<sup>B</sup> Flexural modulus determined on 12.5 by 3.2-mm injection molded specimen, 2-in. span, tangent, Method I, 1.3 mm/s.

<sup>C</sup> Izod impact strength determined on 12.5 by 3.2-mm injection molded specimen. The specimen shall be cut from a bar of 125 mm in length (such as that used in the Vicat test). All specimens shall be taken from the dead end (opposite to gate).

<sup>D</sup> Vicat softening point shall be 1-kg load, 12.5 by 3.2-mm injection molded specimen, Rate B.

**TABLE A Detail Requirements for Reinforced S/MA Materials**

Designation Grade	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
1	Tensile Strength <sup>A</sup> D 638, MPa, min	Unspecified	40	50	60	70	80	90	100	120	<sup>B</sup>
2	Flexural Modulus <sup>C</sup> D 790, MPa, min	Unspecified	3500	4500	5500	6500	7500	8500	10 500	14 000	<sup>B</sup>
3	Izod Impact Strength <sup>D</sup> D 256, J/m, min	Unspecified	20	50	100	150	200	250	300	350	<sup>B</sup>
4	Heat Deflection Temperature <sup>E</sup> D 648, °C, min	Unspecified	90	100	110	120	130	150	170	190	<sup>B</sup>
5	To be determined	...	...	...	...	...	...	...	...	...	...

<sup>A</sup> Tensile strength shall be determined on 3.2-mm thick injection-molded Type I specimen, tested at 5 mm/min.

<sup>B</sup> Specific value appears on drawing or contract, or both.

<sup>C</sup> Flexural modulus shall be determined on 12.5 by 3.2-mm injection molded specimen, 2-in. span, tangent, Method I, 1.3 mm/min.

<sup>D</sup> Izod impact strength shall be determined on 12.5 by 3.2-mm injection-molded specimen. The specimen shall be cut from a bar of 125 mm in length (such as that used in the Vicat test). All specimens shall be taken from the dead end (opposite to gate).

<sup>E</sup> Heat-deflection temperature: 1.8-MPa load, 12.5 by 3.2-mm injection molded specimen.

**TABLE B Detail Requirements for Unreinforced S/MA Materials**

Designation Grade	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
1	Tensile Strength <sup>A</sup> D 638, MPa, min	Unspecified	20	30	40	50	60	70	80	90	<sup>B</sup>
2	Flexural Modulus <sup>C</sup> D 790, MPa, min	Unspecified	1800	2000	2200	2400	2600	2800	3000	3200	<sup>B</sup>
3	Izod Impact Strength <sup>D</sup> D 256, J/m, min	Unspecified	20	50	100	150	200	250	300	350	<sup>B</sup>
4	Vicat Softening Temperature <sup>E</sup> D 1525, °C, min	Unspecified	90	100	110	120	130	150	170	190	<sup>B</sup>
5	To be determined	...	...	...	...	...	...	...	...	...	...

<sup>A</sup> Tensile strength determined on 3.2-mm thick injection-molded Type I specimen, tested at 5 mm/min.

<sup>B</sup> Specific value appears on drawing or contract, or both.

<sup>C</sup> Flexural modulus determined on 12.5 by 3.2-mm injection molded specimen, 2-in. span, tangent, Method I, 1.3 mm/min.

<sup>D</sup> Izod impact strength determined on 12.5 by 3.2-mm injection-molded specimen. The specimen shall be cut from a bar of 125 mm in length (such as that used in the Vicat test). All specimens shall be taken from the dead end (opposite to gate).

<sup>E</sup> Vicat softening point shall be 1-kg load, 12.5 by 3.2-mm injection-molded specimen, Rate B.

4.2 Reinforced versions of the materials are classified in accordance with Table A.

4.2.1 A single letter shall be used for the *major* reinforcement or combination, or both, along with two numbers which indicate the percentage of addition by mass with the tolerances as tabulated as follows:

Symbol	Material	Tolerance
C	carbon	±2 %
G	glass-reinforced	±2 %
L	lubricants (for example, PTFE, graphite, silicone, and molybdenum disulfide)	By agreement between supplier and user
M	mineral-reinforced	±2 %
R	combinations of reinforcements or fillers, or both	±3 % for total reinforcement

NOTE 3—This part of the system uses percent of reinforcements or additives, or both, in the control of the modified basic material. The types and percentages of reinforcements and additives should be shown on the supplier's technical data sheet unless this information is proprietary in nature. If necessary, additional control of these reinforcements and additives can be accomplished by the use of the suffix part of the system, Section 5.

4.2.2 Specific requirements for reinforced, filled, or lubricated materials 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 in which they appear in Table A.

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.

4.2.3 When the grade of the basic material is not known, or is not important, the use of "0" grade classification shall be used for reinforced materials in this system.

NOTE 4—An example of a reinforced styrene-maleic anhydride of this classification system is as follows: The designation S/MA 210G30A22450 would indicate the following, with the material requirements from Table A:

- S/MA 210 = Styrene-maleic anhydride, molding resin, general-purpose
- G30 = Glass reinforced at 30 % nominal (see 4.2.1),
- A = Table A for Property Requirements,
- 2 = 30 MPa Tensile Strength, min,

- 2 = 2000 MPa Flexural Modulus, min,
- 4 = 150 J/M Izod Impact Strength, min,
- 5 = 130°C Heat-Deflection Temperature, min, and
- 0 = Unspecified.

If no properties are specified, the designation would be S/MA 210G30A00000.

4.3 Table B has been incorporated into this specification to facilitate the classification of special materials where Table S/MA or Table A does not reflect the required properties. Table B shall be used in the same manner as Table A.

NOTE 5—An example of a special material using this classification system is as follows: The designation S/MA310B54220 would indicate the following, with the material requirements from Table B.

- S/MA 310 = Styrene-maleic anhydride, extrusion resin, general-purpose,
- B = Table B Property Requirements,
- 5 = 60 MPa Tensile Strength, min,
- 4 = 2400 MPa Flexural Modulus, min,
- 2 = 50 J/m Izod Impact Strength, min,
- 2 = 100°C Vicat Softening Point, min, and
- 0 = Unspecified.

NOTE 6—Mechanical properties of pigmented or colored S/MA materials can differ from the mechanical properties of natural S/MA 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 and tensile elongation values. If specific properties of pigmented S/MA materials are necessary, prior testing between the materials supplier and end user should be initiated. Once these agreements are reached, a classification using Table B should be employed to ensure proper property compliance.

## 5. Suffixes

5.1 When requirements are needed that are not covered in Table S/MA they shall be indicated through the use of suffixes.

5.2 A list of suffixes can be found in Classification System D 4000 (Table 3) and may be used for additional requirements as appropriate. Additional suffixes will be added to that classification system as test methods and requirements are developed and requested.

## 6. Basic Requirements

6.1 Basic requirements from property or cell tables, 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. The color and form of the material shall be as specified in the purchase order or contract. Specification changes due to the effects of colorants shall be noted by both parties and, where necessary, covered by suffixes.

## 8. Detail Requirements

8.1 Test specimens and testing parameters for the various materials shall conform to the requirements prescribed in Tables S/MA, A, and B, and suffix requirements as they apply.

8.2 Observed or calculated values obtained from analysis, measurement, or test shall be rounded off to the nearest unit in the last right-hand place of figures used in expressing the specified limiting value, in accordance with the rounding-off method of Practice E 29. The value obtained is compared

directly with the specified limiting value. Conformance or nonconformance with the specification is based on this comparison.

## 9. Sampling

9.1 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 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 of material.

## 10. Specimen Preparation

10.1 Physical property requirements in Table S/MA are based on injection molded specimens 3.2 mm thick. Test specimens shall be molded in accordance with Practice D 3641.

10.2 Group 3 (extrusion) materials may be compression molded or machined from extruded sheet.

## 11. Test Methods

11.1 The following specimen conditioning and test methods are required:

11.2 Condition test specimens in standard laboratory atmosphere in accordance with Procedure A (40/23/50) of Practice D 618 before performing the required tests. Specimens will not be annealed.

11.3 Perform all tests in the standard laboratory atmosphere (23/50) in accordance with Practice D 618.

11.4 *Tensile Strength (Maximum Stress)*—Test Method D 638, Type 1, 3.2 mm, at 5-mm/min crosshead speed.

11.5 *Flexural Modulus (Tangent Method)*—Test Methods D 790 with 12.5 by 3.2-mm injection molded bar with 2-in. support span and tested at 1.3-mm/mm crosshead speed.

11.6 *Izod Impact*—Test Methods D 256 with a 12.5 by 3.2-mm injection molded bar 125 mm in length. Mill the notch in the bar at the dead end (most distant from the gate)

11.7 *Vicat Softening Point*—Test Method D 1525 with 1-kg load at Rate B. Obtain specimens from 12.5 by 3.2 by 125-mm injection molded bar.

11.8 *Heat Deflection Temperature (DTUL)*—Test Method D 648, 1.8-MPa load on 12.5 by 3.2 by 125-mm injection molded bar. Specimens shall not be annealed.

## 12. Inspection and Certification

12.1 Inspection and certification of S/MA material supplied with reference to this specification based on this classification system shall be for conformance to the requirements specified herein.

12.2 *Lot-Acceptance Inspection*—Lot acceptance inspection shall be the basis on which acceptance or rejection of the lot is made.

12.3 Periodic check inspection with reference to this specification based on this classification system shall consist of the tests for all the requirements of the material under this specification. Inspection frequency shall be adequate to ensure that the material is certifiable in accordance with 12.4.

12.4 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 this classification system (line call out).

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

### 13. Packaging, Packing, and Marking

13.1 The provisions of Practice D 3892 apply to the packaging, packing, and marking of containers for plastic materials.

### 14. Keywords

14.1 extrusion; high-heat resistant; molding; styrene copolymers; styrene-maleic anhydride

## QUALITY ASSURANCE PROVISION FOR GOVERNMENT/MILITARY PROCUREMENT

S1. Selection of acceptable quality level (AQL) and of inspection level (IL) shall be made with consideration of the specific use requirements. This is discussed in Practice D 1898, in the “Sections-Means and Standard Deviations,” and “Comparison of Sampling Plans” with reference to MIL-STD-105. In the absence of contrary requirements, the following values shall apply:

Testing (polymer unfabricated)	IL	AQL
	SL <sup>A</sup>	...

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

## 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 also include descriptions of the changes or reasons for the changes, or both.

*D 4634 – 99:*

- (1) Revised for five-year reapproval.
- (2) Editorial changes were made throughout.

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