Designation: D 4474 – 00

Standard Classification System for Styrenic Thermoplastic Elastomer Injection Molding and Extrusion Materials (TES)[1]

This standard is issued under the fixed designation D 4474; 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.

INTRODUCTION

This classification system is intended to be a means of calling out materials used in the fabrication of end items or parts. It is not intended for the selection of materials. 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, 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 classification system, and the economics.

1. Scope *

1.1 This classification and subsequent line callout (specification) cover styrenic block copolymer thermoplastic elastomer materials for injection molding and extrusion. Copolymers consist of polystyrene segments bound to rubbery segments. The rubbery segments may be saturated or unsaturated. Compounding ingredients may be present as necessary for the application. The compounding ingredients may consist of reinforcements, resins, plasticizers, fillers, stabilizers, and colorants. Recycled styrenic thermoplastic elastomers are not covered in this classification.

1.2 The properties included in this classification are those required to identify the compositions covered. There may be other requirements necessary to identify particular characteristics that are important to specialized applications. These may be described by using the suffixes specified in Section 5.

1.3 The values stated in SI units, as detailed in IEEE/ASTM SI 10, are to be regarded as the standard.

NOTE 1—There is no equivalent ISO standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension[2]

D 618 Practice for Conditioning Plastics for Testing[3]

D 624 Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers[2]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[3]

D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement[3]

D 883 Terminology Relating to Plastics[3]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[3]

D 1898 Practice for Sampling of Plastics[4]

D 2240 Test Method for Rubber Property—Durometer Hardness[2]

D 3892 Practice for Packaging/Packing of Plastics[5]

D 4000 Classification System for Specifying Plastic Materials[5]

D 5740 Guide for Writing Material Standards in the Classification D 4000 Format[6]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specification[7]

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI): The Modern Metric System [8]

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of technical terms pertaining to plastics used in this classification, see Terminology D 883.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *styrenic thermoplastic elastomer (TES)*— a copolymer material comprising styrenic end-block segments which are

[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] *Annual Book of ASTM Standards*, Vol 09.01.

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

[4] Discontinued 1998; see *1997 Annual Book of ASTM Standards*, Vol 08.01.

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

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

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

[8] *Annual Book of ASTM Standards*, Vol 14.04.

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

bound to a rubbery segment that may be saturated or unsaturated and which normally contain substantial amounts of added materials such as other polymers, oils, fillers, and colorants.

3.2.2 *unsaturated styrenic thermoplastic elastomer (TESU)*—a copolymer material comprising styrenic end-blocks which are bound to an unsaturated rubbery segment.

3.2.3 *saturated styrenic thermoplastic elastomer (TESS)*—a copolymer material comprising styrenic end-blocks which are bound to a saturated rubbery segment.

3.2.4 *thermoplastic elastomers (TPE)*—a diverse family of rubber-like materials that, unlike conventional vulcanized rubbers, can be processed and recycled like thermoplastic materials.

4. Classification

4.1 Styrenic thermoplastic elastomer materials are classified into groups according to their basic composition. These groups are subdivided into classes and grades as shown in Table TES.

4.1.1 An example of this classification system is as follows: The designation TES 0112 would indicate TES = thermoplastic elastomerstyrenic, as found in Terminology D 1600, 01 (group) = saturated rubber, 1 (class) = low hardness, and 2 (grade) with requirements given in Table TES.

4.1.2 To facilitate the incorporation of future or special materials, the "other/unspecified" category (0) for group, class, and grade is shown in Table TES. The basic properties can be obtained from Table A.

4.2 Styrenic thermoplastic elastomers suitable for injection molding and extrusion are fully compounded materials of a proprietary nature. Consequently, there is no distinction between reinforced and unreinforced versions. This part of the callout is omitted.

4.3 Specific requirements shall be shown by a six character designation. The designation will 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.

4.3.1 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.

4.3.2 An example of this classification system is as follows: The designation TES 0110 A22240 would indicate the following, with the material requirements from Table A:

TES 0110 = Styrenic saturated thermoplastic elastomer having low hardness from Table TES.

A = Table A property requirements,
2 = 50 Durometer A hardness, min,
2 = 50 MPa flexural modulus, min,
2 = 5.0 MPa tensile strength, min,
4 = 500 % elongation, min, and
0 = Unspecified.

If no properties are specified, the designation would be TES 0110 A00000.

TABLE TES Detail Requirements for Styrenic Thermoplastic Elastomers

Group	Description	Class	Description	Grade	Description	Hardness, ASTM D 2240, A/D Durometer Typical	Flexural Modulus, ASTM D 790, min, MPa	Tensile Strength, ASTM D 412, min, MPa	Elongation, (Ultimate) ASTM D 412, min, %	Tear Resistance, ASTM D 624, Die C, min, KN/m	Specific Gravity, ASTM D 792, ± 0.02,
01	Saturated rubber segment	1	Low hardness	1		47A	<10	3.0	500	13	1.19
				2		55A	<10	9.0	600	15	0.92
				3		59A	11	4.0	500	16	1.20
				0	Other						
		2	Medium hardness	1		82A	52	7.8	450	47	1.01
				2		89A	130	3.9	300	21	1.86
				3		91A	125	9.0	450	36	1.14
				0	Other						
		3	High hardness	1		45D	480	11	400	50	1.20
				2		44D	310	12	400	70	1.14
				3		49D	360	4.1	200	26	1.83
				4		57D	450	15	500	85	1.02
				5		60D	520	13	350	98	0.91
				6		64D	1480	15	350	76	1.29
				0	Other						
		0	Other	0	Other						
02	Unsaturated rubber segment	1	Low hardness	0	Other						
		2	Medium hardness	0	Other						
				0	Other						
		3	High hardness	1		47D	250	6.7	300	52	1.05
				0	Other						
		0	Other	0	Other						
00	Other	0	Other	0	Other						

TABLE A Detail Requirements Styrenic Thermoplastic Elastomers

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Hardness, ASTM D 2240, A/D Durometer, min	Unspecified	40A	50A	60A	70A	80A	40D	50D	60D	Specify value
2	Flexural modulus ASTM D 790, MPa, min	Unspecified	10	50	100	200	300	500	700	900	Specify value
3	Tensile Strength, ASTM D 412, MPa, min	Unspecified	3.0	5.0	7.0	9.0	11.0	13.0	15.0	17.0	Specify value
4	Elongation, ASTM D 412, %, min	Unspecified	200	300	400	500	600	700	800	900	Specify value
5	To be determined										

5. Suffixes

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 conditions 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.

5.1.1 Additional suffixes will be added to this classification as test methods and requirements are developed or requested, or both.

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.

8. Detail Requirements

8.1 Test specimens for the materials shall conform to the requirements prescribed in Tables TES, A, 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 Prepare all test specimens by cutting test pieces from injection-molded plaques in accordance with the following procedures.

NOTE 2—Physical and mechanical properties are dependent upon the technique of specimen preparation. Specimen preparation by means other than those described below can lead to significant variation in test results, with resultant departure from specification values.

10.1.1 *Plaque*—Prepare test specimens by cuttings made from an injection molded plaque of 3.1- to 3.3-mm thickness and dimensions similar to those shown in Fig. 1. The temperature of the mold shall be 20 to 70°C, depending on product grade. Make temperature measurements with a surface pyrometer, or equivalent, to an accuracy of ±2°C after equilibrium cycle conditions have been established. For grades having saturated rubber segments, the molding cycle time shall be 30 to 40 s total with 10 to 13 s plunger forward (including 8 to 10 s holding time), 15 to 20 s cooling, and 5 to 8 s mold-open time. For grades having unsaturated rubber segments, the molding cycle time shall be 35 to 50 s total with 15 to 20 s plunger forward (including 8 to 10 s hold time), 15 to 20 s cooling, and 5 to 8 s mold-open time. Set the stock temperature for molding the plaque at 220 to 225°C for saturated rubber grades and 175 to 180°C for unsaturated types. Set injection pressures to fill the mold with little or no flash.

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 atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity in accordance with Practice D 618.

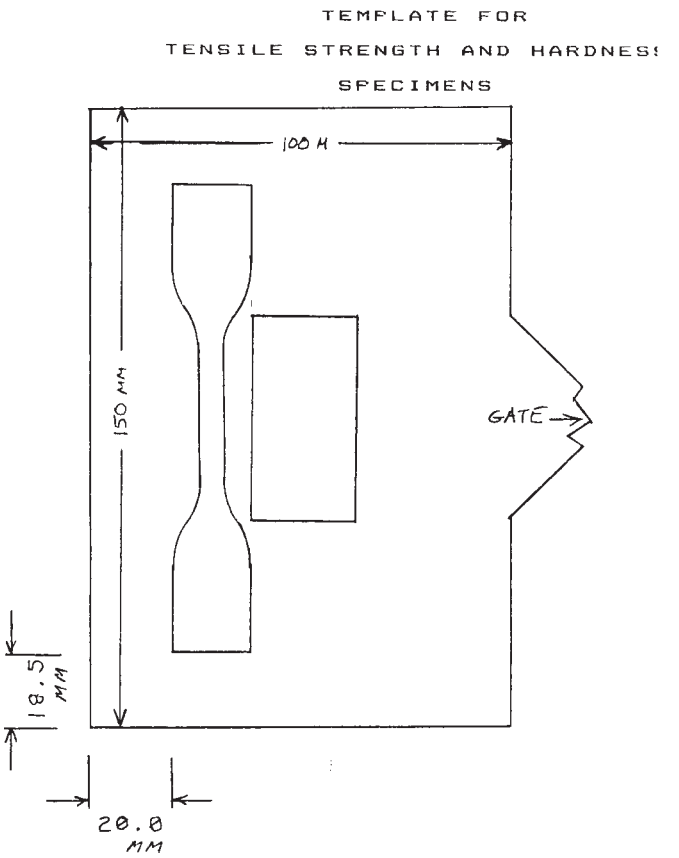

FIG. 1 Template for Tensile Strength and Hardness Specimens

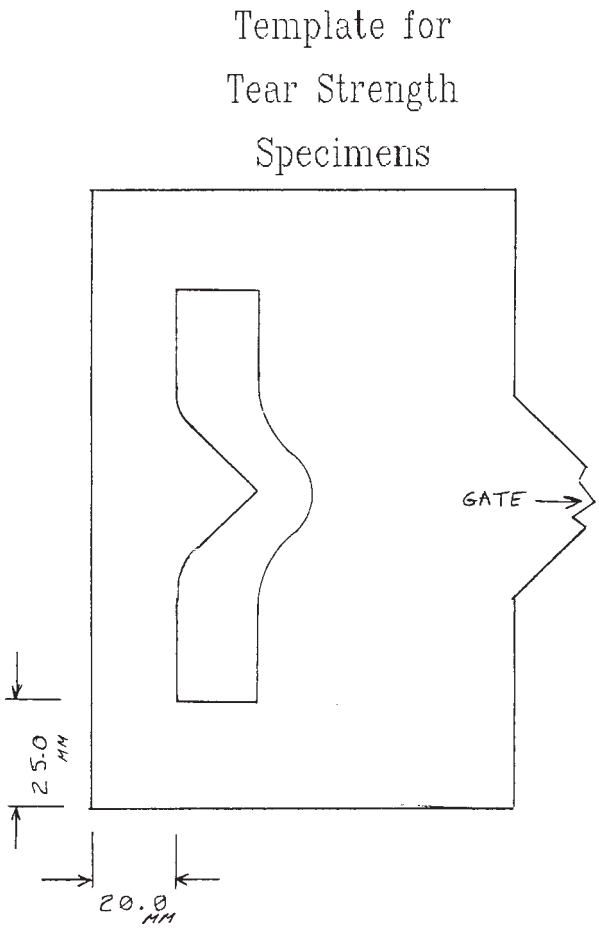

FIG. 2 Template for Tear Strength Specimens

12. Test Methods

12.1 Determine the properties that are enumerated in this classification in accordance with the ASTM test methods listed.

12.2 *Tensile Strength and Elongation*:

12.2.1 Test for tensile strength and elongation at break using Test Methods D 412. Die cut the specimen from the plaque using a Type C die at the location shown in Fig. 1. Only one dumbbell shall be taken from each plaque and must be taken from the same location on each plaque.

12.2.2 Use extensometers accurate to 1 mm.

12.2.3 Rulers or scales are not acceptable for determining elongation.

12.3 *Flexural Modulus*:

12.3.1 Evaluate materials for flexural modulus using Test Methods D 790.

12.3.2 Cut specimens from injection-molded plaques having the dimensions 125 mm by 12.7 mm by 3.2 mm (see Test Methods D 790, Test Specimens, Molding Materials (Thermoplastics and Thermosets)). Die cut specimens with their long axes in the direction parallel to the long dimension of the plaque.

12.3.3 The span between the supports shall be 50 mm.

12.3.4 The crosshead speed shall be 12.7 mm/min.

12.3.5 Report flexural modulus as the tangent modulus.

12.4 *Tear Strength*:

12.4.1 Determine tear strength using Test Method D 624.

12.4.2 Die cut the specimen using a Die C from the location shown in Fig. 2.

12.4.3 Use a testing speed of 500 mm/min (20 in./min).

12.5 *Hardness*:

12.5.1 Test for durometer hardness using Test Method D 2240. Use durometer scale “A” for materials having Type A values of 90 or less. Cut rectangular specimens from the injection-molded plaques at the location shown in Fig. 1 and plied to 6.4 mm (.250 in.) or 2 plies.

12.5.2 Use durometer scale “D” for materials having Type A values above 90.

12.5.3 Take the hardness reading 10 s after the indentor is applied to the specimen.

12.6 *Specific Gravity*:

12.6.1 Evaluate materials for specific gravity using Test Methods D 792.

12.6.2 Cut the materials specimens from injection-molded plaques in an area at least 50 mm (2 in.) from the gate.

12.6.3 The mass of the sample used for specific gravity determination shall be greater than 1 g.

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 *Periodic Check Inspection*—The periodic check inspection shall consist of the test specified for all requirements of the material under this specification.

13.3 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).

13.4 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 latest periodic check inspection.

14. Packaging and Marking

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

15. Keywords

15.1 line callout; plastic; styrenic; thermoplastic elastomer

SUMMARY OF CHANGES

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

D 4474 – 00:

(*1*) Revised 3.2.1 to include after the word unsaturated "and which normally contain substantial amounts of added materials such as other polymers, oils, fillers, and colorants."

(*2*) Deleted 3.2.1.1, Discussion.

(*3*) Added new 3.2.2.

(*4*) Added new 3.2.3.

(*5*) Revised existing 3.2.2 to 3.2.4.

(*6*) 12.3.1—Removed reference to Procedure B.