Designation: D3489 – 17

Standard Test Methods for Microcellular Urethane Materials[1]

This standard is issued under the fixed designation D3489; 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 These test methods cover the preparation of a standard-size test sample and basic tests for physical property determinations of microcellular urethane materials.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.3 *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 known ISO equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
D395 Test Methods for Rubber Property—Compression Set
D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
D573 Test Method for Rubber—Deterioration in an Air Oven
D575 Test Methods for Rubber Properties in Compression
D624 Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D883 Terminology Relating to Plastics
D1052 Test Method for Measuring Rubber Deterioration—Cut Growth Using Ross Flexing Apparatus
D1622 Test Method for Apparent Density of Rigid Cellular Plastics
D1630 Test Method for Rubber Property—Abrasion Resistance (Footwear Abrader)
D2240 Test Method for Rubber Property—Durometer Hardness
D2584 Test Method for Ignition Loss of Cured Reinforced Resins
D2632 Test Method for Rubber Property—Resilience by Vertical Rebound
D3040 Practice for Preparing Precision Statements for Standards Related to Rubber and Rubber Testing (Withdrawn 1987)[3]
D3137 Test Method for Rubber Property—Hydrolytic Stability
D3389 Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform Abrader)
D3574 Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams
D3768 Test Method for Microcellular Urethanes—Flexural Recovery
D3769 Test Method for Microcellular Urethanes—High-Temperature Sag
G195 Guide for Conducting Wear Tests Using a Rotary Platform Abraser

3. Terminology

3.1 For definitions of terms used in this test method and associated with plastics issues refer to the terminology contained in standard D883.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *microcellular urethane*—an elastomeric material made by the interaction of a polyol and an organic isocyanate, having cell diameters in the range from 0.0001 to 0.001 mm, with a minimum density of 160 kg/m^3 (10 lb/ft^3).

NOTE 2—In the following sections, the term "retaining the molded surfaces" refers to the two major surfaces (faces) of the sample and/or specimens prepared from it and was not meant to include the minor surfaces (ends or sides).

[1] These test methods are under the jurisdiction of ASTM Committee D20 on Plastics and are the direct responsibility of Subcommittee D20.22 on Cellular Materials - Plastics and Elastomers.

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[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* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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

4. Summary of Test Method

4.1 Unless otherwise specifically stated and agreed upon by the purchaser and the supplier, all tests shall be made in accordance with the methods specified in Sections 7-23, which include test procedures for the following:

Tests	Sections
Density	7
Tensile Properties	8
Tear	9
Hardness	10
Compression Set	11
Compression Deflection	12
Resilience	13
Abrasion Resistance	14
Surface and Core Abrasion	15
Heat Aging	16
Hydrolytic Resistance	17
Cut Growth Resistance	18
Impact Strength	19
Flexural Modulus	20
Ash	21
Flexural Recovery	22
High-Temperature Sag	23

5. Significance and Use

5.1 Tests made on materials herein prescribed have the potential to give considerable value in comparing physical properties of different materials, in controlling manufacturing processes, and as a basis for writing specifications.

5.2 Before proceeding with these test methods, if appropriate, make reference to the specification associated with the material or product being tested. Any test specimen preparation, conditioning, dimensions, testing parameters, or combination thereof, covered in the ASTM materials or product specification shall take precedence over those mentioned in these test methods. If there are no relevant ASTM specifications, then the default conditions apply.

6. Sampling

6.1 Test samples are to be made in a suitable mold. The following three sizes are recommended (length, width, and thickness): 305 by 152 by 3.15 mm (12 by 6 by ⅛ in.), 305 by 152 by 6.3 mm (12 by 6 by ¼ in.), and 305 by 152 by 12.5 mm (12 by 6 by ½ in.).

6.2 The procedure used to prepare the test sample relating to component ratios, temperature, mixing direction, mold temperature, and curing conditions shall conform to the manufacturer's recommendations.

6.3 The test sample shall be allowed to age a minimum of 40 h before testing, at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity.

7. Density

7.1 Determine the density in accordance with either Test Method D792 or Test Method D1622. Prepare test specimens retaining the molded surfaces. If using Test Method D1622, report any deviations from the specified minimum specimen size.

8. Tensile Properties

8.1 Determine the tensile properties in accordance with Test Method D412. Cut tension specimens using the Die A or any other suitable die in accordance with Test Method D412 from the 3.15-mm (⅛-in.) or 6.3-mm (¼-in.) test sample. Retain the molded surfaces.

8.2 *Precision*—These precision statements were prepared in accordance with the statistical and other testing terminology and concepts presented in Practice D3040.

8.2.1 The precision of this test method was determined from an interlaboratory study of one microcellular urethane material. One laboratory made the microcellular urethane material. One laboratory made the microcellular urethane material plaques, and three laboratories tested the material on two days.

8.2.2 Table 1 gives the LQC precision data as obtained in the interlaboratory program. The values given are equivalent to" repeatability" for within laboratories testing and "reproducibility" for among laboratories testing.

8.2.3 A "test result" is the average result from the testing of three dumbbell specimens.

9. Tear

9.1 Using Die C, determine the tear strength in accordance with Test Method D624. Cut the specimen from the 3.15-mm (⅛-in.) sample, retaining the molded surface.

9.2 Determine the split tear (Type T or trouser tear) strength in accordance with Test Method D624. Cut the Type T specimen from the 3.15-mm (⅛-in.) sample. The direction of tear shall include both molded surfaces.

9.3 Determine the block tear in accordance with Test Methods D3574, except the specimen shall be 19.0 mm (0.75 in.) wide by 12.5 mm (0.5 in.) thick. The tear direction shall be through the core retaining both molded surfaces.

10. Hardness

10.1 Determine the hardness in accordance with Test Method D2240 on the 6.3-mm (¼-in.) thick sample. The Type A, or Type D durometer, or both, shall be used. Report the 5-s drift value and the type durometer used. If the determination is to be made at subnormal temperatures, condition the instrument at the same temperature. To prevent moisture from damaging the instrument, it is advisable to place the tester directly in a desiccator after removing from the cold box.

TABLE 1 LQC Test Precision of Tensile Property Test

Property	Mean	Within Laboratories		Among Laboratories	
		S	LSD	S	LSD
100 % tensile stress, MPa (psi)	2.2 (324)	0.08 (12)	0.24 (34)	0.13 (19)	0.38 (54)
Tensile strength, MPa (psi)	4.3 (624)	0.18 (26)	0.51 (74)	0.24 (35)	0.69 (99)
Elongation, 90 %	297	9	25	11	31

11. Compression Set

11.1 Determine the compression set in accordance with Test Methods D395, Method B, using 22 h at 70°C (158°F). Cut the specimen from the 12.5-mm (0.5-in.) sample, retaining the molded surfaces.

12. Compression Deflection

12.1 Determine the compression deflection at 25 % deflection in accordance with Test Method D575, Test Method A. Cut the specimen from the 12.5-mm (0.5-in.) sample, retaining the molded surfaces. The sample is not preflexed. The initial compression value is reported.

13. Resilience

13.1 Determine the resilience by vertical rebound test in accordance with Test Method D2632. Cut the specimen from the 12.5-mm (0.5-in.) sample, retaining the molded surfaces.

14. Abrasion Resistance

14.1 Determine the surface abrasion resistance by employing a Taber Abraser using the weight (mass) loss procedure described in Test Method D3389 with the following parameters: H-18 wheels, vacuum suction force set at maximum, vacuum pickup nozzle gap of 7 ± 1 mm and abrading wheel loading of 1000 g per wheel. Conduct test on a 100 mm by 100 mm (4 in. by 4 in.) specimen with a 6.3 mm (¼ in.) center hole either from the 6.3 mm (¼ in.) or 12.5 mm (½ in.) sample. If the vacuum lifts the 6.3 mm thick specimen during the test, retest using a clamping ring with a 105 mm (4 ⅛ in.) diameter circular specimen. Report the mass loss in mg/1000 cycles.

NOTE 3—Guide G195 is available as a reference for conducting wear tests using a rotary platform, double-head abraser.

15. Surface and Core Abrasion

15.1 Determine the surface and core abrasion, using the general procedure in Test Method D1630. Cut or mold the specimens from the 12.7-mm (0.5-in.) slab to conform to the dimension in Test Method D1630. Mount the specimens in the specimen holders and place on the surface of the sandpaper. Set the dial gages at zero and at the end of every 1.25 mm (0.05 in.) of wear, record the number of cycles until a total wear of 3.8 mm (0.15 in.) has occurred. Report the number of cycles to wear 1.25 mm as the surface abrasion (SA 50) and the number of cycles to abrade the next 2.54 mm (0.10 in.) as the core abrasion (CA 100).

16. Heat Aging

16.1 Determine the accelerated heat aging in accordance with Test Method D573 for 2 days at 100°C.

17. Hydrolytic Resistance

17.1 Determine the hydrolytic resistance in accordance with Test Method D3137. Report the percent change in tensile strength in accordance with 8.1.

17.2 Determine the hydrolytic resistance in a steam autoclave, at Procedure J_1 for 3 h at 105 ± 3°C, or Procedure J_2 for 5 h at 120 ± 5°C in accordance with Test Methods D3574. Report the percent change in tensile strength in accordance with 8.1.

18. Cut Growth Resistance

18.1 Determine the cut growth resistance on the Ross Flexing Machine in accordance with Test Method D1052. Cut the specimens from the 6.3-mm (¼-in.) or 12.5-mm (½-in.) thick sample. If subnormal temperature testing is to be done, condition the specimen for a minimum of 30 min after reaching the specified temperatures before starting the test.

19. Impact Strength

19.1 Determine the brittle impact properties in accordance with Test Method D256 on the 12.5-mm (½-in.) specimen with the mold surface in accordance with Test Method A or E at −30°C (−22°F). If no test temperature has been specified, the following temperatures are recommended: −10, −25, and −40°C (+14, −13, and −40°F).

20. Flexural Modulus

20.1 Determine flexural modulus, using the general procedure in Test Methods D790, Procedure A.

20.2 The following test parameters are recommended for microcellular urethanes:

20.2.1 *Specimen Size*—Length 75 ± 0.5 mm (3.0 ± 0.02 in.), width 25 ± 0.5 mm (1.0 ± 0.02 in.), and thickness 3.2 ± 0.2 mm (0.125 ± 0.01 in.).

20.2.2 *Span*—50 mm (2.0 in.).

20.2.3 *Rate of Crosshead Motion*—0.20 ± 0.02 mm/s (0.5 in./min).

20.2.4 *Calculation*—Calculate the tangent modulus of elasticity. See the Calculations section of Test Methods D790. When calculating slope, use the steepest tangent as shown in Fig. 1

NOTE 4—The crosshead rate of 0.2 mm/s (0.5 in./min) differs from the rate of 0.02 mm/s (0.05 in./min) specified in Test Methods D790. Test data have shown that the faster rate provides a lower coefficient of variation than does the slower rate.

20.2.5 Condition a specimen at the test temperature for a minimum of 30 min.

20.3 *Precision:*

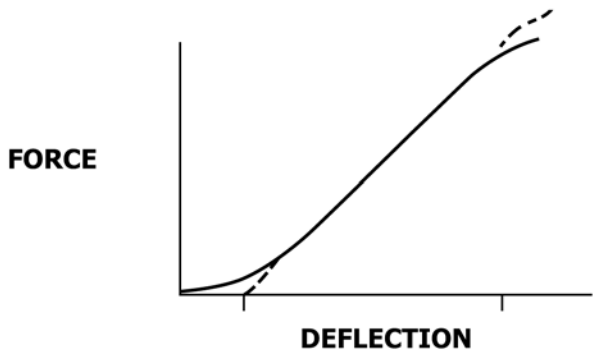

FIG. 1 Determination of Tangent Modulus of Elasticity

20.3.1 This precision statement has been prepared in accordance with Practice D3040. Please refer to Practice D3040 for terminology and other testing and statistical concept explanation.

20.3.2 These precision data are based on limited data. The number of participating laboratories and property levels tested are included in the precision statement summary.

20.3.3 For the LQC (Laboratory Quality Control) test precision expressed in relative terms, see Table 2.

21. Ash

21.1 Determine the ignition loss of microcellular urethane in accordance with Test Method D2584.

22. Flexural Recovery

22.1 Determine the flexural recovery of microcellular urethane in accordance with Test Method D3768.

23. High-Temperature Sag

23.1 Determine the heat sag of microcellular urethane in accordance with Test Method D3769.

23.2 The length of the specimen, temperature, and time vary in some specifications, which shall be consulted and referenced when reporting results.

24. Report

24.1 Report the following information:
24.1.1 Complete identification of the material,
24.1.2 Test methods used and thickness of specimen, and
24.1.3 Any modification of test method or procedure.

25. Precision and Bias

25.1 Precision statements are found within the individual test methods called out in these test methods.

26. Keywords

26.1 microcellular; test method; urethane

TABLE 2 Precision of Flexural Modulus Test

Test Method	Property Range Tested	No. of Property Levels Tested	Repeatability		Reproducibility		Participating Laboratories
			CV (%)	(LSD)[A] (%)	*CV (%)*	(LSD)[A] (%)	
Flexural modulus	140 to 700 MPa (2.0 to 10.0 × 10^4 psi)	4	2.9	8.2	6.2	12.7	6

[A] Least significant difference between the means of three individual test results based on a 95 % confidence limit.

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D3489 - 11) that may impact the use of this standard. (March 1, 2017)

(1) Added ASTM D883 to the Referenced Documents.
(2) Added reference to D883 in Terminology section
(3) Added new Summary of the Test Methods Sections (sequential sections will be renumbered).
(4) Edited Significance and Use Section to conform with wording with D4968.
(5) Removed permissive language in renumbered Sections 6, 23, and 25.
(6) Changed referenced section in Section 17.
(7) Changed temperature in 17.2 to agree with value in referenced standard D3574.