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Standard Test Methods for Rubber—Microcellular Urethane[1]

This standard is issued under the fixed designation D 3489; 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 rubber.

1.2 The values stated in SI units are to be regarded as the 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 similar or equivalent ISO standard to these test methods.

2. Referenced Documents

2.1 *ASTM Standards:*

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

D 395 Test Methods for Rubber Property—Compression Set[3]

D 412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension[3]

D 573 Test Method for Rubber—Deterioration in an Air Oven[3]

D 575 Test Methods for Rubber Properties in Compression[3]

D 624 Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers[3]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[2]

D 1044 Test Method for Resistance of Transparent Plastics to Surface Abrasion[2]

D 1052 Test Method for Measuring Rubber Deterioration—Cut Growth Using Ross Flexing Apparatus[3]

D 1630 Test Method for Rubber Property—Abrasion Resistance Footwear Abrader[3]

D 1938 Test Method for Tear Propagation Resistance of Plastic Film and Thin Sheeting by a Single-Tear Method[2]

D 2240 Test Method for Rubber Property—Durometer Hardness[3]

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins[4]

D 2632 Test Method for Rubber Property—Resilience by Vertical Rebound[3]

D 3040 Practice for Preparing Precision Statements for Standards Related to Rubber and Rubber Testing[5]

D 3137 Test Method for Rubber Property—Hydrolytic Stability[3]

D 3574 Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams[6]

D 3768 Test Method for Microcellular Urethanes—Flexural Recovery[6]

D 3769 Test Method for Microcellular Urethanes—High-Temperature Sag[6]

3. Terminology

3.1 *Description of Term Specific to This Standard:*

3.1.1 *microcellular urethane*—a rubber 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).

4. Significance and Use

4.1 Tests made on materials herein prescribed can be of considerable value in comparing physical properties of different materials, in controlling manufacturing processes, and as a basis for writing specifications.

4.2 Before proceeding with these test methods, reference should be made to the specification of the material being tested. Any test specimen preparation, conditioning, or dimensions, or

[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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This revision includes addition of the following: an ISO equivalency statement, a material specifications statement, and a keywords section. Also, this revision now references another ASTM test method for the Ash Test.

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

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

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

[5] Discontinued—see *1987 Annual Book of ASTM Standards*, Vols 09.01 and 09.02.

[6] *Annual Book of ASTM Standards*, Vol 09.02.

combination thereof, and testing parameters covered in the materials specification shall take precedence over those mentioned in these test methods. If there are no material specifications, then the default conditions apply.

5. Sampling

5.1 Test samples can be made in any 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.).

5.2 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.

5.3 The test sample shall be allowed to age a minimum of 48 h before testing, at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity.

6. Density

6.1 *Procedure*—Section density can be determined on any thickness of molded material. The minimum specimen size shall be 8.19 cm^3 (0.5 $in.^3$). Weigh and measure the volume of the specimen. Calculate the density as follows:

$$\text{Density, kg/m}^3 = \frac{W}{V}$$

where:

W = mass of specimen, kg, and
V = volume of specimen, m^3.

6.2 *Report*—Report the following information:

6.2.1 Density, to the nearest 1.6 kg/m^3, and

6.2.2 Thickness.

7. Tensile Properties

7.1 Determine the tensile properties in accordance with Test Methods D 412. Cut tension specimens using the Die A or any other suitable die in accordance with Test Methods D 412 from the 3.15-mm (⅛-in.) or 6.3-mm (¼-in.) test sample. Retain the molded surfaces.

7.2 *Precision*—These precision statements were prepared in accordance with the statistical and other testing terminology and concepts presented in Practice D 3040.

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

7.2.2 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.

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

8. Tear

8.1 Using Die C, determine the tear strength in accordance with Test Method D 624. Cut the specimen from the 3.15-mm (⅛-in.) sample, retaining the molded surface.

8.2 Determine the split tear strength in accordance with Test Method D 1938. Cut the specimen from the 3.15-mm (⅛-in.) sample. The direction of tear shall include both molded surfaces.

8.3 Determine the block tear in accordance with Test Methods D 3574, 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.

9. Hardness

9.1 Determine the hardness in accordance with Test Method D 2240 on the 6.3-mm (¼-in.) thick sample. Report the initial and 5-s drift value. 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.

10. Compression Set

10.1 Determine the compression set in accordance with Test Methods D 395, 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.

11. Compression Deflection

11.1 Determine the compression deflection at 25 % deflection in accordance with Test Methods D 575. 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.

12. Resilience

12.1 Determine the resilience by vertical rebound test in accordance with Test Method D 2632. Cut the specimen from the 12.5-mm (0.5-in.) sample, retaining the molded surfaces.

13. Abrasion Resistance

13.1 Determine the surface abrasion resistance by the Taber Abraser in accordance with Test Method D 1044 using the H18 wheels and 1000-g mass pieces. Cut the specimen from the 6.3-mm (¼-in.) or 12.5-mm (½-in.) sample. Report the mass loss in mg/1000 cycles.

14. Surface and Core Abrasion

14.1 Determine the surface and core abrasion, using the general procedure in Test Method D 1630. Cut or mold the

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

specimens from the 12.7-mm (0.5-in.) slab to conform to the dimension in Test Method D 1630. 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).

15. Heat Aging

15.1 Determine the accelerated heat aging in accordance with Test Method D 573 for 2 days at 100°C.

16. Hydrolytic Resistance

16.1 Determine the hydrolytic resistance in accordance with Test Method D 3137. Report the percent change in tensile strength in accordance with 7.1.

16.2 Determine the hydrolytic resistance in a steam autoclave, at Condition A for 3 h at 105°C, or Condition B for 5 h at 125°C in accordance with Test Methods D 3574. Report the percent change in tensile strength in accordance with 7.1.

17. Cut Growth Resistance

17.1 Determine the cut growth resistance on the Ross Flexing Machine in accordance with Test Method D 1052. 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.

18. Impact Strength

18.1 Determine the brittle impact properties in accordance with Test Method D 256 on the 12.5-mm (½-in.) specimen with the mold surface in accordance with Test Method A or B 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).

19. Flexural Modulus

19.1 Determine flexural modulus, using the general procedure in Test Methods D 790, Method I.

19.2 The following test parameters are recommended for microcellular urethanes:

19.2.1 *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.).

19.2.2 *Span*—50 mm (2.0 in.).

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

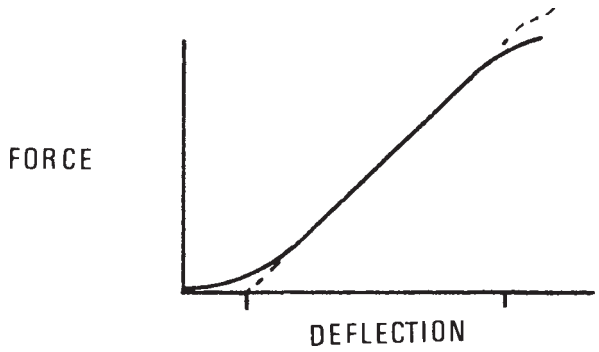

FIG. 1 Determination of Tangent Modulus of Elasticity

19.2.4 *Calculation*—Calculate the tangent modulus of elasticity. See 11.11.1 of Test Methods D 790.

NOTE 2—When calculating slope, use the steepest tangent as shown in Fig. 1.

NOTE 3—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 D 790. Test data have shown that the faster rate provides a lower coefficient of variation than does the slower rate.

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

19.3 *Precision*:

19.3.1 This precision statement has been prepared in accordance with Practice D 3040. Please refer to Practice D 3040 for terminology and other testing and statistical concept explanation.

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

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

20. Ash

20.1 Determine the ignition loss of microcellular urethane in accordance with Test Method D 2584.

21. Flexural Recovery

21.1 Determine the flexural recovery of microcellular urethane in accordance with Test Method D 3768.

22. High-Temperature Sag

22.1 Determine the heat sag of microcellular urethane in accordance with Test Method D 3769.

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

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.

23. Report

23.1 Report the following information:

23.1.1 Complete identification of the material,

23.1.2 Test methods used and thickness of specimen, and

23.1.3 Any modification of test method or procedure.

24. Precision and Bias

24.1 Precision statements can be found within the individual test methods called out in these test methods.

25. Keywords

25.1 microcellular; test method; urethane