Designation: D 3769 – 96 (Reapproved 2000)

# Standard Test Method for Microcellular Urethanes—High-Temperature Sag[1]

This standard is issued under the fixed designation D 3769; 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 test method covers the procedure and apparatus for measuring high-temperature sag of microcellular urethane materials.

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

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 this test method.

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 3040 Practice for Preparing Precision Statements for Standards Related to Rubber and Rubber Testing[2]

E 145 Specification for Gravity-Convection and Forced-Ventilation Ovens[3]

E 691 Practice for Conducting and Interlaboratory Study to Determine the Precision of a Test Method[3]

## 3. Significance and Use

3.1 This test method is used to indicate the deformation tendency of microcellular materials that may occur during paint application in an assembly plant operation. Since a standard specimen is used, heat sag measurements cannot be assumed to be exactly those which will occur on a part during or after the paint application and baking operation of an assembly process.

3.2 Before proceeding with this test method, reference should be made to the specification of the material being tested. Any test specimen preparation, conditioning, or dimensions, or 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.

NOTE 2—This test method may be applied to solid urethanes.

## 4. Apparatus

4.1 *Test Fixture*, capable of holding the specimens in a fixed cantilever position for the duration of the entire test procedure. The test fixture shall be constructed from a material such as aluminum or steel that exhibits a low coefficient of linear thermal expansion and therefore allows the test fixture's height to be considered constant through the test. See Fig. 1.

4.2 *Oven*, conforming to the specifications for a Type I laboratory oven in accordance with Specification E 145.

4.3 *Scaled Rule*, accurate to 1.0 mm.

4.4 *Thickness Indicator*, accurate to 0.25 mm.

## 5. Test Specimens

5.1 The test specimen shall have a minimum length of 125 mm, and be 25 mm in width by the nominal thickness of the plaque or part. The recommended standard test specimen is 4 mm in thickness. Thinner specimens may be used, but shall not be less than 3 mm.

5.2 Three specimens to each material shall be tested.

NOTE 3—If test specimens are cut from parts, the specimens must be cut from areas that are of constant thickness; that is, no ribs, bosses, holes, or other section changes are allowed.

## 6. Conditioning

6.1 Unless otherwise specified, condition the specimens and fixture a minimum of 1 h at 23 ± 2°C and 50 ± 5 % relative humidity before testing.

## 7. Procedure

7.1 Measure the thickness in the clamping area of the test specimen to the nearest 0.25 mm.

7.2 Clamp the specimen in the fixture with a 100-mm unsupported overhang. Primed or painted surfaces are to be mounted facing up.

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[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.22 on Cellular Materials—Plastics and Elastomers.

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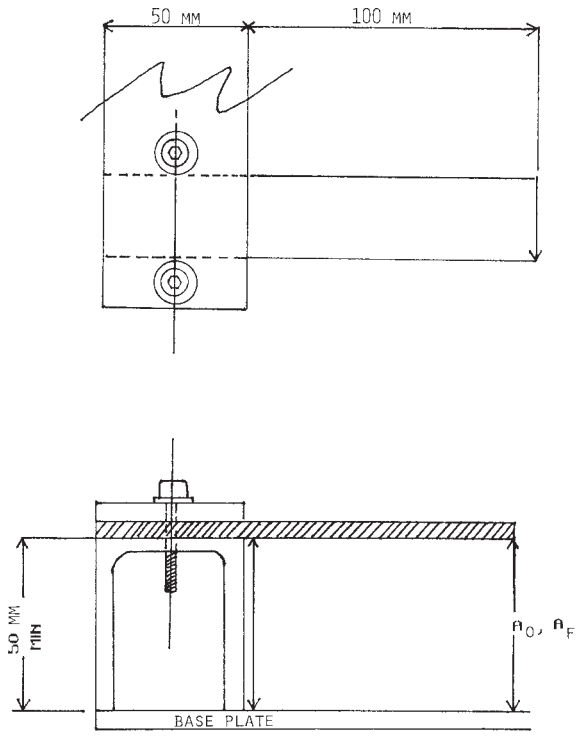
This revision includes the addition of the following: an ISO equivalency statement, a material specifications statement, and a keyword section. This revision also includes a change in the minimum height requirement of the test fixture, an expanded description of the test figure, a change in the oven specification, a change in the accuracy requirement for the scaled rule, and a change in the measuring procedure.

[2] Discontinued—see *1986 Annual Book of ASTM Standards*, Vols 09.01 and 09.02.

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




NOTE 1—Note to scale.
NOTE 2—Fixture fabricated from aluminum.

**FIG. 1 Fixture for High-Temperature Sag**

7.3 After 5 min ± 10 s, measure the distance between the base and the unsupported end of the specimen as shown in Fig. 1 and call this $A_o$ .

7.4 Place the clamped specimen in an air-circulating oven at the test temperature of 120 ± 1°C for 60 ± 1 min.

7.5 After oven aging, remove the fixture with the specimen from the oven.

7.6 Within 5.0 ± 0.2 min, repeat the measurement as in 7.3.1 for $A_o$ and call this distance $A_f$ .

## 8. Calculation

8.1 Sag = $A_o - A_f$ .

## 9. Report

9.1 The report shall include the following:

9.1.1 Direction of cutting,

9.1.2 Conditioning procedures before testing,

9.1.3 Time and temperature of the test,

9.1.4 Initial value at 23°C, average of three,

9.1.5 Final sag value at test temperature, average of three, and

9.1.6 Specimen thickness.

## 10. Precision and Bias

10.1 Table 1 is based on a round robin[4] conducted in 1980 in accordance with Practice D 3040, involving three materials tested by four laboratories. For each material, all the samples were prepared at one source and the individual specimens were also prepared at one source. Each test result consisted of one individual determination. Each laboratory obtained four test results for each material.

NOTE 4—**Caution:** The explanation of *r* (10.2-10.2.2) is only intended to present a meaningful way of considering the approximate precision of these test methods. The data in Table 1 should not be applied to acceptance or rejection of materials, as these data apply only to the materials tested in the round robin and are unlikely to be rigorously representative of other lots, formulations, conditions, materials, or laboratories. Users of this test method should apply the principles outlined in Practice E 691 to generate data specific to their materials and laboratory (or between specific laboratories). The principles of 10.2-10.2.2 would then be valid for such data.

10.2 *Concept of r in Table 1*—If $S_r$ has been calculated from a large enough body of data, and for test results that were averages from testing three specimens for each test result, then:

**TABLE 1 Precision for Heat Sag Test**

| Material | Flexural Modulus MPa (psi) | Values expressed in unit of mm (in.) | | |
|---|---|---|---|---|
| | | Average | $S_r$[A] | $r$[B] |
| Urethane A | 700 (100 000) | 7.06 (0.278) | 1.55 (0.061) | 4.34 (0.171) |
| Urethane B | 350 ( 50 000) | 0.43 (0.017) | 0.66 (0.026) | 1.85 (0.073) |
| Urethane C | 175 ( 25 000) | 3.40 (0.134) | 3.53 (0.139) | 9.88 (0.389) |

[A] $S_r$ = within-laboratory standard deviation for the indicated material. It is obtained by pooling the within-laboratory standard deviations of the test results from all of the participating laboratories:

$$S_r = [[(s_1)^2 + (s_2)^2 \cdots + (s_n)^2]/n]^{1/2} \quad (1)$$

[B] $r$ = within-laboratory critical interval between two test results = 2.8 × $S_r$ .

10.2.1 *Repeatability*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the *r* value of that material. *r* is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

10.2.2 Any judgment in accordance with 10.2.1 would have an approximate 95 % (0.95) probability of being correct.

10.3 There are no recognized standards by which to estimate bias of this test method.

## 11. Keywords

11.1 deformation; high-temperature; microcellular; sag; urethane

[4] Supporting data are available from ASTM Headquarters.