



Standard Practice for Dynamic Mechanical Analysis and Thermogravimetry of Roofing and Waterproofing Membrane Material¹

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1. Scope

1.1 This practice covers test procedures and conditions that are applicable when Test Methods D 5023, D 5024, D 5026, D 5279, and D 5418 are used for conducting dynamic mechanical analysis of roofing and waterproofing membrane material in three-point bending, compression, tension, torsion, and dual cantilever modes, respectively. The specific method is selected by the analyst and depends on the membrane material and the operating principles of the individual instrument used for the analysis.

1.2 This practice covers test procedures and conditions that are applicable when Test Method E 1131 is used for conducting thermogravimetry of roofing and waterproofing membrane material.

1.3 Membrane materials include bituminous built-up roofing, polymer-modified bitumen sheets, vulcanized rubbers, non-vulcanized polymeric sheets, and thermoplastics. The membrane materials can be either nonreinforced or reinforced.

1.4 This practice is applicable to new membrane materials received from the supplier, those exposed artificially in the laboratory or outdoors on an exposure rack, and those sampled from field installations.

1.5 This practice contains notes which are explanatory and are not part of the mandatory requirements of this practice.

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

1.7 *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.*

2. Referenced Documents

2.1 ASTM Standards:

D 1079 Terminology Relating to Roofing, Waterproofing, and Bituminous Materials²

D 4092 Terminology Relating to Dynamic Mechanical

Measurements on Plastics³

D 5023 Test Method for Measuring the Dynamic Mechanical Properties of Plastics Using Three Point Bending⁴

D 5024 Test Method for Measuring the Dynamic Mechanical Properties of Plastics in Compression⁴

D 5026 Test Method for Measuring the Dynamic Mechanical Properties of Plastics in Tension⁴

D 5279 Test Method for Measuring the Dynamic Mechanical Properties of Plastics in Torsion⁴

D 5418 Test Method for Measuring the Dynamic Mechanical Properties of Plastics Using a Dual Cantilever Beam⁴

E 473 Terminology Relating to Thermal Analysis⁵

E 1131 Test Method for Compositional Analysis by Thermogravimetry⁵

E 1142 Terminology Relating to Thermophysical Properties⁵

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminologies E 473, D 1079, D 4092, and E 1142.

4. Summary of Practice

4.1 In conducting a dynamic mechanical analysis, the roofing or waterproofing membrane specimen is placed in a test chamber and subjected to a controlled, increasing temperature program. The temperature range can be from well-below (for example, -80°C) to somewhat (for example, 50°C) above room temperature. The glass transition temperature, storage modulus, loss modulus, and damping factor of the specimen are measured.

4.2 In conducting a thermogravimetry analysis, the roofing or waterproofing membrane specimen is placed in a test chamber and subjected to a controlled, increasing temperature program. The temperature range can be from about room temperature (for example, 20 to 40°C) to well-above room temperature (for example, 900°C), and the atmosphere of the chamber is controlled through the use of inert gas such as nitrogen or reactive gas such as air. The percent mass loss of the specimen is determined as a function of temperature.

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² *Annual Book of ASTM Standards*, Vol 04.04.

³ *Annual Book of ASTM Standards*, Vol 08.02.

⁴ *Annual Book of ASTM Standards*, Vol 08.03.

⁵ *Annual Book of ASTM Standards*, Vol 14.02.

5. Significance and Use

5.1 Dynamic mechanical analysis provides a measure of the rheological properties of roofing and waterproofing membrane materials.

5.2 Thermogravimetry is used to characterize the thermal stability of roofing and waterproofing membrane materials under the specific temperature program and gaseous atmosphere conditions selected for the analysis.

5.3 Both dynamic mechanical analysis and thermogravimetry are used to evaluate the effect of either laboratory-simulated or in-service exposure on roofing and waterproofing membrane materials.

5.4 Both dynamic mechanical analysis and thermogravimetry can be applied to asphalt shingles. However, their application to asphalt shingles is beyond the scope of this practice, which is limited to low-slope membrane materials at this time.

5.5 This practice can be useful in the development of performance criteria for roofing and waterproofing membrane materials.

DYNAMIC MECHANICAL ANALYSIS

6. Test Procedure

6.1 Select the specific test method (that is, Test Method D 5023, D 5024, D 5026, D 5279, or D 5418) depending on the available instrument and specific type of roofing or waterproofing membrane material to be analyzed. If questions arise, consult the individual manufacturer's literature on instrument operation.

6.2 Prepare a specimen, appropriately sized for the specific instrument, cut in either the machine or cross machine direction of the membrane material.

6.3 Remove granules, if present on the surface of the membrane material, taking care to avoid damage to the specimen.

NOTE 1—Tweezers or a razor-edged laboratory knife have been found to be suitable for this purpose.

6.4 Remove dirt and bonding adhesive to the extent possible, if present on the surface of membrane materials sampled after outdoor exposure or from field installations (see Note 2), taking care to avoid damage to the specimen. Use of solvents other than water is not permissible. If water is used, dry the sample overnight at $23 \pm 2^\circ\text{C}$ ($74 \pm 4^\circ\text{F}$) before analysis.

NOTE 2—In some cases where dirt or bonding adhesive is well adhered to the membrane material, it may not be possible to completely remove it. In such cases, the decision to conduct the analysis is left to the analyst. If the analysis is conducted, the presence of dirt or bonding adhesive on the specimen is included in the report.

7. Test Conditions

7.1 Conduct the dynamic mechanical analysis using the following conditions and parameters:

7.1.1 *Preconditioning*—Precondition the specimen in an oven for 1 h at $80 \pm 2^\circ\text{C}$ ($176 \pm 4^\circ\text{F}$) to provide a consistent thermal history prior to analysis. Then allow the preconditioned specimen to cool to $23 \pm 2^\circ\text{C}$ ($74 \pm 4^\circ\text{F}$) in a desiccator. Store the preconditioned specimen in the desiccator at $23 \pm 2^\circ\text{C}$ ($74 \pm 4^\circ\text{F}$) until conducting the analysis.

7.1.2 *Temperature Range*—The temperature range shall be -80 to 50°C (-112 to 122°F), with an allowed variation of $\pm 2^\circ\text{C}$ ($\pm 4^\circ\text{F}$).

7.1.3 *Low Temperature Stabilization*—The specimen shall remain at -80°C (-112°F) for 5 min before beginning an analysis.

7.1.4 *Heating Rate*—The heating rate shall be $2^\circ\text{C}/\text{min}$ ($4^\circ\text{F}/\text{min}$).

7.1.5 *Frequency*—The frequency shall be 1 Hz.

7.1.6 *Clamping Pressure*—The clamping pressure shall be in accordance with the equipment manufacturer's instructions.

8. Test Report

8.1 Report the generic type of membrane material, and indicate whether it was new, exposed artificially in the laboratory or outdoors on an exposure rack, or sampled from a field installation.

8.1.1 For membrane materials exposed in the laboratory, indicate the conditions and length of exposure.

8.1.2 For membrane materials exposed outdoors or sampled from field installations, indicate pertinent information including geographical location and exposure time or sample age.

8.2 Report whether dirt or bonding adhesive was removed from, or remained on, surfaces of membrane materials sampled after outdoor exposure or from field installations.

8.3 Report the test method used to conduct the dynamic mechanical analysis.

8.4 Report the information as required in the report section of the test method used.

THERMOGRAVIMETRY

9. Test Procedure

9.1 Conduct the thermogravimetry procedure in accordance with Test Method E 1131.

9.2 Prepare a specimen having a mass within the range from 10 to 25 mg. The specimen shall be cut through the full thickness of the membrane material.

9.3 Remove granules, if present on the surface of the membrane material, taking care to avoid damage to the specimen (see Note 1).

9.4 Remove dirt and bonding adhesive to the extent possible, if present on the surface of membrane materials sampled after outdoor exposure or from field installations (see Note 2), taking care to avoid damage to the specimen. Use of solvents other than water is not permissible. If water is used, dry the sample overnight at $23 \pm 2^\circ\text{C}$ ($74 \pm 4^\circ\text{F}$) before analysis.

10. Test Conditions

10.1 Conduct the thermogravimetry analysis using the following conditions and parameters:

10.1.1 *Test Atmosphere*—The test atmosphere shall consist of an inert gas (for example, nitrogen or argon) for temperatures up to 600°C (1112°F), and air for temperatures beyond 600°C (1112°F).

10.1.2 *Temperature Range*—The minimum temperature shall be between 20 to 40°C (68 and 104°F), with an allowed variation of $\pm 2^\circ\text{C}$ ($\pm 4^\circ\text{F}$). The maximum temperature shall be at least 900°C (1652°F).

10.1.3 *Heating Rate*—The heating rate shall be 20°C/min (36°F/min).

11. Test Report

11.1 Report the generic type of membrane material, and indicate whether it was new, exposed artificially in the laboratory or outdoors on an exposure rack, or sampled from a field installation.

11.1.1 For membrane materials exposed in the laboratory, indicate the conditions and length of exposure.

11.1.2 For membrane materials exposed outdoors or sampled from field installations, indicate pertinent information including geographical location and exposure time or sample age.

11.2 Report whether dirt or bonding adhesive was removed

from, or remained on, surfaces of membrane materials sampled after outdoor exposure or from field installations.

11.3 In addition to the items specified in the Report Section of Test Method E 1131, the report shall include the following information:

11.3.1 The percent mass lost on heating to 600°C (1112°F)

11.3.2 The percent mass lost on heating from 600°C (1112°F) to termination of the analysis.

11.3.3 The percent mass remaining as residue upon termination of the analysis.

12. Keywords

12.1 dynamic mechanical analysis; membrane materials; roofing; thermal analysis; thermogravimetry; waterproofing

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