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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Determination of Fogging Characteristics of Vehicle Interior Trim Materials[1]

This standard is issued under the fixed designation D 5393; 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 a procedure for determining the tendency of interior trim materials used in automobiles and other vehicles to produce a light-scattering film, which may be called fog film or fog, on a glass surface in a controlled environment.

1.2 Acceptance criteria for materials tested using this test method will be established by the specifications of those companies that implement this test method.

1.3 This procedure is applicable to the measurement of fog condensate on glass surfaces within the limits of the test conditions. This test will not measure or cannot measure accurately those cases in which:

1.3.1 The condensate's surface tension is low, resulting in early coalescing into a thin transparent film.

1.3.2 The condensate is present in such large quantity that the droplets coalesce and form a heavy oily/clear film on the glass surface. This heavy film would result in false glossmeter readings during the final evaluation.

1.3.3 The condensate is reactive within the vehicle environment or interactive with other volatiles in the vehicle not present in the test chamber.

1.4 All testing on compounds indicated herein is based on materials conditioned in a controlled atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity for 24 h prior to any testing and tested under the same controlled conditions.

NOTE 1—This standard and ISO 6452 are essentially equivalent.

1.5 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.6 The values stated in SI units are to be regarded as the standard. The values given 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.* See Note 4 for a specific hazard statement.

2. Referenced Documents

2.1 *ASTM Standards:*

D 523 Test Method for Specular Gloss[2]

D 883 Terminology Relating to Plastics[3]

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

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[4]

2.2 *ISO Standards:*

ISO 6452 Rubber and Plastic Coated Fabrics—Determination of Windscreen Fogging Characteristics of Organic Trim Materials in Motor Vehicles[5]

ISO 2813 Paints and Varnishes—Measurement of Specular Gloss of Non-Metallic Paint Films at 20°, 60°, and 85°[5]

3. Terminology

3.1 *General*—Definitions are in accordance with Terminology D 883 and abbreviations with Terminology D 1600, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *fogging*—the deposit of an undesirable light-scattering film on the interior glass surface of vehicles.

3.2.2 *fogging number*—the quotient in percent from a 60° glossmeter value of a glass plate with fogging condensate and the 60° glossmeter value of a glass plate without the condensate.

4. Summary of Test Method

4.1 A glass plate is cleaned and its specular reflectance is measured using a glossmeter. A test piece of the material is placed on the bottom of a beaker. The beaker is placed in a temperature-controlled heating unit. The cleaned glass plate is placed upon the beaker with a silicone rubber seal so that any volatile materials that migrate from the test piece will condensate upon its undersurface.

4.2 A cooling system is placed upon the glass plate to

[1] This test method 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 06.01.

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

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

[5] Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

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

control the condensate temperature. After a specified time the glass plate is removed, and its specular reflectance is again measured with the same glossmeter. The reflectance of the fogged plate expressed as a percentage of reflectance of the clean plate is reported as the fogging number. The fogging number is used as a comparative ranking between materials.

5. Significance and Use

5.1 Fogging is believed to be caused largely by the vaporization of volatile ingredients from all materials within the passenger compartment and their condensation on the cooler glass surfaces. These volatile ingredients may come from the polymer, lubricant, plasticizer, catalyst, stabilizer or other additive used in the manufacture of interior trim materials or components, or both.

5.2 Before proceeding with this test method, reference should be made to the specification of the material being tested. Any test specimen preparation, conditioning, dimensions, and/or testing parameters covered in the materials specification shall take precedence over those mentioned in this test method. If there are no material specifications, then the default conditions apply.

6. Apparatus and Reagents

6.1 *Apparatus*:

6.1.1 *Suitable 60° Glossmeter* meeting the requirements of Test Method D 523 (see Section 6.2 of Test Method D 523).

6.1.2 *Heating Unit*, temperature-controlled, with multiple chambers and a typical temperature range from 60° to 120°C. A temperature override cutout to prevent overheating in the event of thermostat failure can be employed.

6.1.2.1 The heating must be able to maintain the temperature desired to within ±0.5°C.

6.1.2.2 The test temperature should be attained prior to starting the test and should be reattained within 20 min after the beakers holding the samples are placed in the heating unit.

6.1.3 The temperature of the cooling system for the glass plates must be maintained at 21 ± 0.5°C during the test. The cooling plate, which is laid upon the glass plate, should be held firmly in place to ensure a good seal for the test chamber.

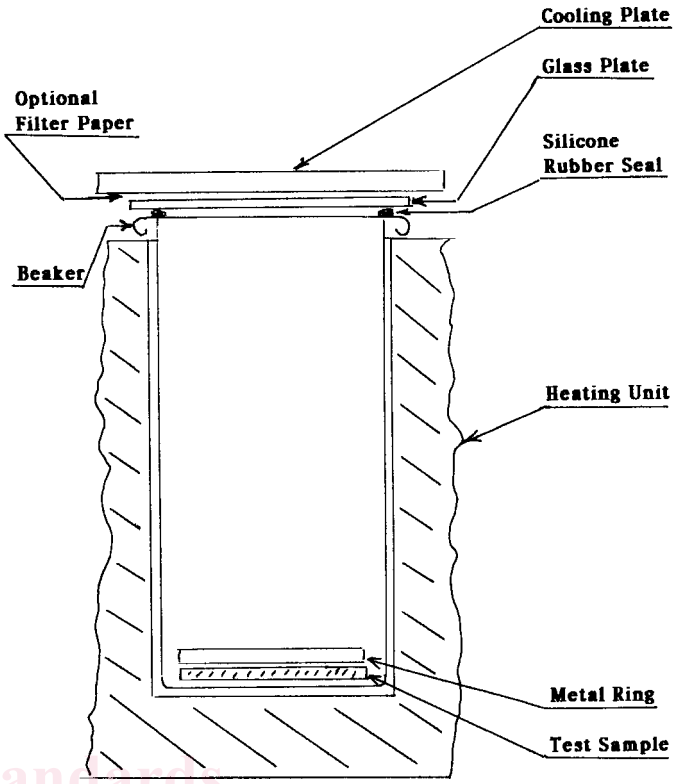
NOTE 2—See the listing of equipment sources in Appendix A.

6.1.4 *Heat-Resistant Glass Beakers* as recommended by the manufacturer are used as the sample chamber (see Fig. 1 for a typical design).

6.1.5 *Float Glass Plates, Windshield, or Residential Window-Quality Glass* must have the tin and non-tin surfaces identified. The thickness and dimensions of the glass plates shall be as recommended by the manufacturer. Glossmeter readings on the cleaned glass plates shall be within ±2 gloss units from plate to plate.

NOTE 3—The tin and non-tin surfaces of the glass plates can be identified by viewing the surfaces in a darkened room under a UV light at 254 nm wavelength. The tin surface will fluoresce when it is exposed to the UV light.

6.1.6 *Metal Rings* having a uniform mass within ±1 g and made of a chromium-plated steel or other inert material with a diameter to fit inside the beaker are used to hold the sample flat on the bottom of that beaker.



NOTE 1—Actual equipment would consist of multiple chambers.

FIG. 1 Schematic of a Typical Chamber for Fog Testing

6.1.7 *Silicone Rubber Seals* as recommended by the manufacturer, with a diameter to match the beaker rim.

6.1.8 *Black Matte Surface* for mounting the glass plates during reflectance measurements. The matte surface shall have specular reflectance readings of less than 0.5 gloss units when measured with a 60° glossmeter.

6.1.9 *Suitable Microscope* with a 400 × magnification.

6.2 *Reagents*:

6.2.1 *Acetone, Ethyl Acetate, and Ethanol*, certified ACS or HPLC grade.

6.2.2 *Diisodecyl Phthalate, DIDP*, or other suitable reference material agreed upon by the testing parties.

6.2.3 *Heat-Stabilized Liquid* for the thermostatically controlled heating unit, if required.

6.2.4 *Detergent*, nonionic.

6.2.5 *Filter Paper*, Whatman #1, 11-cm diameter.[6]

6.2.6 *Lint-Free Cotton Cloth*.

6.2.7 *Lint-Free Laboratory Wipers*, Kimwipes[7] or equivalent.

7. Specimen Preparation

7.1 Cut at least 3 circular test pieces each with the specified area 50 ± 1 cm^2 (80 mm diameter) for Haake equipment (see Appendix X1) or 27 ± 1 cm^2 (58 mm diameter) for Hart equipment (see Appendix X1) and not greater than 10 mm

[6] Available from Whatman Intn. Ltd., Maidstone, England or from Fisher Scientific, 711 Forbes Ave., Pittsburgh, PA 15219.

[7] Available from Kimberly Clark Corp., Roswell, GA 30016.

thick. Generally, the thicker materials are machined on the underside to 10 mm. This would not be possible with plush carpets. For components with irregular surfaces, several pieces cut to make up the required area may be used.

8. Procedure

8.1 *Cleaning*:

8.1.1 Wash the glass plates with a cotton cloth and ethanol, acetone, or ethyl acetate, *if necessary*, to remove any heavy oil deposit.

8.1.1.1 A laboratory dishwasher having a deionized-water-rinse cycle may be used in place of the following manual method.

8.1.1.2 Wash the glass plates with a solution of detergent and water, followed by a thorough water rinse. Rinse the plates generously with acetone and lightly wipe off excess acetone with a lint-free wiper. Allow the glass surfaces to air-dry for 2 to 3 min. Inspect visually for streaking and general cleanliness. Repeat acetone rinse or rewash if cleanliness is not acceptable.

NOTE 4—Due to the hazardous nature of some reagents, appropriate clothing, gloves, and eye protection equipment should be worn. Consult supplier's Material Safety Data Sheets for further information.

NOTE 5—Optional cleaning verification steps: Check the surface energy of each plate with solutions and procedure found in Appendix X2. Surface tension can be used as a measure of uniformity of the cleaning procedure.

8.1.2 Rinse the beakers thoroughly with ethanol, acetone, or ethyl acetate, *if necessary*, to remove any oils. Wash with a strong solution of detergent and water; rinse thoroughly with water. Use distilled or deionized water for a final rinse and dry for ½ to 1 h at 100°C.

8.1.3 Wash the silicone rubber seals and metal rings in a strong detergent solution, rinse with distilled or deionized water, and dry with a lint-free cloth.

8.1.4 If the beakers are not used immediately, store inverted on clean filter paper at room temperature. Glass plates should be stored and separated in a dust-free environment until used; otherwise the plates should be recleaned before measurements are taken.

8.1.5 Silicone rubber seals can become harbors of fogging materials. When high-deposit material is tested, special attention should be given to cleaning the seals to avoid fugitive material in later tests.

8.2 *Control Test*:

8.2.1 Measure 10 ± 0.2 g of diisodecyl phthalate (DIDP) or other suitable reference material into a beaker, taking care to avoid moistening the wall of the beaker with the DIDP.

8.2.2 This control test is carried out in parallel with the test on the trim material. The testing period is 3 h with a recommended heating unit temperature of 100°C. The DIDP should provide a fogging number of 77 ± 3. If the values obtained are outside this range, adjust the temperature of the heating unit until the correct fogging number is obtained (increase the temperature to lower the fog number; decrease the temperature to raise the fog number). Once a heating-unit temperature has been established, adjustments should not be required. Other reference materials will have different fogging numbers.

NOTE 6—Alternate testing periods, temperatures, and standards may be used if specified and agreed upon by the testing parties. Di octyl phthalate (DOP) should provide a fogging number of 32 ± 3 % when tested for 6 h at a temperature of 90°C.

8.2.3 An empty beaker can be run in the test to check the adequacy of the cleaning method. The control value should be 99 ± 1 for fog number.

8.2.4 During continuous use, run a control test run once every five testing periods. With intermittent use, it is recommended that a control DIDP be used for each test to ensure proper equipment operation and to provide a daily check on the repeatability of the testing.

8.3 *Calibration*:

8.3.1 Calibrate the glossmeter according to the manufacturer's instructions.

8.3.2 Place a cleaned glass plate on a black matte surface (as described in 6.1.8), and measure the gloss of the glass surface. Take four readings at 90° rotations and calculate the average value. Record this value as R_0.

8.3.3 It is recommended that the glass plates not be reused since microscopic scratches may affect the rate of deposition of any vapors and the resulting reproducibility of the test method. Discard any glass plates that have surface scratches or abraded spots.

8.4 *Exposure of Test Specimens*:

8.4.1 Place a test piece (see Section 7) into the bottom of a beaker with the side to be tested facing the bottom of the glass plate. Place a metal ring onto the test piece to prevent curling of the test piece, resulting in nonuniform heating of the test piece. Multiple-piece samples should be laid as flat as possible and held down with a metal ring.

8.4.1.1 If powders, pastes, or liquids are to be tested, place a quantity of 10 ± 0.2 g into the bottom of the beaker, ensuring that the wall of the beaker is not moistened and that the test specimen is evenly distributed over the bottom of the beaker.

8.4.1.2 Materials that may stick to the bottom of the beaker may be placed in an aluminum-foil dish and the entire foil dish set into the beaker. No metal ring need be used.

8.4.2 Cover the control test beaker (see 8.2.1) and the beaker containing the test piece with the silicone rubber seals, position the cleaned glass plates with the non-tin surface exposed toward the sample, and place in the heating unit.

8.4.3 Cover the glass plate with the cooling plate maintained at 21°C. Maintain the previously determined temperature of the chamber for 3 h (see 8.2.2), and then carefully remove the cooling plate and glass plates from the top of the beakers.

8.4.3.1 If the piece to be tested is a composite of dissimilar material, test both sides to determine the reflectance ratio. Having established which side of the composite material has a lower reflectance ratio (fog number), test this side in accordance with 8.4.1.

NOTE 7—A circle of new filter paper placed between the glass plates and the cooling plates will prevent sticking of the two surfaces.

8.4.4 Carefully store the glass plates in a horizontal position, fog side up, in a dust-free atmosphere at 23°C ± 2°C and 50 % relative humidity, ensuring that the fogging deposits on the glass plates are not disturbed and are exposed only to artificial light.

8.4.5 After 1.0 ± 0.1 h, remeasure the gloss of the glass.