



Standard Test Method for Calorimetric Determination of Hemispherical Emittance and the Ratio of Solar Absorptance to Hemispherical Emittance Using Solar Simulation¹

This standard is issued under the fixed designation E434; 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 measurement techniques for calorimetrically determining the ratio of solar absorptance to hemispherical emittance using a steady-state method, and for calorimetrically determining the total hemispherical emittance using a transient technique.

1.2 *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:*²

E349 Terminology Relating to Space Simulation

3. Summary of Test Method

3.1 In calorimetric measurements of the radiative properties of materials, the specimen under evaluation is placed in a vacuum environment under simulated solar radiation with cold surroundings. By observation of the thermal behavior of the specimen the thermophysical properties may be determined by an equation that relates heat balance considerations to measurable test parameters.

3.2 In a typical measurement, to determine α/ϵ as defined in Definitions E349, the side of the specimen in question is exposed to a simulated solar source, through a port having suitable transmittance over the solar spectrum. This port, or window, must be of sufficient diameter that the specimen and radiation monitor will be fully irradiated and must be of sufficient thickness that it will maintain its strength without deformation under vacuum conditions. The radiant energy absorbed by the specimen from the solar source and emitted by

the specimen to the surroundings cause the specimen to reach an equilibrium temperature that is dependent upon the α/ϵ ratio of its surface.

3.3 In the dynamic radiative method of measuring total hemispherical emittance, the specimen is heated with a solar simulation source and then allowed to cool by radiation to an evacuated space chamber with an inside effective emittance of unity. From a knowledge of the specific heat of the specimen as a function of temperature, the area of the test specimen, its mass, its cooling rate, and the temperature of the walls, its total hemispherical emittance may be calculated as a function of temperature.

4. Apparatus

4.1 The main elements of the apparatus include a vacuum system, a cold shroud within the vacuum chamber, instrumentation for temperature measurement, and a solar simulator.

4.2 The area of the thermal shroud shall not be less than 100 times the specimen area (controlled by the specimen size). The inner surfaces of the chamber shall have a high solar absorptance (not less than 0.96) and a total hemispherical emittance of at least 0.88 (painted with a suitable black paint),³ and shall be diffuse. Suitable insulated standoffs shall be provided for suspending the specimen. Thermocouple wires shall be connected to a vacuumtight fitting where the temperature of feedthrough is uniform. Outside of the chamber, all thermocouples shall connect with a fixed cold junction.

4.3 The chamber shall be evacuated to a pressure of 1×10^{-6} torr (0.1 mPa) or less at all times.

4.4 The walls of the inner shroud shall be in contact with coolant so that their temperature can be maintained uniform at all times.

4.5 A shutter shall be provided in one end of the chamber which can be opened to admit a beam of radiant energy from a solar simulator. When open, this shutter shall provide an aperture admitting the full simulator beam. When the shutter is

¹ This test method is under the jurisdiction of ASTM Committee E21 on Space Simulation and Applications of Space Technology and is the direct responsibility of Subcommittee E21.04 on Space Simulation Test Methods.

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² *Annual Book of ASTM Standards*, Vol 15.03.

³ Nextel Brand Velvet Coating 401-C10 Black, available from Reflective Products Div., 3M Co., has been found to be satisfactory.