Designation: C1864 – 17 (Reapproved 2022)

Standard Test Method for Determination of Solar Reflectance of Directionally Reflective Material Using Portable Solar Reflectometer[1]

This standard is issued under the fixed designation C1864; 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 technique for determining the solar reflectance of a directionally reflective material using a commercial portable solar reflectometer, including but not limited to roofing materials with granules or surface design that results in angularly dependent reflectance. The purpose of the method is to evaluate the seasonal and annual solar reflectances of a directionally reflective roofing product.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C1549 Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer

3. Terminology

3.1 *Definitions*—The definitions included in Test Method C1549 are applicable to this method.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *directionally reflective material (DRM), n*—material with solar reflectance that varies with solar incidence angle.

3.3 *Symbols:*

3.3.1 $\rho_{J,K}$—solar reflectance measured by reflectometer in azimuthal orientation *J*, within measurement series *K*.

3.3.2 ρ_J—solar reflectance measured by reflectometer in azimuthal orientation *J*, averaged over all measurement repetitions.

4. Summary of Test Method

4.1 This method uses a hemispherical solar reflectometer to determine the solar reflectance of a DRM. The reflectometer is operated in accordance with Test Method C1549, except that evaluation of the surface follows the procedure described in 4.2 and 4.3.

4.2 The solar reflectance of a test specimen is measured 12 times by rotating the measurement head of the reflectometer in 30° increments about the normal to the test specimen.

4.3 The set of 12 measurements is repeated three times to calculate the solar reflectance in each orientation as the average of the three measurements at the same orientation.

5. Significance and Use

5.1 The solar reflectance of a DRM depends on the solar incidence angle. This method is intended to provide solar reflectance values for DRM roofing products.

6. Apparatus

6.1 This test method employs a portable solar reflectometer that is operated in accordance with Test Method C1549.

6.2 The test specimen shall be flat (not curved) and have area sufficient to completely cover the measurement port of the reflectometer.

6.3 The test specimen shall be placed at the center of a compass pattern marked in 30° increments as shown in Fig. 1.

6.4 A vertical indicator arrow, parallel to the central axis of the reflectometer head and affixed to the outer wall of the

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

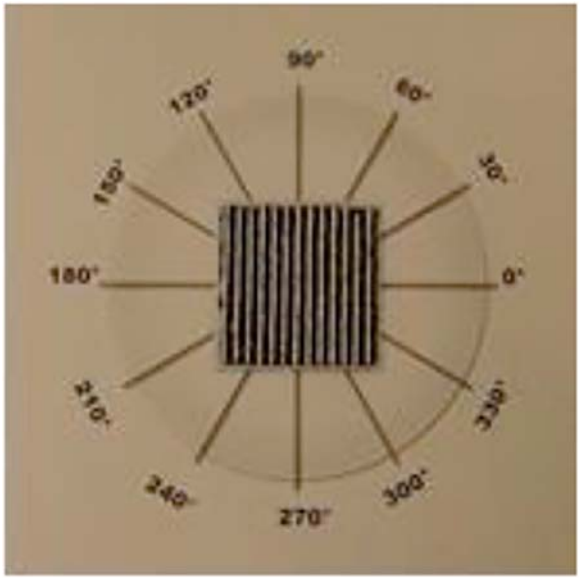

FIG. 1 Specimen Placed at Center of Compass Pattern

FIG. 2 Vertical Indicator Arrow Affixed to Side of Portable Reflectometer

reflectometer head, shall be used to gauge the azimuthal angle of the reflectometer head with respect to the compass markings.

7. Procedure

7.1 *Set-Up:*

7.1.1 Prepare the compass pattern template as shown in Annex A1 and cut out the square that identifies the measurement area.

7.1.2 Affix the compass pattern to the test bench and place the test specimen on the compass pattern. The compass pattern shall not move during the test.

7.1.3 Affix a vertical indicator arrow parallel to the central axis of the reflectometer head as shown in Fig. 2.

7.1.4 Set up and calibrate the reflectometer in accordance with Test Method C1549.

7.2 *Solar Reflectance Measurements:*

7.2.1 Solar reflectance measurements shall be performed in accordance with Test Method C1549, at positions specified in this section.

7.2.2 Place the test specimen at the center of the compass pattern. The specimen shall not move during the test.

7.2.3 Center the reflectometer measurement port over the specimen such that the compass pattern markings are clearly visible as show in Fig. 3.

7.2.4 Orient the reflectometer head with the indicator arrow pointing to 0° being the direction of maximum reflectance from the manufacturer. A diagram of the orientation is shown in Fig. 4. The angular deviation of the indicator arrow from 0° shall not exceed 5°.

7.2.5 Rest the reflectometer measurement port on the specimen.

7.2.6 Record this value as $\rho_{1,1}$.

7.2.7 Rotate the reflectometer 30° about the specimen surface normal as shown in Fig. 5, keeping the center of the reflectometer within one cm of its previous position in the horizontal plane.

7.2.8 Rest the reflectometer measurement port on the specimen, and record solar reflectance measured in this orientation as $\rho_{2,1}$.

7.2.9 Repeat steps 7.2.7 and 7.2.8 for each remaining 30° intervals, recording these solar reflectances as $\rho_{3,1} \ldots \rho_{12,1}$.

7.2.10 Repeat steps 7.2.7 and 7.2.8 two times, recording the additional solar reflectance measurement series as $\rho_{1,2} \ldots \rho_{12,2}$ and $\rho_{1,3} \ldots \rho_{12,3}$.

7.2.11 The average solar reflectance in each orientation J is:

$$\rho_J = (\rho_{J,1} + \rho_{J,2} + \rho_{J,3})/3 \quad (1)$$

7.2.12 Define R_S as the maximum of $\{\rho_1 \ldots \rho_{12}\}$.

$$R_W = (\Sigma_{J=1}^{12}\ \rho_J)/12 \quad (2)$$

$$R_a = (R_s + R_w)/2 \quad (3)$$

R_S is an estimate of the summer season DSR, R_W is an estimate of the winter DSR,[3] and R_a is an estimate of the annual DSR.

8. Report

8.1 Reporting requirements shall be in accordance with Test Method C1549 and 8.1.1 – 8.1.4.

8.1.1 A table containing the 36 measured solar reflectances as shown in Annex A2.

8.1.2 The values determined for R_s, R_w, and R_a.

8.1.3 A description of the color variation of observation angle (if any).

8.1.4 A photograph of the specimen that shows the zero azimuth direction.

[3] Akbari, H. and Touchaei, A.G., "Modeling and labeling heterogeneous directional reflective roofing materials," *Solar Energy Materials and Solar Cells*, Vol. 124, 2014, pp. 192–210.