Designation: E972 – 96(Reapproved 2007)

Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight[1]

This standard is issued under the fixed designation E972; 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 measurement of solar photometric transmittance of materials in sheet form. Solar photometric transmittance is measured using a photometer (illuminance meter) in an enclosure with the sun and sky as the source of radiation. The enclosure and method of test is specified in Test Method E1175 (or Test Method E1084).

1.2 The purpose of this test method is to specify a photometric sensor to be used with the procedure for measuring the solar photometric transmittance of sheet materials containing inhomogeneities in their optical properties.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E772 Terminology of Solar Energy Conversion

E1084 Test Method for Solar Transmittance (Terrestrial) of Sheet Materials Using Sunlight

E1175 Test Method for Determining Solar or Photopic Reflectance, Transmittance, and Absorptance of Materials Using a Large Diameter Integrating Sphere

2.2 *CIE Standard:*

Standard Illuminant D65[3]

3. Terminology

3.1 *Definitions*—For definitions of other terms used in this test method, refer to Terminology E772.

3.1.1 *illuminance, n*—luminous irradiance.

3.1.2 *luminous (photometric), adj—referring to a radiant (or radiometric) quantity*, indicates the weighted average of the spectral radiometric quantity, with the photopic spectral luminous efficiency function (see Annex A1) being the weighting function.

3.1.3 *radiant flux,* $\Phi = d\ Q/dt$*[Watt (W)], n*— power emitted, transferred, or received in the form of electromagnetic waves or photons. See radiometric properties and quantities.

3.1.4 *reflectance,* ρ, Φ_r/Φ_i, *n*—the ratio of the reflected flux to the incident flux.

3.1.5 *solar irradiance at a point of a surface,* $E_s = d\Phi/dA$, *n*—the quotient of the solar flux incident on an element of a surface containing the point, by the area of that element, measured in watts per square metre.

3.1.5.1 *Discussion*—Measured values of transmittance and reflectance depend upon angle of incidence, solid angles of incidence and of transmission and reflection, the method of measurement of the reflected or transmitted flux, and the spectral composition of the incident flux. Because of this dependence, complete information on the technique and conditions of measurement should be specified.

3.1.6 *solar, adj—(1) referring to a radiometric term*, indicates that the quantity has the sun as a source or is characteristic of the sun. *(2) referring to an optical property*, indicates the weighted average of the spectral optical property, with the solar spectral irradiance $E_{s\lambda}$ used as the weighting function.

3.1.7 *spectral, adj—(1) for dimensionless optical properties*, indicates that the property was evaluated at a specific wavelength, λ, within a small wavelength interval, Δλ about λ, symbol wavelength in parentheses, as *L* (350 nm, 3500 Å), or as a function of wavelength, symbol *L*(λ). *(2) for a radiometric quantity*, indicates the concentration of the quantity per unit wavelength or frequency, indicated by the subscript lambda, as $L_\lambda = dL/d\lambda$, at a specific wavelength. The wavelength at which the spectral concentration is evaluated may be indicated by the wavelength in parentheses following the symbol, L_λ (350 nm).

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[1] These test methods are under the jurisdiction of ASTM Committee E44 on Solar, Geothermal and Other Alternative Energy Sources and is the direct responsibility of Subcommittee E44.05 on Solar Heating and Cooling Systems and Materials.

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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.

[3] Available from Commission Internationale de l'Eclairage (International Commission on Illumination), Barean Central de la CIE, 4 Av. du Recteur Poincaré, 75-Paris, France.

3.1.8 *transmittance,* $\tau = \Phi_t/\Phi_i$, *n*—the ratio of the transmitted flux to the incident radiant flux.

4. Summary of Test Method

4.1 Using sunlight as the source and a photometer as the detector, the specimen is made to be the cover of an enclosure with the plane of the specimen normal to the direct component of the incident solar radiation. Luminous transmittance is measured as the ratio of the transmitted illuminance to the incident illuminance.

5. Significance and Use

5.1 Glazed apertures in buildings are generally utilized for the controlled admission of both light and solar radiant heat energy into the structure. Other devices may also be used to reflect light and solar radiant heat into a building.

5.2 The bulk of the solar radiant energy entering a building in this manner possesses wavelengths that lie from 300 to 2500 nm (3000 to 25 000 Å). Only the portion from 380 to 760 nm (3800 to 7600 Å) is visible radiation, however. In daylighting applications, it is therefore important to distinguish the radiant (solar radiant energy) transmittance or reflectance of these materials from their luminous (light) transmittance or reflectance.

5.3 For comparisons of the energy and illumination performances of building fenestration systems it is important that the calculation or measurement, or both, of solar radiant and luminous transmittance and reflectance of materials used in fenestration systems use the same incident solar spectral distribution.

5.4 Solar luminous transmittance and reflectance are important properties in describing the performance of components of solar illumination systems including windows, clerestories, skylights, shading and reflecting devices, and other passive fenestrations that permit the passage of daylight as well as solar radiant heat energy into buildings.

5.5 This test method is useful for determining the solar luminous transmittance and reflectance of optically inhomogeneous sheet materials and diffusely reflecting materials used in natural lighting systems that are used alone or in conjunction with passive or active solar heating systems, or both. This test method provides a means of measuring solar luminous transmittance under fixed conditions of incidence and viewing. This test method has been found practical for both transparent and translucent materials as well as for those with transmittances reduced by reflective coatings. This test method is particularly applicable to the measurement of luminous transmittance of inhomogeneous, fiber reinforced, patterned, corrugated, or otherwise optically inhomogeneous materials when the transmittance is averaged over an area that is large in comparison to the inhomogeneities.

6. Apparatus

6.1 The apparatus to be used in this test method shall be as described in either Test Method E1175 or E1084, with the exception that the sensing element shall be replaced by the sensing element described by this test method.

6.1.1 The sensing element of this instrument shall be a photometer (illuminance meter) consisting of a suitable radiation detector (such as a silicon photovoltaic device), a filter, and a diffusing element. The filter shall be designed so that the spectral response of the photometer very closely matches that of the standard human observer, as specified by the C.I.E. photopic spectral luminous efficiency function tabulated in Annex A1. The response of the photometer at wavelength λ, divided by its response at 555 nm (5550 Å), shall depart from the spectral luminous efficiency of the standard human observer at wavelength λ by no more than 2 % for all wavelengths from 390 to 750 nm (3900 to 7500 Å). Photometer response shall be essentially zero outside this range.

6.1.2 *Cosine Response*[4]—The response of the photometer to uniform, collimated incident radiation at an angle θ of incidence, divided by its response at normal incidence (θ = 0°), shall depart from the cosine of θ by no more than (θ ÷ 18) %, with θ in deg.

6.1.3 The diffusing element and detector electronics shall be designed so that the voltage (or current) output of the sensor is proportional to hemispherical illuminance incident upon it. The photometer shall be located inside the box so that its entrance aperture (the diffusing element) is centered approximately 50 mm (2 in.) below the plane of the rim of the box. Other instructions shall be closely followed.

7. Test Specimens

7.1 The test specimens shall be as described in Test Method E1175 (or Test Method E1084).

8. Procedure

8.1 The tests shall be conducted in accordance with the procedure provided in Test Method E1175 (or Test Method E1084).

9. Report

9.1 The report shall be prepared in accordance with Test Method E1175 (or Test Method E1084) with the exception that the calculated solar luminous transmittance shall be reported to the nearest 0.01 instead of solar (radiant) transmittance and solar illuminance shall be reported instead of solar irradiance.

10. Keywords

10.1 photometer; sheet materials; solar luminous transmittance; solar photometric transmittance; sunlight; transmittance

[4] Photometers containing so-called cosine-response diffusing attachments are available from: Photo Research (Division of Kollmorgan Corp.) Burbank, CA; International Light, Inc., Newburyport, MA; Optronics Laboratories, Orlando, FL; Tektronix, Beaverton, OR; and Gamma Scientific, Inc., San Diego, CA, and have been found satisfactory for this purpose. Other photometers may be acceptable.