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Standard Test Method for Luminance Ratio of a Fluorescent Specimen using a Narrow Band Source[1]

This standard is issued under the fixed designation E2630; 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 instrumental measurement of the luminance ratio of a fluorescent coating or sheet sample when illuminated by a narrow band source.

1.2 This test method is generally applicable to any coating or sheeting material having combined fluorescent and reflective properties, where the fluorescence is activated by 405 nm light.

1.3 This test method is intended as a companion to Specification E2501 to support the development and specification of industrial coatings that are used in a system for detection of coating defects when inspected with the Specification E2501 light source. This test method establishes a quantitative measure of the optical property of a coating that correlates to its ability to enhance defect contrast under the specified inspection light source.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *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]

D2805 Test Method for Hiding Power of Paints by Reflectometry

D4356 Practice for Establishing Consistent Test Method Tolerances (Withdrawn 2007)[3]

D5162 Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates

E179 Guide for Selection of Geometric Conditions for Measurement of Reflection and Transmission Properties of Materials

E284 Terminology of Appearance

E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation

E1488 Guide for Statistical Procedures to Use in Developing and Applying Test Methods

E2501 Specification for Light Source Products for Inspection of Fluorescent Coatings

2.2 *Other Documents:*

ISO 10527:2007(E)/CIE S 014-1/E:2006 CIE Standard Colorimetric Observers[4]

CIE Publication 69:1987 Methods of characterizing illuminance meters and luminance meters: Performance, characteristics and specifications[4]

2.3 *SSPC:*

SSPC-SP 10/NACE No. 2 Near-White Blast Cleaning[5]

3. Terminology

3.1 The definitions contained in Guide E179, Terminology E284, and Practice E1164 are applicable to this test method.

3.2 The definitions for coating defects, discontinuity, holiday, and pinhole are contained in Practice D5162.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *luminance ratio, n*—luminance of the sample under a given narrow band 405 nm source divided by the luminance of a 25 % reflecting Lambertian diffuser under the same narrow band 405 nm source.

4. Summary of Test Method

4.1 This test method provides a procedure for measuring the luminance ratio of a fluorescent, reflective coating compared to

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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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from U.S. National Committee of the CIE (International Commission on Illumination), C/o Thomas M. Lemons, TLA-Lighting Consultants, Inc., 7 Pond St., Salem, MA 01970, http://www.cie-usnc.org.

[5] Available from Society for Protective Coatings (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656, http://www.sspc.org.

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a 25 % reflecting Lambertian diffuser, which is similar to steel grit blasted to an SSPC-SP 10/NACE No. 2 near-white metal blast.

4.2 This test method requires the use of a luminance meter, a narrow band 405 nm source and a calibrated non-fluorescent reflectance standard.

5. Significance and Use

5.1 The test method is suitable for the development, specification and quality control testing of fluorescent and non-fluorescent coatings that are intended to be inspected for defects under Specification E2501 illumination.

6. Apparatus

6.1 *Illuminator:*

6.1.1 The source shall have a peak wavelength of 405 nm (±1 nm), a symmetric unimodal distribution with a full width half maximum of 16 nm (±2 nm). The shape of the spectral distribution shall be triangular, Gaussian or isosceles trapezoidal where the width of the peak shall be less than one sixth the size of the base.

NOTE 1—A uniform or rectangular distribution does not meet this condition.

NOTE 2—An informational appendix (Appendix X1) is provided that briefly summarizes the reasons for the choices of tolerances in this test method.

6.1.2 The integrated irradiance over the wavelength range 490 to 760 nm shall be less than 0.01 % of the integrated irradiance over the wavelength range 380 to 760 nm.

NOTE 3—The light from 490 to 760 nm is typically from fluorescence generated in the light source. This light is heavily weighted by the luminous efficacy function, V(λ), resulting in large errors in the luminance ratio measurement. The fluorescence can be eliminated with a blue-green colored glass filter that has an internal transmittance at a reference thickness of 1 mm greater than 0.90 at 405 nm and less than 0.05 across the wavelength range of 500 to 680 nm.

6.1.3 The source shall produce a minimum irradiance sufficient to ensure a signal-to-noise ratio of 100 to 1 for the luminance meter described in 6.2.

NOTE 4—An irradiance of 10 W/m^2 is typically sufficient.

6.1.4 The illuminated area shall be at least twice the viewing area of the luminance meter. The minimum viewing area is specified in 6.2.4.

6.1.5 The source irradiance shall be stable to 1 % over the time frame of the measurements.

6.1.6 The illuminance on the sample surface shall be uniform within ±5 % of the average illuminance normal to the source. The illuminator may be collimated or not.

6.2 *Luminance Meter:*

6.2.1 The responsivity and range of the luminance meter shall be sufficient so that readings of both the non-fluorescent reflectance standard and the fluorescent sample are measured with a resolution of at least 1 part in 100.

6.2.2 If the luminance meter is filter based, the spectral responsivity of the luminance meter shall match that of the 1931 CIE Standard Photopic Observer. (ISO 10527:2007(E)/CIE S 014-1/E:2006) The individual spectral mismatch correction factors or the ratio of spectral mismatch correction factors with respect to the illuminator described in 6.1 shall be determined for the luminance meter to at least 1 part in 100 when measuring the non-fluorescent reflectance standard and the fluorescent sample.

NOTE 5—The ratio of the spectral mismatch correction factors may be determined by using a non-fluorescent reflectance standard calibrated under the source described in 6.1 and a fluorescent sample similar to the test sample, which are calibrated for luminance ratio under the source described in 6.1.

NOTE 6—An informational appendix (Appendix X1) is provided that briefly summarizes the method for calculating the spectral mismatch correction factors or the ratio of such.

6.2.3 If the luminance meter is spectrally based, the out-of-band stray light rejection shall be better than 1×10^{-5}.

6.2.4 The field-of-view of the luminance meter and the distance from the sample surface shall be such that the viewed region shall be larger than 2.5 cm^2 with no dimension smaller than 1.3 cm.

NOTE 7—The viewing area of the luminance meter depends on the field of view and the distance from the sample. The viewing area for a circular aperture is calculated by using the following equation:

$$viewing\ area = \left(\tan\left(v/2\right) \cdot d \right)^2 \cdot \pi / \cos(45°) \quad (1)$$

where:

v = field of view of the luminance meter and
d = distance between the luminance meter and the test sample.

6.2.5 The luminance meter shall be insensitive to the polarization of the light.

6.2.6 The linearity of the luminance meter over the range of measurements shall be within 1 %. Correction factors may be used to ensure a linear response.

6.2.7 The stability of the luminance meter over the duration of the measurements shall not vary more than 1 %.

6.2.8 The out-of-view sensitivity, described in CIE Publication 69, of the luminance meter shall be less than 0.5 %.

6.3 *Non-fluorescent Reflectance Standard:*

6.3.1 The non-fluorescent reflectance standard shall be calibrated in a 0°:45° geometry for luminous reflectance under the source described in 6.1with an expanded uncertainty (k = 2) of less than 1 %.

NOTE 8—The magnitude of the luminous reflectance of the non-fluorescent reflectance standard is somewhat arbitrary, because it is normalized to 0.25 in the calculations shown in 10.1. Typically, the magnitude of the luminous reflectance of the non-fluorescent reflectance standard is above 0.9 in order to have a larger signal-to-noise ratio.

6.3.2 The non-fluorescent reflectance standard shall have an integrated radiance over the wavelength range 490 to 760 nm less than 0.05 % of the integrated radiance over the wavelength range 380 to 760 nm under the illuminator specified in 6.1.

6.3.3 The non-fluorescent reflectance standard shall produce a diffuse distribution when illuminated.

7. Test Specimen

7.1 Prepare coating in accordance with Test Method D2805 for drawdown sample for hiding power by reflectometry.

7.2 Alternately, prepare by spraying or drawing down on a black substrate that has a maximum reflectance of 1 % and does not fluoresce.

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