



Designation: D5215 – 93 (Reapproved 2021)

Standard Test Method for Instrumental Evaluation of Staining of Vinyl Flooring by Adhesives¹

This standard is issued under the fixed designation D5215; 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 describes procedures and instrumentation for accurately measuring the degree of staining that may occur in vinyl flooring as a result of its contact with adhesives. Measured color differences between vinyl flooring specimens contacting the adhesive and not contacting the adhesive are expressed in the CIELAB Color-Scale System.

1.2 This test method provides for visual evaluation of staining which may occur when vinyl flooring contacts adhesives.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *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.*

1.5 *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

D907 *Terminology of Adhesives*

D2244 *Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates*

¹ This test method is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.70 on Construction Adhesives.

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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.

E284 *Terminology of Appearance*

E1347 *Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry*

E1349 *Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45°:0° or 0°:45°) Geometry*

G53 *Practice for Operating Light-and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials (Withdrawn 2000)*³

3. Terminology

3.1 *Definitions:*

3.1.1 *chromaticity coordinates, n*—the ratio of each of the tristimulus values of a psychophysical color to the sum of the tristimulus values (see Terminology E284).

3.1.1.1 *Discussion*—Chromaticity coordinates in the CIE system of color specification are designated by x , y , and z .

3.1.2 *CIE 1976 $L^*a^*b^*$ uniform color space, CIELAB, (1, 2)*⁴, n —an approximately uniform color space, that is produced by plotting in rectangular coordinates the quantities L^* , a^* , b^* , from which the total difference between two colors may be calculated.

3.1.2.1 *Discussion*—The abbreviation CIELAB is recommended.

3.1.3 *color difference, n*—as visually perceived, the magnitude and character of the difference between two colors described by such terms as redder, bluer, lighter, darker, grayer, or cleaner (see Terminology E284).

3.1.4 *color difference, n*—as computed, the magnitude and direction of the difference between two psychophysical color stimuli and their components computed from tristimulus values, or by chromaticity coordinates and luminance factor, by means of a specified set of color-difference equations (see Terminology E284).

3.1.5 *CIELAB color difference equation, n (1, 2)*—the total difference ΔE^*_{ab} between two colors, each given in terms of L^* , a^* , b^* , calculated as follows:

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ The boldface numbers in parentheses refer to the list of references at the end of this test method.

$$\Delta E_{ab}^* = (\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})^{\frac{1}{2}} \quad (1)$$

3.1.5.1 *Discussion*—The magnitude, ΔE_{ab}^* , gives no indication of the character of the difference since it does not indicate the relative quantity and direction of the hue, saturation, and lightness differences. The CIELAB color differences are uniformly 1.1 times Adams-Nickerson (AN40) color differences.

3.1.5.2 *Discussion*—The direction of the color difference is described by the magnitude and algebraic signs of the components ΔL^* , Δa^* , Δb^* as follows:

$$\Delta L^* = L_1^* - L_0^* \quad (2)$$

$$\Delta a^* = a_1^* - a_0^* \quad (3)$$

$$\Delta b^* = b_1^* - b_0^* \quad (4)$$

where L_0^* , a_0^* , and b_0^* refer to the reference, and L_1^* , a_1^* , and b_1^* refer to the test specimen.

3.1.6 *directional optical measuring system, n*—an optical system for measuring the reflecting or transmitting properties of specimens, in which the illuminator and receiver each subtend small angles at the specimen surface.

3.1.7 *luminance factor, n*—the ratio of the luminance of a specimen to that of a perfect diffuser, when illuminated and viewed under specified geometric conditions (see Terminology E284).

3.1.7.1 *Discussion*—In the CIE 1931 system, the luminance factor is tristimulus factor Y .

3.1.8 *CIE tristimulus values, n*—the amounts of three specified stimuli required to match a color (see Terminology E284).

3.1.8.1 *Discussion*—In the CIE system, they are assigned the symbols X , Y , and Z .

3.2 *Symbols:*

3.2.1 L^* —an individual CIELAB color (opponent-color) coordinate relating to luminance (lightness).

3.2.2 a^* —an individual CIELAB color (opponent-color) coordinate relating to redness/greenness.

3.2.3 b^* —an individual CIELAB color (opponent-color) coordinate relating to blueness/yellowness.

3.2.4 ΔE_{ab}^* —the magnitude of the difference.

3.2.5 ΔL^* , Δa^* , Δb^* —the CIELAB color differences as described by the magnitude and algebraic signs of the components, and giving the following approximate meanings (3):

3.2.5.1 $+\Delta L^*$ —lighter.

3.2.5.2 $-\Delta L^*$ —darker.

3.2.5.3 $+\Delta a^*$ —redder (less green).

3.2.5.4 $-\Delta a^*$ —greener (less red).

3.2.5.5 $+\Delta b^*$ —yellowier (less blue).

3.2.5.6 $-\Delta b^*$ —bluer (less yellow).

3.2.6 x , y , z —the chromaticity coordinates in the CIE system of color specification.

3.2.7 X , Y , Z —the CIE 1931 tristimulus values.

4. Summary of Test Method

4.1 The differences in color between a reference and test specimen are determined with a spectrophotometer or colorimeter. Reflectance readings are made which in turn are converted

by computations to color-scale values. These reflectance readings may be automatically converted and computed by a computer with the appropriate software program connected to the spectrophotometer or colorimeter.

4.2 Specimens are heat aged at $140 \pm 5^\circ\text{F}$ ($60 \pm 3^\circ\text{C}$) for seven days.

4.3 Specimens are exposed to ultraviolet light for 48 h.

5. Significance and Use

5.1 Certain substances in adhesives may cause discoloration of vinyl flooring. This test method provides a means of measuring the discolorations that may occur in the vinyl as a result of contact with these adhesives. Vinyl flooring specimens, either contacting or not contacting the adhesive, are exposed to heat and UVA light to accelerate discoloration. By means of colorimeter or spectrophotometer, color differences between exposed specimens are accurately measured. Therefore, instrumental evaluation rather than personal subjective evaluation is used to determine the amount of discoloration an adhesive may produce in vinyl flooring. This test method does not attempt to simulate or duplicate the heat and sunlight conditions that may impact vinyl floor coverings while in service.

6. Apparatus

6.1 *Instrumentation for Color Readings*—A colorimeter or spectrophotometer that measures color coordinates as described in Test Methods E1347 and E1349.

6.1.1 *Scale*—CIELAB Color-Scale System.

6.1.2 *Illuminant*—D65 illuminant or equivalent.

6.1.3 *Standard Observer*—2 or 10° .

6.1.4 *Viewpoint Diameter*—Equal to or less than 1.0 in. (25 mm).

6.1.5 *Bidirectional Geometry*— $45^\circ/0^\circ$ (45° circumferential illumination/ 0° viewing).

6.2 *Spatula*—Unspecified size.

6.3 *Applicator*—A 15-in. long (381 mm) threaded rod, $\frac{3}{8}$ in. (9.5 mm) in diameter with 16 threads/in. (25.4 mm) to be used for application of adhesive.

6.4 *Oven*—Hot air recirculating oven.

6.5 *Test Chamber*—A UV condensation-type cabinet⁵ meeting the requirements of Practice G53.

6.5.1 *Lamps*—UVA-351 lamps.

7. Reagents and Materials

7.1 *Adhesives*—Construction and flooring adhesives used for installation of residential vinyl floor covering (both felt and vinyl backed).

7.2 *Aluminum Foil*—To be used for wrapping test specimens.

7.3 *Solvents*—Those necessary for clean-up.

⁵ Cabinet available from Q. Panel Co., 26200 First St., Cleveland, OH 44145 or Atlas Electrical Devices Co., 4114 N. Ravenswood Ave., Chicago, IL 60613 has been found suitable.

8. Test Specimens

8.1 *Size of Specimens*—Unless otherwise specified, specimens shall be 3 by 6 in. (75 by 150 mm).

8.2 *Color of Specimens*—The specimens shall be a light-colored (preferably white) floor covering. Greatest precision of color difference is obtained when reading the smoothest, unpatterned area of flooring surface. Special attention is required to be certain that like areas of all specimens are read.

8.3 *Number of Specimens*—Prepare three control specimens with no adhesive, and three specimens for each adhesive to be evaluated (see Fig. 1).

8.3.1 In addition, retain a 3 by 6 in. (75 by 150 mm) piece of flooring for visual evaluation. Wrap this sample in aluminum foil.

9. Procedure

9.1 Cut specimens of flooring as described in Section 8.

9.2 Place the specimen identification number at the top of the back side of each specimen. Use a sharp pencil to minimize the possibility of smearing other specimens in the course of testing.

9.3 On the face side of each specimen, mark a circular area of the lightest, smoothest, unpatterned section of flooring (see 8.2). Again, use a sharp pencil to avoid smearing or marring the specimen. The designated area shall be a minimum of 1/8 in. (3 mm) larger than the 1.0-in. (25-mm) or smaller viewport of the colorimeter or spectrophotometer.

9.4 Calibrate the colorimeter or spectrophotometer according to the manufacturer’s recommendations. Take initial L^* , a^* , b^* readings on all specimens by means of the calibrated colorimeter or spectrophotometer (Test Methods E1347 and E1349). Use D65 illuminant or equivalent. Position each

specimen to read the encircled area. Record all readings in the CIELAB Color-Scale System.

9.5 Record all initial and subsequent readings on the prepared chart (Fig. 1).

9.6 Wrap the control specimens in aluminum foil after the initial readings.

9.7 Place each set of three specimens for adhesive evaluation on a flat surface side by side with the wear surface down. Leave an approximate 1/2-in. (13-mm) space between the specimens. The larger dimension of each specimen should lie in the same direction that the adhesive will be applied. Tape the leading edge of each specimen to the flat surface beneath. Using a spatula, apply the adhesive on the leading edge of each of the three specimens, making certain that the entire width of each specimen is covered with adhesive. Using the threaded-rod applicator, spread the adhesive evenly and simultaneously on the three specimens. Clean the rod thoroughly after each application to prevent cross-contamination of adhesives.

9.8 Allow all specimens to air-dry 24 h at room temperature.

9.9 Wrap each specimen in aluminum foil to prevent any cross-contamination or degradation from exposure to light.

9.10 Place control and adhesive specimens in a clean container in such a manner that air can circulate between the specimens. Condition in the recirculating oven for seven days at $140 \pm 5^\circ\text{F}$ ($60 \pm 3^\circ\text{C}$). Maintain the wrapped visual specimen at room temperature.

9.11 After seven days, remove specimens from the oven and condition them to room temperature for approximately 2 h.

9.12 Unwrap and place each specimen in the specimen holder with the wear surface showing through the specimen-holder window. Place all specimens in a fluorescent UV-condensation-type apparatus (see 6.5) that meets the requirements of Practice G53, and is equipped with UVA-351 lamps. Program the unit for UV exposure only (no exposure to condensation) at a temperature of $140 \pm 5^\circ\text{F}$ ($60 \pm 3^\circ\text{C}$) for 48 continuous hours. Do not use the two outside positions on either side of the racks when placing the specimen holders in the cabinet. Be certain that the specimen-holder window faces the UV lights. Maintain the light as specified in Practice G53.

9.13 After UV exposure, carefully remove the specimens and wrap them in foil until they are reread on the colorimeter or spectrophotometer.

9.14 Allow specimens to condition approximately 2 h at room temperature before rereading.

9.15 For each specimen, unwrap, reread and record the final set of L^* , a^* , b^* values. Record the ΔL^* , Δa^* , Δb^* , and ΔE^*_{ab} values.

9.16 Make a visual evaluation at the conclusion of this test procedure. The visual evaluations are to be used as cross-checks of the numerical evaluations, and it is expected that one will substantiate the other.

VINYL FLOORING - UV EXPOSURE

Flooring Materials: _____ Color Instrument & Model #: _____ UV Cabinet: _____
 Adhesives: _____ Illuminant: _____ Model #: _____
 Standard Observer: _____
 Orifice: _____
 Geometry: _____

| Set # | Description | Spec # | Initial Readings | | | Final Readings | | | Delta Values | | | Color Change due to Adhesive |
|-------|-------------------|--------|------------------|-------|-------|----------------|-------|-------|--------------|-------|-------|------------------------------|
| | | | L^* | a^* | b^* | L^* | a^* | b^* | L^* | a^* | b^* | |
| 1 | Control | 1 | | | | | | | | | | |
| | | 2 | | | | | | | | | | |
| | | 3 | | | | | | | | | | |
| | | X | | | | | | | (1) | (2) | (3) | |
| 2 | Test Adhesive "A" | 1 | | | | | | | | | | |
| | | 2 | | | | | | | | | | |
| | | 3 | | | | | | | | | | |
| | | X | | | | | | | (4) | (5) | (6) | |
| | | | | | | | | (7) | (8) | (9) | (10) | |
| 3 | Test Adhesive "B" | 1 | | | | | | | | | | |
| | | 2 | | | | | | | | | | |
| | | 3 | | | | | | | | | | |
| | | X | | | | | | | | | | |

Prepared by: _____ Date(s) prepared: _____ Key: (7) = (4) minus (1)
 (8) = (5) minus (2)
 (9) = (6) minus (3)
 (10) = [(7)² + (8)² + (9)²]^{1/2}

FIG. 1 Form for Reporting Color Readings, Computations, and Identification of Materials and Apparatus Used to Measure Color Differences

10. Calculation

10.1 See Fig. 1.