

Gray Scale for Staining

Adopted in 1954 by AATCC; under jurisdiction of AATCC Committee RA36; revised 1979, 1981, 1996, 2002, 2005; reaffirmed 1989; editorially revised 1992, 2006. Related to ISO 105-A03.

1. Scope

1.1 This evaluation procedure describes the use of the Gray Scale for evaluating staining of textiles resulting from colorfastness tests. A precise colorimetric specification of the differences between the reference and the 9-step Scale is given as a permanent record against which newly prepared Gray Scales, and old Scales that may have changed, can be compared.

2. Principle

2.1 The result of staining from a colorfastness test is rated by visually comparing the difference in color or the contrast between the stained and unstained specimens with the differences represented by the Scale (see 7.1). The colorfastness grade is equal to the Gray Scale step which is judged to have the same color or contrast difference.

3. Terminology

3.1 **colorant staining**, *n.*—the unintended pickup of colorant by a substrate due to (1) exposure to a colored or contaminated liquid medium, or (2) direct contact with dyed or pigmented material, from which colorant transfers by sublimation or mechanical action (as in crocking).

3.2 **colorfastness**, *n.*—the resistance of a material to change in any of its color characteristics, to transfer of its colorant(s) to adjacent materials or both, as a result of the exposure of the materials to any environment that might be encountered during the processing, testing, storage or use of the material.

3.3 **Gray Scale**, *n.*—a scale consisting of pairs of standard gray chips representing progressive differences in color or contrast corresponding to numerical colorfastness grades.

4. Description of the Scale

4.1 Staining grade 5 is represented on the Scale by two identical white reference chips mounted one above the other, having a Y tristimulus value of 85 ± 2 . The color difference of the pair is 0.0 with a tolerance of ± 0.2 (see 7.2).

4.2 Staining grades 4.5 to 1, inclusive, are represented by a reference white chip identical with those used for grade 5, paired with darker neutral gray chips of similar dimensions and gloss. The differences in the whole step pairs—staining grades 4, 3, 2 and 1 are in geometric steps of color difference. The differences in the half-step staining grade pairs—4-5, 3-4, 2-3 and 1-2—are intermediate between the whole step grade pairs (see 7.3, 7.4 and Fig. 1).

5. Use of the Scale

5.1 Provided with the Scale is a mask with three rectangular holes in it. One is labeled “For Evaluating Stained Multifiber,” the second “For Evaluating Crock Squares,” and the third “For Evaluating General Staining.” The cleanliness and physical condition of the Gray Scale is extremely important in obtaining consistent results (see 7.5).

5.2 How the Scale and mask are used will depend on the nature of the stained materials. The following sections are concerned with the creation of a junction, where necessary, between the stained and unstained materials.

5.2.1 Large pieces of stained material. Place the specimen of the stained material side by side with a piece of the unstained material oriented in the same direction. Take special care to create a sharp junction between the two pieces of material. Place the Gray Scale along the edges of the test specimen and unstained material with the junctions of the Gray Scale and the textiles aligned. Place the “For Evaluating General Staining” mask (Y tristimulus of 53 ± 1) provided with the Scale over the samples and the Scale to normalize the surrounding area (see Fig. 2).

5.2.2 Stained crock specimens. Place the “For Evaluating Crock Squares” mask (Y tristimulus value of 53 ± 1) provided with the Scale over the crock square with the stained area centered in the mask to normalize surrounding areas. Place the Gray Scale over the mask next to the test specimen.

5.2.3 Multifiber material. Place the specimen of the stained multifiber material and a piece of the unstained multifiber material oriented in the same direction. Take special care to create a sharp junction between the two pieces of material by trimming the stained specimen. Place the Gray Scale along the edges of the test specimen and unstained

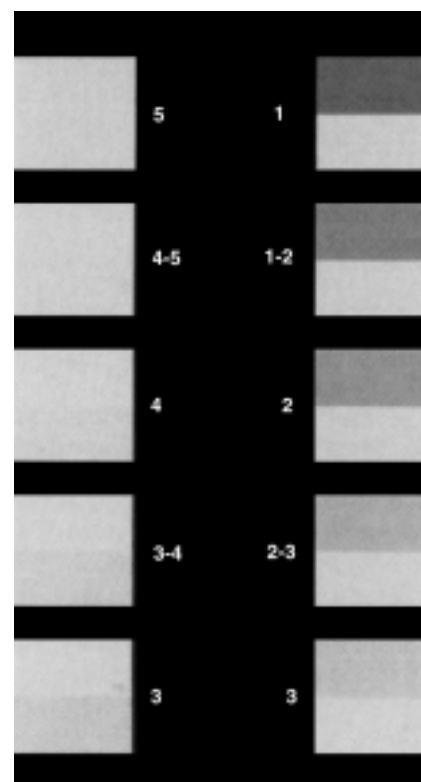


Fig. 1—Gray Scale for Staining.

material with the junctions of the Gray Scale and the textiles aligned. Place the “For Evaluating General Staining” mask (Y tristimulus of 53 ± 1) provided with the Scale over the samples and the Scale to normalize the surrounding area.

5.2.4 Irregular stains. Select appropriate sized mask and follow instructions in 5.2.1 above.

5.3 Back the stained and unstained materials with unstained, undyed material of the same kind to achieve visual opacity. Illuminate the surfaces with a daylight simulator with illumination level at the specimen plane in the range of 1080-1340 lx (100-125 fc) (see 7.6). The light should be incident upon the surfaces at approximately 45° and the direction of viewing approximately perpendicular to the plane of the surfaces (see Fig. 3). Compare the visual difference between original unstained and stained pieces with the differences represented by the Gray Scale. The grade of the specimen is that number of the Gray Scale which most closely corresponds to the contrast between the original and tested pieces. A grade of 5 is given only when there is no difference in color or contrast between

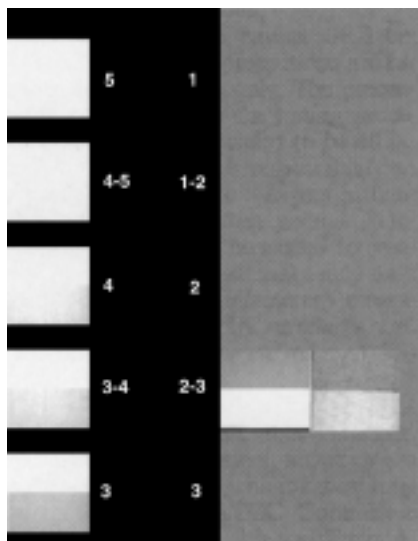


Fig. 2—Illustration on how to use scale.

the original undyed material and the tested piece.

6. Colorimetric Specification of the Color Differences of the Gray Scale

6.1 The color differences and tolerances between the reference white and the nine steps of the Scale are expressed as total color difference ΔE^*_{CIELAB} using the CIE 1976 $L^*a^*b^*$ color difference formula:

$$\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

where:

$$L^* = 116 (Y/Y_n)^{1/3} - 16$$

$$a^* = 500 [(X/X_n)^{1/3} - (Y/Y_n)^{1/3}]$$

$$b^* = 200 [(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}]$$

$$(X/X_n, Y/Y_n, Z/Z_n > 0.01)$$

The tristimulus values X_n, Y_n, Z_n define the color of the nominally white object-

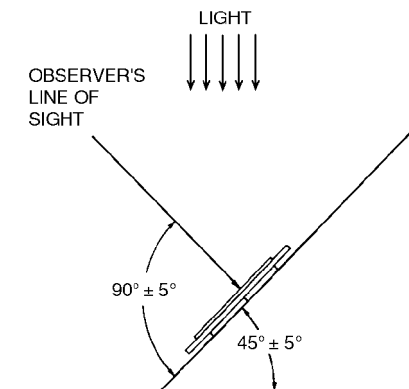


Fig. 3—Illumination and viewing angles for rating samples.

color stimulus. For D_{65} 10° observer calculation $X_n = 94.811$, $Y_n = 100.000$ and $Z_n = 107.304$.

6.2 Permissible tolerances for the Gray Scales used as working standards are given in the last column of Table I, Appendix A.

7. Notes

7.1 Available from AATCC, P.O. Box 12215, Research Triangle Park NC 27709; tel: 919/549-8141; Fax: 919/549-8933; e-mail: orders@aatcc.org.

7.2 AATCC guarantees that the Gray Scale for Staining meets the specifications given in this evaluation procedure.

7.3 The staining grades of the Scale steps and the corresponding color differences and tolerances, determined by the CIE 1976 $L^*a^*b^*$ (CIELAB) formula, are given in Table I, Appendix A. Sphere geometry spectrophotometric measurement of the chips shall be taken with the specular component included. A 0°/45° (45°/0°) geometry is an acceptable alternate. The colorimetric data shall be calculated using the CIE 1964 10° observer data for Illuminant D_{65} .

7.4 Provision for a colorfastness grade lower than 1 is provided for in *Nomenclature for Subjective Rating Processes* elsewhere in this MANUAL. Any test specimen which has a change in color or contrast decidedly greater than a grade of "1" may be given a grade of "0."

7.5 The Scale should be inspected frequently for fingerprints and any other marks. If the marks are considered to interfere with the rating process, then the Scale should be replaced. The Scale must be measured quarterly on a spectrophotometer or colorimeter to ensure that the total color differences are as shown in Table I, Appendix A. Keep the Scale in its case when it is not in use.

7.6 See AATCC Evaluation Procedure 9, Visual Assessment of Color Difference of Textiles, for notes on choice of daylight simulator and illumination level.

Appendix A

A.1 Table I provides the color difference values in CIE 1976 $L^*a^*b^*$ (CIELAB) units for the grade pairs in each step of the Gray Scale for Staining. This table is for instrumental measurement and confirmation that a Gray Scale is within tolerance, only. Table I is NOT to be used for assigning a Gray Scale based on instrumental measurement of two specimens.

Table I

Staining Grade	Total Color Difference CIELAB Units	Tolerance for Working Standards CIELAB Units
5	0	+ 0.2
4-5	2.2	± 0.3
4	4.3	± 0.3
3-4	6.0	± 0.4
3	8.5	± 0.5
2-3	12.0	± 0.7
2	16.9	± 1.0
1-2	24.0	± 1.5
1	34.1	± 2.0