Designation: D 4086 – 92a (Reapproved 2003)

Standard Practice for Visual Evaluation of Metamerism[1]

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INTRODUCTION

Because perceived color involves the spectral characteristics of source, object, and eye, different combinations of spectral characteristics can evoke the same color sensation. For this reason, metamerism has been described as "invisible spectral differences."

A pair of specimens is said to be metameric when the specimens match under one set of illuminating and viewing conditions and do not match under another set. For this condition to exist, there must be differences in spectral character of specimens and sources or specimens and observers. There may be more than one condition under which the specimens match, as well as more than one for which they are a mismatch. Similarly, two specimens may be a near-match under one set of conditions, and under another set the direction and magnitude of the color difference may change.

1. Scope

1.1 This practice describes visual methods for detecting metamerism and for estimating the magnitude of a metameric color difference.

1.2 The practice is limited to the consideration of illuminant metamerism and observer metamerism. It is not designed to cover so-called geometric metamerism, in which members of specimen pairs change relative appearance as the angles of illumination and viewing are changed, for example, because they incorporate flake metal or pearlescent colorants.

1.3 This practice does not provide for the computation of indices of metamerism based upon instrumental measurement of spectral characteristics.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 2616 Test Method for Evaluation of Visual Color Difference With a Gray Scale

E 284 Terminology of Appearance

3. Terminology

3.1 Definitions of appearance terms used in this practice may be found in Terminology E 284.

3.2 *Definitions:*

3.2.1 *metamerism, n*—property of two specimens that match under a specified illuminator and to a specified observer and whose spectral reflectances or transmittances differ in the visible wavelengths.

3.2.1.1 *Discussion*—As a consequence of the required difference, the two specimens may not match under a different illuminator or to a different observer. Similar considerations apply to two lights matching to a specified observer but not to other observers. **(E 284)**

3.2.2 *paramerism, n*—phenomenon in which specimens having different spectrophotometric curves produce approximately the same color sensation under the same illuminating and viewing conditions. **(E 284)**

4. Significance and Use

4.1 Metameric color matches result from the use of different colorants (pigments, dyes, and the like) in achieving the same color match. Usually, the purchaser requires that the color match be nonmetameric; this practice permits this requirement to be quickly tested in both field and laboratory. Where nonmetameric matches are not possible or practicable, for cost or other reasons, some limitation of metamerism may be required. The procedures for estimating the magnitude of

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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.

metamerism described in this practice provide methods for assessing the effectiveness of such limitation.

5. Test Specimens

5.1 This practice does not cover the preparation of test specimens. The method shall be agreed upon between the purchaser and the seller.

6. Procedure for Visual Detection of Metamerism

6.1 *Illuminant Metamerism*—After observing that a pair of specimens is a visual match under one light source, the observer should view the specimens under one or more sources having distinctly different spectral power distributions. Among the suggested sources are daylight, incandescent light, and fluorescent lamp light. The larger the differences in spectral character of the sources, the easier it is to detect small degrees of metamerism.

6.2 *Observer Metamerism*—Specimens that are a match to one observer under a given light source are then viewed by other normal observers under the same conditions. Typically, five to ten observers should be used so that the results are not biased by differences among observers within the range of normal color vision. Replicate judgments by each observer may also be useful. Observer metamerism is indicated when there is obvious disagreement among observers as to the magnitude and direction of the color difference.

7. Procedures for Estimating Degrees of Metamerism

7.1 When the existence of metamerism has been established by visual evaluation of a pair of specimens, as indicated in Section 6, the degree of metamerism for that combination of source and observer can be determined by a visual estimate of the color difference. Use is made of paired gray scales, as specified in Test Method D 2616, that display increasingly larger color differences with each successive pair of grays in the scale. The metameric specimen pair is placed in juxtaposition with the edge of the gray scale and compared with various gray pairs. The total perceived color difference between the two members of the test pair is compared to the lightness differences of the pairs on the gray scale, and the gray scale pair is selected that is the best visual equivalent to the color difference of the test pair. It is assumed, as in Test Method D 2616, Section 5.1 that, the total color difference can be so evaluated in terms of an equivalent lightness difference. Observers can be expected to reproduce such evaluations within a half-step on the gray scale.

NOTE 1—*Visual Evaluation of Spectral Reflectance Curves*—When specimens that match under one set of circumstances are measured on a spectrophotometer that produces a reflectance curve in the visual region of the spectrum, direct comparison of such curves will disclose if there is metamerism. It is convenient to plot the spectral curves of the two members of a metameric pair on the same sheet. The curves must intersect a minimum of three times for specimens to be metameric. Specimens are not metameric when the curves intersect only one or two times in the visible wavelengths, or when the curves do not intersect, but are merely proportionally higher or lower in reflectance throughout the wavelength region. Judgment of the degree of metamerism by qualitative visual inspection of spectrophotometric curves requires considerable skill and experience.

8. Report

8.1 Report the following information:

8.1.1 Identification of the specimens,

8.1.2 Procedures employed,

8.1.3 Results observed in Section 6,

8.1.4 Matching gray scale pair in Section 7,

8.1.5 Observed qualitative differences in hue, saturation, and lightness in accordance with Section 8.2.1 of Test Method D 2616,

8.1.6 Number of observers and whether or not they were tested for color vision anomalies, and

8.1.7 Description of light sources used as to type, size, color temperature, and spectral power distribution.

9. Precision and Bias

9.1 *Precision*—The only quantitative portion of this practice, for which consideration of precision is appropriate, is Section 7, where use is made of Test Method D 2616. The precision statements of that test method should be consulted if D 2616 is used.

9.2 *Bias*—There are no recognized standards by which to assess the bias of this practice.

10. Keywords

10.1 metamerism; visual examination-color; visual examination-metamerism