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Standard Guide to Evaluation of Optical Properties of Powder Coatings[1]

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INTRODUCTION

The term optical properties of powder coatings refers to those properties associated with the interaction of visible light with the coatings. These properties include, but are not limited to, color, color difference, gloss, and metamerism. Coating powder users and producers may sometimes be overwhelmed by the sheer number of standard practices and standard test methods available for the evaluation of the optical properties of the finished coatings.

This guide is intended to lead the user to each of the practices and test methods needed, once the user decides whether the evaluation is to be by visible means or by instrumental means. Further, the user must decide which of the several optical properties mentioned above are to be evaluated. This guide will lead the user to the applicable practices and test methods for the properties chosen by the means selected.

1. Scope

1.1 This standard provides the user with a guide to the various available practices and test methods for the evaluation of color, color difference, gloss, and metamerism by both visual and by instrumental means.

1.2 *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.*

1.3 *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]

D523 Test Method for Specular Gloss

D1535 Practice for Specifying Color by the Munsell System

D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials

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

D2616 Test Method for Evaluation of Visual Color Difference With a Gray Scale

D3134 Practice for Establishing Color and Gloss Tolerances

D4039 Test Method for Reflection Haze of High-Gloss Surfaces

D4086 Practice for Visual Evaluation of Metamerism

D4449 Test Method for Visual Evaluation of Gloss Differences Between Surfaces of Similar Appearance

D5767 Test Methods for Instrumental Measurement of Distinctness-of-Image Gloss of Coating Surfaces

E284 Terminology of Appearance

E308 Practice for Computing the Colors of Objects by Using the CIE System

E430 Test Methods for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry

E1247 Practice for Detecting Fluorescence in Object-Color Specimens by Spectrophotometry

E1331 Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry

E1345 Practice for Reducing the Effect of Variability of Color Measurement by Use of Multiple Measurements

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

[1] This guide is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.51 on Powder Coatings.

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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.

E1360 Practice for Specifying Color by Using the Optical Society of America Uniform Color Scales System
E1541 Practice for Specifying and Matching Color Using the Colorcurve System (Withdrawn 2007)[3]

3. Terminology

3.1 The definitions in Terminology E284 are applicable to the appearance terms used in this standard. The following terms from Terminology E284 are specific to this standard.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *coating powder(s), n*—finely divided particles of resin, either thermoplastic or thermosetting, generally incorporating pigments, fillers, and additives and remaining finely divided during storage under suitable conditions, which, after fusing and possibly curing, give a continuous film.

3.2.2 *color, n*—(*2*) *perceived*, attribute of visual perception that can be described by color names such as white, gray, black, yellow, brown, vivid red, deep reddish purple, or by combinations of such names.

(*3*) *psychophysical*, characteristics of a color stimulus (that is, light producing a sensation of color) denoted by a colorimetric specification with three values, such as tristimulus values.

3.2.3 *color difference, n*—(*1*) *perceived*, the magnitude and character of the difference between two colors described by such terms as redder, bluer, lighter, darker, grayer, or cleaner.

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

3.2.4 *gloss, n*—angular selectivity of reflectance, involving surface reflected light, responsible for the degree to which reflected highlights or images of objects may be seen as superimposed on a surface.

3.2.5 *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.

3.2.6 *powder coatings, n*—coatings which are protective or decorative, or both, formed by the application of a coating powder to a substrate and fused in a continuous film by the application of heat or radiant energy.

4. Visual Evaluation of Optical Properties

4.1 *Visual Gloss*—To assess the visual gloss difference between two powder coated surfaces of similar appearance use Test Method D4449.

4.2 *Color*—To obtain the color notation of a specimen in the Munsell Color Order System use Practice D1535. To obtain the color notation of a specimen in the Optical Society of America Uniform Color System use Practice E1360. To obtain the color notation of a specimen in the Colorcurve System use Practice E1541.

4.3 *Color Difference*—Practice D1729 will provide visual color difference in descriptive terms. If it is desirable to quantify the color difference visually, use Test Method D2616.

4.4 *Metamerism*—Carry out visual evaluation of a metameric pair of specimens by Practice D4086.

4.5 *Miscellaneous Optical Properties*—Evaluate visually reflection haze of high gloss surfaces, as well as distinctness-of-image gloss, by Test Method D4449.

5. Instrumental Evaluation of Optical Properties

5.1 *Specular Gloss*—Measure the specular gloss of a powder coating by Test Method D523.

5.2 *Color*—If filter photometry is to be employed, use Test Method E1347. If spectrophotometric means are to be employed, acquire spectral data on instruments having 45° illumination and normal viewing by Test Method E1349, and on instruments having an integrating sphere by Test Method E1331. The spectrophotometric data are then integrated to tristimulus values by Practice E308.

5.3 *Color Difference*—Evaluate the color difference between two powder-coating specimens by Practice D2244 using the tristimulus values acquired in 5.2.

5.4 *Metamerism*—Although Practice D4086 is a visual method, Note 1 to Section 7 in that practice describes a method for comparison of spectral curves of two specimens to detect the presence of metamerism.

5.5 *Miscellaneous Optical Properties and Methods*—Evaluate reflection haze of high gloss surfaces instrumentally by Test Method D4039. Evaluate distinctness-of-image gloss of high gloss surfaces by Test Methods E430 or by Test Methods D5767. Fluorescence in a powder coating may be identified by Test Method E1247. Establish color and gloss tolerances by Practice D3134. Practice E1345 gives methods of reducing the variability of color measurements by making multiple measurements.

6. Report

6.1 Reports that may be required are contained in each of several referenced standards that may be utilized as a result of following this guide.

7. Keywords

7.1 appearance; coating powders; color; color difference; gloss; metamerism; powder coatings

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