

TAPPI/ANSI T 527 om-13

SUGGESTED METHOD – 1972
CLASSICAL METHOD – 1992
OFFICIAL METHOD – 1994
REVISED – 2002
CORRECTED – 2002
REVISED – 2007
REVISED – 2013
©2013 TAPPI



The information and data contained in this document were prepared by a technical committee of the Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

CAUTION:

This Test Method may include safety precautions which are believed to be appropriate at the time of publication of the method. The intent of these is to alert the user of the method to safety issues related to such use. The user is responsible for determining that the safety precautions are complete and are appropriate to their use of the method, and for ensuring that suitable safety practices have not changed since publication of the method. This method may require the use, disposal, or both, of chemicals which may present serious health hazards to humans. Procedures for the handling of such substances are set forth on Material Safety Data Sheets which must be developed by all manufacturers and importers of potentially hazardous chemicals and maintained by all distributors of potentially hazardous chemicals. Prior to the use of this method, the user must determine whether any of the chemicals to be used or disposed of are potentially hazardous and, if so, must follow strictly the procedures specified by both the manufacturer, as well as local, state, and federal authorities for safe use and disposal of these chemicals.

Color of paper and paperboard (d/0, C/2)

1. Scope

1.1 This method specifies a procedure for measuring the color of paper or paperboard with tristimulus filter colorimeters or spectrophotometers incorporating diffuse/0 geometry and CIE (International Commission on Illumination) illuminant C.

NOTE 1: TAPPI T 524 “Color of Paper and Paperboard (45/0, C/2)” describes a similar procedure using directional illumination and normal viewing.

1.2 In the method, tristimulus values X (red), Y (green), and Z (blue), appropriate to the CIE-1931 (2°) standard observer, are calculated from reflectance measurements R_x , R_y , and R_z or from $R(\lambda)$ data. Color can then be expressed in various color space systems:

1. Hunter L , a , b
2. CIE L^* , a^* , b^*
3. L^* , C^* , h
4. Dominant wavelength, purity, luminosity
5. Color difference, $[\Delta E, \Delta E^*, \Delta E^*94, \Delta E \text{ (CMC)}]$

1.3 Instruments equipped with microprocessors which give direct information relating to different color scale systems conform to this method only if the means of measurements and calculation conform to the descriptions herein.

2. Significance

2.1 The color appearance of paper and paperboard is important for its aesthetic value in marketing packaged products, as an aid to distribution of multi-ply forms; to differentiate pages or sections of published literature, in artwork, and in many other applications.

Approved by the Standard Specific Interest Group for this Test Method



Documents
Document Sharing Hub

2.2 A numerical definition of color is essential to good quality control and to customer-producer relationships.

3. Definitions

3.1 *Dominant wavelength (of an illuminated object)*, the wavelength of spectrally pure energy which when mixed with the illuminant in suitable proportions will match the color of the specimen.

3.2 *Purity, excitation*, the ratio of the distance on a CIE chromaticity diagram between the achromatic point and the specimen point to the distance along a straight line from the achromatic point through the specimen point to the illuminant spectrum locus. The term “saturation” is also applied to this quantity.

3.3 *Luminosity*, the scale of perception representing a color's similarity to achromatic colors between black and white. This quantity is also known as “luminance” and “luminous reflectance.”

3.4 L, a, b, L^*, a^*, b^* , these symbols are used to designate color values as follows: L, L^* represents lightness increasing from zero for black to 100 for perfect white; a, a^* represents redness when positive, greenness when negative; and b, b^* represents yellowness when positive, blueness when negative. When a^* and b^* are simultaneously zero, they represent grey.

3.5 L^*, C^*, h, L^* is as described in 3.4, C^* represents chroma, and h represents hue angle.

3.6 $\Delta E, \Delta E^*, \Delta E$ (CMC), the overall color difference values take into account lightness/darkness differences as well as chromatic differences. The intent is for a given value of $\Delta E, \Delta E^*, \Delta E$ (CMC), to represent the same visual perception of color difference anywhere in color space.

4. Apparatus

4.1 *Instrumental components*¹, consisting of a means for fixing the location of the surface of the specimen, a system for proper illumination of the specimen, suitable filters, gratings, or other optical components for altering the spectral character of the rays reflected from the specimen, photosensitive receptors to receive the reflected rays, and a means for transforming the receptor outputs to tristimulus functions.

4.2 *Spectral characteristics*

4.2.1 *Incident light*. The spectral power distribution of the light incident on the specimen determines the extent to which reflected light may be augmented by fluorescence. The product of the spectral power distribution of the source and spectral transmittance of the glass lenses and infrared absorbing filter in the incident system should correspond to the energy distribution as defined for a source matching illuminant C given as a function of wavelength in Table 1. This relative spectral power distribution may be approximated by a select combination of a tungsten filament source, a heat absorbing filter, and UV trimming filter in the incident beam. If the paper or paperboard being measured by a spectrophotometer contains no fluorophores (fluorescent components, i.e., optical brightness), the spectral distribution of incident light will not affect the measurement of color, provided that sufficient energy is available at each wavelength of measurement.

4.2.2 *Light energy*. The light energy incident on the test specimen should not appreciably heat or fade the specimen during the measurement. An infrared absorbing filter (heat filter) in the incident beam will normally prevent overheating the specimen.

4.2.3 *Spectral response*. The overall spectral response of the instrument, as determined by the combination of the spectral distribution of incident light on the specimen, the absorption characteristics of the filters and other light altering optics, and the photosensitive response of the receptors to light reflected from the specimen, shall simulate the CIE color-matching functions weighted by the relative spectral energy distribution of CIE Illuminant C/2° given in Table 2. All color spectrophotometers conforming to this method, T 527, must use the integration tables contained in ASTM E308 (Table 5.6), “Standard Practice for Computing the Color of Object by Using the CIE System,” for the computation of tristimulus values X, Y , and Z .

4.3 *Geometric characteristics*. The specimen shall be illuminated diffusely by means of an integrating sphere meeting the requirements of ISO 2469. The direction of viewing shall be perpendicular ± 0.5 degrees to the specimen surface. Only reflected rays within a solid cone, whose vertex is in the specimen aperture, and of half-angle not greater than 4° , shall fall on the receptor. To prevent specularly reflected light from reaching the receptor, the

¹Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list, available as part of the CD or printed set of Standards, or on the TAPPI website general Standards page.

receptor aperture shall be surrounded by a black annulus (gloss trap) with external diameter subtending a half-angle of $15.5 \pm 0.5^\circ$ at the center of the specimen aperture.

NOTE 2: Interchange of incident and viewing directions is allowed under this method.

Table 1. Relative spectral energy distribution incident on the specimen

<i>Wavelength, nm</i>	<i>Relative energy, E Illuminant C</i>
320	0.01
330	0.40
340	2.70
350	7.00
360	12.90
370	21.40
380	33.00
390	47.40
400	63.30
410	80.60
420	98.10
430	112.40
440	121.50
450	124.00
460	123.10
470	123.80
480	123.90
490	120.70
500	112.10
510	102.30
520	96.90
530	98.00
540	102.10
550	105.20
560	105.30
570	102.30
580	97.80
590	93.20
600	89.70
610	88.40
620	88.10
630	88.00
640	87.80
650	88.20
660	87.90
670	86.30
680	84.00
690	80.20
700	76.30