INTERNATIONAL STANDARD

ISO 105-J02

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Textiles — Tests for colour fastness —

Part J02:
Instrumental assessment of relative whiteness

Textiles — Essais de solidité des teintures —

Partie J02: Évaluation instrumentale de la blancheur relative

Reference number
ISO 105-J02:1997(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 105-J02 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 1, *Tests for coloured textiles and colorants.*

This second edition cancels and replaces the first edition (ISO 105-J02:1987), which has been technically revised.

ISO 105 was previously published in thirteen "parts", each designated by a letter (e.g. "Part A"), with publication dates between 1978 and 1985. Each part contained a series of "sections", each designated by the respective part letter and by a two-digit serial number (e.g. "Section A01"). These sections are now being republished as separate documents, themselves designated "parts" but retaining their earlier alphanumeric designations. A complete list of these parts is given in ISO 105-A01.

Annex A forms an integral part of this part of ISO 105.

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Textiles — Tests for colour fastness —

Part J02:
Instrumental assessment of relative whiteness

1 Scope

1.1 This part of ISO 105 specifies a method intended for quantifying the whiteness and tint of textiles, including fluorescent materials.

1.2 Whiteness as measured by this test method is an indication of how white the textile appears to an average viewer. Tint, if other than zero, is an indication of a reddish or greenish hue having shifted away from a bluish (neutral) hue with a dominant wavelength of 466 nm. The formulae for calculation of whiteness and tint are those recommended by the CIE[1)].

1.3 Because reflectance is affected by the nature of the surface of the textile, comparisons can be made only between specimens of the same type of textile.

1.4 The application of the formulae is restricted to specimens that are called "white" commercially, that do not differ much in colour and fluorescence and that are measured on the same instrument at nearly the same time. Within these restrictions, the formulae provide relative, but not absolute, evaluations of whiteness that are adequate for commercial use when employing measuring instruments having suitable modern and commercially available capabilities.

1) International Commission on Illumination, Vienna.

1.5 Many impurities in textiles absorb short wavelength light, resulting in a yellowish appearance to observers. Therefore, a measurement of whiteness may be an indication of the degree to which a textile is free from impurities.

1.6 The effect of blueing components or fluorescent whitening agents (FWAs) on the whiteness of textiles may also be determined using the whiteness measurement.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 105. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this part of ISO 105 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of the IEC and ISO maintain registers of currently valid International Standards.

ISO 105-J01:—[2], *Textiles — Test for colour fastness — Part J01: General principles for measurement of surface colour.*

CIE Publication No. 15.2: 1986[3], *Colorimetry* (second edition).

CIE Publication No. 17.4:1987[3], *International Lighting Vocabulary.*

ASTM E 284-96b:1996[4], *ASTM Terminology of Appearance (Revised).*

ASTM E 308-96:1996[4], *Practice for computing the colors of objects by using the CIE system.*

2) To be published.

3) Available from CIE Central Bureau, Kegelgasse 27, A-1030 Vienna, Austria.

4) Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 USA.

3 Definitions

For the purposes of this part of ISO 105, the following definitions apply:

3.1 CIE chromaticity coordinates. The ratio of each of the tristimulus values of a psychophysical colour to the sum of the tristimulus values.

3.2 CIE tristimulus values. The amounts of three non-real reference colour stimuli required to give a colour match with the colour stimulus considered, and defined by the CIE for the CIE 1931 colorimetric observer (2° standard observer) and the CIE 1964 supplementary colorimetric observer (10° standard observer).

3.3 fluorescent whitening agent (FWA). Colorant that absorbs near ultraviolet (UV) radiation and re-emits visible (violet-blue) radiation causing a yellowish material to which it has been applied to appear whiter.

3.4 perfect reflecting diffuser. Ideal isotropic diffuser with reflectance of unity.

NOTES

1 An isotropic diffuser is one in which the spatial distribution of reflected radiation is such that the radiance or luminance is the same in all directions in the hemisphere into which the radiation is reflected.

2 The perfect reflecting diffuser is the basis of calibration of reflectance measuring instruments. The equations for whiteness and tint are formulated so that the CIE concept of the perfect reflecting diffuser has a whiteness index of 100,0 and a tint value of 0,0.

3.5 whiteness. The attribute by which an object colour is judged to approach a preferred white.

3.6 tint. The hue of a white material as influenced by the wavelength of peak emission or reflectance.

NOTE — These definitions are based on CIE publication 15.2, CIE publication 17.4 or ASTM E 284-96b.

4 Principle

The CIE tristimulus values are measured using a reflectance spectrophotometer or colorimeter, and the whiteness and tint calculated from formulae based on the CIE chromaticity coordinates.

5 Apparatus and materials

5.1 Colour-measuring instrument, a reflectance spectrophotometer or colorimeter capable of measuring or calculating CIE tristimulus values with at least one of the CIE specified geometries (45/0, 0/45) as defined in ISO 105-J01 (*d*/0, 0/*d*). When integrating spheres are used for measuring fluorescent specimens, the spectral power distribution of the illuminating system is altered by the reflected and emitted power from the specimen. The use of the 45/0 or 0/45 condition is therefore preferable. If an integrating sphere instrument is to be used, measurements should, if possible, be made with the specular component of reflectance excluded.

5.2 Reference standard, the primary standard is the perfect reflecting diffuser (see 3.4). Secondary reference standards are standards that are calibrated in terms of the perfect reflecting diffuser and are used in the standardization of the instrument.

5.3 UV Lamp, used for visual determination of presence of FWA on textile specimens.
CAUTION: Protect the eyes from UV light. The safety recommendations provided by the UV light manufacturer should be followed.

6 Test specimen

Condition each specimen as described in annex A.2 of ISO 105-J01:1997. Keep the specimens free of dirt and stains. The exact size necessary will depend on the aperture of the reflectance-measuring instrument used and on the translucency of the textile material.

7 Procedure

7.1 Before proceeding with colour measurements, determine whether or not a test specimen contains FWA by viewing a specimen in a dark room under ultraviolet light. A test specimen that contains FWA will fluoresce under the UV light. Proceed as follows.

a) If fluorescent whitening agents (FWAs) are present on the textile material, make the measurement with an instrument that illuminates the specimen with polychromatic light (full spectrum) and has a relative spectral power distribution approximating CIE Illuminant D_{65} from 330 nm to 700 nm (see annex A). Consult instrument manufacturers for suitable equipment. Also verify the suitability of the instrument if flash illumination is being used.

b) For the determination of an approximate relative efficiency of an FWA, an instrument which permits the insertion of an ultraviolet cut-off filter into the incident light beam may be used.

c) If the test specimen does not contain an FWA, the measurement may be made on an instrument which illuminates it with either polychromatic or monochromatic light and the spectral power distribution of the illumination will not affect the results obtained.

NOTE — The difference between the measurements taken before and after the insertion of the ultraviolet cut-off filter can provide an indication of the enhancement of the apparent whiteness due to the addition of an FWA. Because of possible variations in light sources and/or ultraviolet cut-off filters, the user is advised to use this procedure only for "relative in-house" determination.

7.2 Operate the colour-measuring instrument according to the manufacturer's instructions for standardization. Prepare and present each test specimen and determine measurement values, in accordance with ISO 105-J01.

8 Calculations, interpretation and limitations

8.1 For each averaged measurement, determine the CIE tristimulus values X_{10}, Y_{10} and Z_{10} for CIE Illuminant D_{65} and 1964 10° observer.

See ASTM E 308-96 for details on calculation of tristimulus values from reflectance data.

From the CIE tristimulus values X_{10}, Y_{10}, and Z_{10}, calculate the chromaticity values x_{10}, and y_{10}. If the instrument used is not capable of calculating CIE Illuminant D_{65} and 1964 10° observer, the user may use CIE Illuminant C and 1931 2° observer method as described in annex A.

8.2 Calculate the whiteness index (W_{10}) for any specimen by use of the equation in 8.3 and the tint ($T_{w,10}$) by use of the equation in 8.4.

NOTES

1 Due to the limitations of instruments and the linearities of CIE whiteness space, comparisons of whiteness and tint values should be made only when measuring similar specimens (see 1.3 and 1.4) at nearly the same time and on the same instrument. The degree of difference that will be accepted or rejected is the sole responsibility of the user, as the requirements are extremely dependent on the particular use and material being measured. The higher the value of W_{10}, the greater the whiteness. Equal differences in W_{10} value do not necessarily indicate equal differences in perceived whiteness or equal concentration differences of FWA. Similarly, equal differences in $T_{w,10}$ value do not always represent equal perceptual differences in greenishness or reddishness of whites.

2 The whiteness index is only applicable for specimens whose values of W_{10} and $T_{w,10}$ lie within the following limits:

Limited to: $40 < W_{10} < 5Y_{10} - 280$

Limited to: $3 < T_{w,10} < +3$

8.3 Whiteness. (For Illuminant D_{65} and 1964 10° observer):

$$W_{10} = Y_{10} + 800\,(0{,}313\,8 - x_{10}) + 1\,700\,(0{,}331\,0 - y_{10})$$

where

W_{10} is the whiteness value or index;

Y_{10} is the tristimulus value of the specimen;

x_{10} and y_{10} are the chromaticity coordinates of the specimen;

0,313 8 and 0,331 0 are, respectively, the x_{10} and y_{10} chromaticity coordinates for the perfect reflecting diffuser.

8.4 Tint (for Illuminant D_{65} and 1964 10° observer):

$$T_{w,10} = 900\,(0{,}313\,8 - x_{10}) - 650\,(0{,}331\,0 - y_{10})$$

where

$T_{w,10}$ is the tint value;

x_{10} and y_{10} are the chromaticity coordinates of the specimen;

0,313 8 and 0,331 0 are, respectively, the x_{10} and y_{10} chromaticity coordinates for the perfect reflecting diffuser.

Values of $T_{w,10}$, when positive indicate a greenish hue, when negative indicate a reddish hue and when zero indicate a bluish (neutral) hue with a dominant wavelength of 466 nm.

9 Test report

Report the relative whiteness value , the tint value, if required, and the particulars specified in ISO 105-J01.

10 Precision and bias

10.1 Precision. Precision for this test method has not been established. There is no contemplated activity to establish precision for this method. Users of the method should use standard statistical techniques in making any comparisons of test results for either within-laboratory or between-laboratory averages.

10.2 Bias. The whiteness and tint of textiles can be defined only in terms of a test method. There is no independent method for determining the true values. As a means of estimating these properties, the method has no known bias.

Annex A

(normative)

Method for Illuminant C/2° observer

Tristimulus colorimeters typically do not conform to CIE Iilluminant D_{65} and the CIE 1964 10° observer. Most produce calculations for CIE Illuminant C and the CIE 1931 2° observer. Although the CIE Publication 15.2 recognizes whiteness and tint calculations for the CIE 1931 2° observer, it does **not** recognize calculations for the CIE Illuminant C. Therefore, the following equations are given for those users of tristimulus colorimeters that have no other choice but to perform calculations for Illuminant C and the 1931 2° observer. Bear in mind however, that these calculations are to be used **only** for relative "in-house" measurements and comparisons (see NOTE 1 in 8.2). For FWA-treated specimens, the use of illuminant C may give misleading results with respect to visual assessments.

Whiteness (For Illuminant C and 1931 2° observer):

$$W_{c,2} = Y + 800\,(0{,}310\,1 - x) + 1\,700\,(0{,}316\,1 - y)$$

where

$W_{c,2}$ is the whiteness value or index;

Y is the tristimulus value of the specimen;

x and y are the chromaticity coordinates of the specimen;

0,310 1 and 0,316 1 are, respectively, the x and y chromaticity coordinates for the perfect reflecting diffuser.

Limited to: $40 < W_{c,2} < 5Y - 280$.

Tint (For Illuminant C and 1931 2° observer):

$$T_{c,2} = 1\,000\,(0{,}310\,1 - x) - 650\,(0{,}316\,1 - y)$$

where

$T_{c,2}$ is the tint value;

x and y are the chromaticity coordinates of the specimen;

0,310 1 and 0,316 1 are, respectively, the x and y chromaticity coordinates for the perfect reflecting diffuser.

Limited to: $-3 < T_{c,2} < +3$.

Values of $T_{c,2}$, when positive indicate a greenish hue, when negative indicate a reddish hue and when zero indicate a bluish (neutral) hue with a dominant wavelength of 466 nm.

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Descriptors: textiles, dyes, colour fastness, tests, colour-fastness tests, determination, colour, rules of calculation.

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