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Textiles — Tests for colour fastness —

Part A11: Determination of colour fastness grades by digital imaging techniques

Textiles — Essais de solidité des coloris —

Partie A11: Détermination des degrés de solidité des coloris par des techniques d'imagerie numérique

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 105-A11 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 1, *Tests for coloured textiles and colorants*.

ISO 105 consists of many parts designated by a part letter and a two-digit serial number (e.g. A01), under the general title *Textiles — Tests for colour fastness*. A complete list of these parts is given in ISO 105-A01.

Textiles — Tests for colour fastness —

Part A11: Determination of colour fastness grades by digital imaging techniques

1 Scope

This part of ISO 105 specifies the requirement for a digital imaging system for use in the methods specified in Annexes A and B for the determination of change in colour and staining by digital imaging techniques.

This method is not suitable for assessment of colour fastness to light as described in the ISO 105 B series, as these standards do not use grey scales to assess the specimen.

This part of ISO 105 describes apparatus, equipment settings and calibration for the assessment of

— change in colour, and

— staining.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 105-A01, *Textiles — Tests for colour fastness — Part A01: General principles of testing*

CIE[1)] Publication S 012/E, *Standard method of assessing the spectral quality of daylight simulators for appraisal and measurement of colour*

CIE Publication 13.3, 1995, *Method of measuring and specifying the colour rendering properties of light sources*, 2nd edition

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
system grey
colour of the internal surfaces and apparatus that would normally be visible in a captured image

NOTE System grey shall be approximately between Munsell N5 and N7 and within CIELAB Lightness value of 50 or 70 ± 2,0 and CIELAB Chroma value not exceeding 2,5 in any hue direction under D65 and CIE 1964 standard colorimetric observer, respectively.

1) Commission Internationale d'Éclairage, Central Bureau, Kegelgasse 27, A-1030, Vienna, Austria.

3.2
verification chart[2)]
chart consisting of a series of colour patches of known colorimetric values

See Annex C.

3.3
system software
software required to control and operate the digital camera

3.4
white tile
tile whose colour is certified and traceable to a national standard

EXAMPLE Standard provided by the National Physical Laboratory in the UK.

3.5
operator-selected area
assessment for either staining or change in colour where the system operator manually selects both the location and size of the specimen test area for the reference and tested pieces

3.6
automatic grading
assessment for either staining or change in colour where the system software selects both the location and size of the specimen test area for the reference and tested pieces

4 Apparatus

4.1 General

The test apparatus consists of a verified digital camera (4.2)[3)], which is mounted on an illumination cabinet (4.3) that gives a controlled and consistent lighting environment. Specimens may be presented for grading individually, in multiples, or in one of a series of pre-defined templates depending on the type of test being carried out. The operator shall manually select the area to be assessed for grading.

Automatic grading (3.6) of specimens is permitted, provided that the grades produced by this method agree with those achieved by the Operator-Selected Area method (3.5).

The equipment shall be maintained and calibrated or verified, as appropriate, in accordance with the manufacturer's instructions.

4.2 Digital camera

4.2.1 Digital camera specification

4.2.1.1 Resolution

The digital camera shall have an effective resolution of not less than 3,0 M pixels.

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2) A verification chart as described in 3.2 and Annex C is manufactured commercially as the DigiEye DigiTizer® series camera calibration chart and is available from VeriVide Limited, Quartz Close, Warrens Business Park, Enderby, Leicester, LE19 4SG, United Kingdom. Tel: +44 (0) 116 2847790; Email: enquiries@verivide.com This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

3) The apparatus as described in Clause 4 with software as described in Annexes A and B manufactured commercially as the DigiEye® is available from VeriVide Limited, Quartz Close, Warrens Business Park, Enderby, Leicester, LE19 4SG, United Kingdom. Tel: +44 (0) 116 2847790; Email: enquiries@verivide.com. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

4.2.1.2 Optical zoom

The digital camera shall be capable of capturing the whole of the specimen assessment area in one image. In order for the image quality to be preserved, any adjustment of the focal length of the camera necessary to capture a suitable image shall be by optical means rather than digital.

4.2.1.3 PC connection

The camera connection to an external computer is done by using a suitable connection for image capture, download and camera control.

4.2.1.4 Camera settings

The system software (3.3) shall control all camera settings and shutter release operations needed for routine setup and imaging. The system software shall have a provision to store and set the operating settings required for different grading requirements.

4.2.2 Camera mounting

The digital camera shall be mounted on top of the illumination cabinet (4.3) at zero degrees to the normal with respect to the tested specimen. The camera mounting shall allow adjustment of the camera lens position to allow parallel alignment to the specimen assessment area.

The height of the camera above the assessment area is such that it will accommodate the required focal length of the lens and capture the whole of the defined assessment area within the image.

4.2.3 Camera verification

4.2.3.1 General

The function of the camera verification is to verify the camera output for each pixel in an image in terms of CIE XYZ data. The verification is then applied to all subsequent images used for digital grading. The camera calibration is done using a digital verification chart as described in Annex C.

4.2.3.2 Verification interval

The camera shall be verified

— at system start-up,

— if the camera settings are changed, and

— at the manufacturer's recommended verification time interval.

4.2.3.3 Verification time

The time and date of the current verification shall be recorded in the system software and be accessible to the user. The system software shall indicate to the user when the recommended verification period has expired.

4.2.3.4 Verification performance

The verification performance of the digital method is expressed in terms of repeatability and accuracy. The results shall be expressed in terms of the median and maximum CIEDE2000 colour difference between the known and measured values of the digital verification chart. The procedures to conduct these tests are described below.

The system software shall store a summary of the verification performance for the current verification such that it is easily retrievable by the user.

4.2.3.5 Accuracy test

The digital imaging apparatus (4.2) shall be verified within the time period as specified by the manufacturer or at 8 hourly intervals, whichever is sooner.

For each colour patch in the verification chart, the CIEDE2000 colour difference value shall be calculated between the prediction from the digital method and the measurement from a spectrophotometer which has been calibrated with white tiles (3.4) certified as traceable to a national standard, such as the National Physical Laboratory in the UK.

The median and maximum CIEDE2000 colour difference values shall be recorded in the system to represent the accuracy performance.

The accuracy shall be deemed satisfactory if

— CIEDE2000 maximum is less than 5,0, and

— CIEDE2000 median is less than 1,0.

4.2.3.6 Repeatability test

The repeatability test shall be carried out at frequent intervals in accordance with the manufacturer's instructions.

Ten consecutive measurements of the verification chart shall be as defined in Annex C. All colour patches used in the verification routine shall be measured and recorded by the system.

The arithmetic mean values of the CIELAB L*, a*, b*, C* and h attributes shall be calculated for each colour patch.

The CIEDE2000 colour difference values shall be calculated between the mean and each individual measurement for each colour patch.

The median of the CIEDE2000 colour difference values shall be calculated for each colour patch.

The median and maximum CIEDE2000 colour difference values shall be reported to represent the repeatability performance.

The repeatability shall be deemed satisfactory if

— CIEDE2000 maximum is less than 1,0, and

— CIEDE2000 median is less than 0,4.

4.3 Illumination cabinet

4.3.1 General

The cabinet shall

— have opaque walls to exclude ambient light,

— be of sufficient area to accommodate the samples being assessed,

— be of a height to provide even illumination, and

— have the lighting configuration and internal surfaces such that the illumination of the specimen area is by diffuse illumination with no direct illumination from the light source.

The digital camera shall be mounted as described in 4.2.2.

4.3.2 Illumination

4.3.2.1 Quality

The illumination shall be provided by a D65 simulator to give an illumination level of not less than 400 lx and not greater than 900 lx at the assessment area surface.

The spectral output of the D65 simulator shall be of sufficient quality to achieve a 'B' or better rating in the visible region for CIE illuminant D65 and CIE 'x' and 'y' chromaticity coordinates of 0,313 and 0,329 ± 0,03 when measured conforming to CIE S 012/E. The CIE General Colour Rendering Index of the D65 simulator shall be greater than 95 conforming to CIE 13.3.

In order to maintain the illumination quality, the D65 simulator shall be changed after a period not exceeding 12 months, or in accordance with the manufacturer's instructions.

4.3.2.2 Evenness

The variation of illumination level across the specimen assessment area shall not be greater than 4 % of the total lux output.

4.3.2.3 D65 simulator

The quality of the D65 simulator and the lux levels of the cabinet illumination shall be checked to ensure conformance to 4.3.3.

The D65 simulator requires a minimum of 10 min to reach a stable operating condition after switch-on prior to use.

A D65 simulator warm-up procedure shall occur when the D65 simulator has been turned off for a period exceeding 10 min.

4.3.3 Specimen assessment area

The size of the assessment area for specimen measurements shall not be greater than 300 mm x 210 mm. The centre of the assessment area shall be located at the centre of a captured image.

The surface of the assessment area shall be a low gloss (less than 2 gloss units) finish and of sufficient durability to maintain its colour tolerance during normal use and cleaning.

4.3.4 Specimen masks

If specimen masks are used, they shall be of system grey (3.1) and of thickness that does not cast a shadow onto the assessment area of any specimen.

Annex A
(normative)

Assessment of the change in colour of a test specimen

A.1 General principle

The original and tested specimens are measured. The area to be measured may be selected by either of the 'Operator-Selected Area' (3.5) or the 'Automatic Grading' methods (3.6) defined in Clause 3 of this part of ISO 105. The colour difference between them is calculated in CIEDE2000 units and converted to a grey scale rating for change in colour by means of an equation.

A.2 Terms and definitions

A.2.1
original specimen
reference specimen for the assessment of change in colour as defined in ISO 105-A01

A.2.2
tested specimen
specimen which has been subjected to a fastness test for change in colour

A.2.3
uniform coloured area
area that is visually perceived as uniform in colour over the area under test

NOTE Effects such as texture, gloss or other physical characteristics that may influence the visual colour appearance shall be disregarded for the purpose of this definition.

A.2.4
non-uniform coloured area
area that is visually perceived as non-uniform in colour over the area under test

NOTE Effects such as texture, gloss or other physical characteristics that may influence the visual colour appearance shall be disregarded for the purpose of this definition.

A.2.5
multi-coloured test specimen
specimen comprised of more than one coloured region within the selected test area

A.3 Apparatus

Use the digital imaging apparatus as defined and verified or calibrated as described in Clause 4 and Annex C.

A.4 Test secimen preparation

The original and tested specimens are mounted using staples on visually uniform white paper or card.

A.5 Procedure

A.5.1 Single colour test specimens

A.5.1.1 Measure the colour of the original specimen.

A.5.1.2 Measure the corresponding colour in the tested specimen. For uniformly coloured areas the arithmetical mean shall be employed in the calculations.

If any colour in the test specimen is visually non-uniform, then by agreement with both parties the area of worst colour change may be determined. In this case, the area is selected by the 'Operator-Selected Area' method (3.5) and shall correspond to the area of worst colour change, rather than the whole of the selected test area. If the "Operator-Selected Area" method is used, it shall be stated in the report.

A.5.2 Multi-colour test specimens

For each colour in the original specimen, repeat the procedure for single-colour test specimens as outlined in A.5.1.

Each tested colour for multi-coloured test specimens shall be reported separately.

A.5.3 Software

The software shall calculate the CIEDE2000 colour difference, ΔE_{00}, and the magnitude of the CIEDE2000 lightness difference, ΔL_{00}, between the average values of all the pixels of the selected areas for the original and the tested specimen, to two decimal places.

A.5.4 Calculation of grades

A.5.4.1 Calculated grade

Calculate, to two decimal places, the grey scale rating for change in colour (GRC) using the following equation

$$GRC = 0{,}88 + 3{,}89e^{-0{,}2\Delta E_{GRC}}$$

where

$$\Delta E_{GRC} = \Delta E_{00} - 0{,}52\sqrt{\Delta E_{00}^2 - \Delta L_{00}^2}$$

and ΔE_{00} calculated with $k_L = 1{,}0$, $k_C = 0{,}5$

k_L = lightness weighting parameter for DE2000;

k_C = chroma weighting parameter for DE2000.

A.5.4.2 Determination of grey scale rating

Determine from Table A.1 the grey scale rating for change in colour to be reported.

Table A.1 — Grey scale rating for change in colour (GRC)

Calculated GRC	Reported GRC
5,00 to 4,75	5
4,74 to 4,25	4 – 5
4,24 to 3,75	4
3,74 to 3,25	3 – 4
3,24 to 2,75	3
2,74 to 2,25	2 – 3
2,24 to 1,75	2
1,74 to 1,25	1 – 2
< 1,25	1