TECHNICAL REPORT

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Textiles — Methods of simulating colour change during actual wear by means of laboratory colour-fastness tests

Textiles — Méthodes de laboratoire pour simuler la dégradation des couleurs, lors du porter réel, au moyen d'essais de solidité des teintures

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Foreword

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In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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ISO/TR 12116 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 1, *Tests for coloured textiles and colorants*.

Introduction

Actual wear of textile garments can be represented by four models. Four test methods corresponding to each of these models are provided in this Technical Report. The user of this Technical Report can select the appropriate method depending on the situation.

Colour-fastness is an important property of coloured textiles. This Technical Report includes the effect of washing, light, weathering, perspiration and rubbing, which are the factors experienced in actual wear. Other chemical and physical tests may be performed in order to evaluate a textile for end-use performance.

It is known that differences exist, in terms of fading and cross-staining, between the results of individual colour-fastness tests and in-use performance. Many factors influence the change in colour of textiles during use.

Research carried out in China, starting in 1964, has attempted to overcome this problem. Summer military uniform was chosen for wear tests to be conducted by army personnel stationed on Hainan Island (Southern China), situated between about 18° and 20° latitude north. Due to the activities of the personnel at this location, the uniforms required frequent washing. All personnel activities in which the uniform was worn were monitored closely. The same kinds of fabrics involved in the wear trial were also subjected to a range of colour-fastness tests ranging from outdoor exposure to manual washing and wet scrubbing. A comprehensive laboratory colour-fastness test involving weathering, manual washing and wet scrubbing was then formulated to simulate the actual wear. It was found that one cycle of this laboratory test was equivalent to about one month of actual wear. The test method used was confirmed as a military standard in China in 1969. Since then, the comprehensive colour-fastness test for military uniforms has been used satisfactorily. Later, the test method was extended to several cities at different latitudes in China and to all coloured fabrics. The same results were obtained when mechanical rather than manual washing was used in the laboratory tests. This extended test method was published as Chinese national standard GB/T 14575-1993 (method 4).

The following points needed to be considered, however:

— external influences and their magnitude depend on the actual wearing situation, which means there are more factors to be taken into consideration in simulating in-use performance;

— ISO 105 only has a xenon arc fading lamp test, used in ISO 105-B02 and ISO 105-B04, for instance;

— home washing machines are now widely used in the world.

Another three kinds of wearing model and associated laboratory test methods (methods 1, 2 and 3) were formulated after a new comparative study in the Beijing area. These three methods simulate three different wearing situations. The external influences and their magnitude were taken sufficiently into consideration in these three methods. Some approximate relationships between colour fading in actual wear and that in laboratory testing were also obtained for some fabrics (see Annex A).

Textiles — Methods of simulating colour change during actual wear by means of laboratory colour-fastness tests

1 Scope

This Technical Report describes four methods designed to simulate, by means of laboratory colour-fastness tests, the colour changes which take place in clothing during actual wear. The four methods are applicable to the following types of clothing:

— sports clothing (method 1);

— smocks and other shirt-like outer garments worn outdoors (method 2);

— indoor clothing and underwear (method 3);

— military uniforms (method 4).

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-B02, *Textiles — Tests for colour fastness — Part B02: Colour fastness to artificial light: Xenon arc fading lamp test*

ISO 105-B04, *Textiles — Tests for colour fastness — Part B04: Colour fastness to artificial weathering: Xenon arc fading lamp test*

ISO 105-C07, *Textiles — Tests for colour fastness — Part C07: Colour fastness to wet scrubbing of pigment printed textiles*

ISO 105-C10:2006, *Textiles — Tests for colour fastness — Part C10: Colour fastness to washing with soap or soap and soda*

ISO 105-E04:2008, *Textiles — Tests for colour fastness — Part E04: Colour fastness to perspiration*

ISO 105-X12, *Textiles — Tests for colour fastness — Part X12: Colour fastness to rubbing*

3 Principle

Textile specimens are subjected to one or more test cycles. In the respective methods, one cycle is composed of the following:

— in method 1, a rubbing/perspiration test, a light/perspiration test and a washing test;

— in method 2, a light/perspiration test and a washing test;

— in method 3, a rubbing/perspiration test, a modified perspiration test and a washing test;

— in method 4, an artificial-weathering, a washing and a wet-scrubbing test.

The change in colour of each specimen is assessed by comparison using the grey scales.

4 Test specimens

4.1 General

When testing multi-coloured textile fabrics, take care to position the specimens in such a way that all the colours in the design are tested. Alternatively, if the areas of colour are sufficiently large, several test specimens can be taken and the individual colours assessed separately.

4.2 Method 1 and method 3

Two test specimens, each measuring 40 mm × 200 mm, are required for acid perspiration and another two for alkaline perspiration. One specimen in each pair shall have its long side parallel to the warp yarns (i.e. to the direction of manufacture), while the other shall have its long side parallel to the weft yarns (i.e. at right angles to the direction of manufacture).

NOTE The dimensions of the specimens are the same as those of the specimen used for the rubbing test in ISO 105-X12.

4.3 Method 2

Prepare two specimens, preferably of a size which matches that of the specimen holder of the xenon arc lamp apparatus used (e.g. 40 mm × 100 mm). One specimen shall have its long side parallel to the warp yarns (i.e. to the direction of manufacture), while the other shall have its long side parallel to the weft yarns (i.e. at right angles to the direction of manufacture).

4.4 Method 4

The length of each specimen shall match the size of the specimen holder of the xenon arc lamp apparatus used. The width of each specimen shall comply with the requirements for the width of the scrubbing track of the wet-scrubbing device used.

5 Test procedures

5.1 Method 1

5.1.1 Preparation of artificial-perspiration solutions and soaking of specimens in the solutions

Prepare acid and alkaline perspiration solutions as specified in Clause 4 of ISO 105-E04:2008 for the light/perspiration test and rubbing/perspiration test.

Thoroughly wet the specimens in the perspiration solutions at a liquor ratio of 50:1, wetting two specimens (one with the long side parallel to the warp yarns and one with the long side parallel to the weft yarns) in the acid perspiration solution and the other two specimens in the alkaline perspiration solution. Allow them to remain in the solutions at room temperature for 30 min. Press and move them from time to time to ensure good and uniform penetration of the liquor.

Take each specimen out of its perspiration solution and squeeze each, using a pair of small iron-cored rubber rollers, to reduce the solution take-up to a level corresponding to (100 ± 5) % of the mass of the specimen.

5.1.2 Rubbing/perspiration test

Following treatment as described in 5.1.1, fasten each specimen by means of clamps to the baseboard of a rubbing device as specified in ISO 105-X12 with the outer surface (with respect to the garment as worn) facing upwards and with the long direction of the specimen parallel to the track of the rubbing device.

Place a dry rubbing cloth as specified in ISO 105-X12 over the end of the 16-mm-diameter rubbing finger specified in ISO 105-X12 and arrange the specimen so that rubbing will take place in the central part of the specimen in the direction of the warp yarns. Then operate in accordance with ISO 105-X12, but rubbing the surface of the specimen for 2×10 complete to-and-fro cycles as opposed to the 10 complete to-and-fro cycles specified in ISO 105-X12.

NOTE ISO 105-X12 specifies 10 times to and fro. More rubbing is needed here and 20 to-and-fro cycles are used.

5.1.3 Light/perspiration test

Following treatment as described in 5.1.2, attach each specimen to an acrylic-resin plate with the rubbed area in the centre of the plate and the rubbed surface facing upwards. Tuck the two ends of the specimen under the ends of the plate. Smooth out the surface of the specimen and place a second plate over it. Wrap the specimen and plates in a film of transparent poly(vinylidene chloride) (PVDC) 0,01 mm thick (see below). Place each wrapped specimen in a specimen holder of a xenon arc lamp apparatus as specified in ISO 105-B02. At the same time, cover each of a set of blue wool references partially with a sheet of opaque cardboard or other opaque material in the manner described in ISO 105-B02, wrap the blue wool references in PVDC film in the same way as the specimens, and place them in specimen holders. Mount the holders with the specimens and blue wool references in the exposure chamber of the xenon arc lamp apparatus, ensuring that the rubbed side of the specimens is facing the light source.

Transparent PVDC film 0,01 mm thick can be wetted without any undesirable effects and resists temperatures of at least 100 °C. The light-transmission factor of the film shall be at least 90 % over the whole of the 390 nm to 750 nm waveband.

Expose the specimens and references in accordance with ISO 105-B02 until the contrast between the exposed and unexposed portions of blue wool reference 5 corresponds to grade 4-5 on the grey scale for assessing change in colour. Cardboard is not used here to cover up any part of the specimens because the exposed surface is subsequently subjected to the washing test in 5.1.4. On completion of the exposure, take all the specimens and the set of blue wool references out of the exposure chamber.

5.1.4 Washing test

Unwrap the specimens from the light/perspiration test and use them to prepare composite specimens by attaching suitable adjacent fabrics to each specimen by sewing as described in ISO 105-C10. Wash, rinse and dry these composite specimens in accordance with the appropriate test procedure in ISO 105-C10.

It is suggested that test A in ISO 105-C10:2006 be used for silk and polyamide and test C in ISO 105-C10:2006 for cotton, linen and polyester.

5.2 Method 2

Prepare perspiration solutions, wet the two specimens and squeeze the specimens out in accordance with the procedure in 5.1.1, using acid perspiration solution for one specimen and alkaline perspiration solution for the other.

Carry out the light/perspiration test and washing test in accordance with the procedures in 5.1.3 and 5.1.4, respectively.

5.3 Method 3

5.3.1 Rubbing/perspiration test

Use the procedure specified in 5.1.2.

5.3.2 Perspiration test

Select suitable adjacent fabrics and treat them in the same manner as in 5.1.1. Then use the treated adjacent fabrics to prepare composite specimens in accordance with the procedure in ISO 105-E04, but with the adjacent fabrics in the centre of the specimen.

Note that there are small differences between the requirements of ISO 105-E04 (for the perspiration test) and ISO 105-C10 (for the washing test — see 5.3.3) concerning the choice of single-fibre adjacent fabrics. For the purposes of this Technical Report, follow the instructions given in ISO 105-E04.

Note also that, for linen, wool shall be chosen as the second adjacent fabric.

Place each composite specimen between two glass or acrylic-resin plates with the test area in the centre of the plate and with the two unheld ends hanging freely outside the plates. Then test the specimens in accordance with the procedure in ISO 105-E04.

5.3.3 Washing

Wash, rinse and dry, following the procedure given in ISO 105-C10, the four composite specimens which have been subjected to the perspiration test.

5.4 Method 4

5.4.1 Exposure to weathering

Expose to artificial weathering in accordance with ISO 105-B04, but using water spray for a period of 3 min at 27-min intervals and repeating this procedure 24 times (giving a total of 25 spray periods).

5.4.2 Washing

Follow the procedure specified in ISO 105-C10:2006, test D, but using a washing time of 10 min as opposed to 30 min.

5.4.3 Wet scrubbing

Follow the procedure specified in ISO 105-C07, scrubbing for 25 complete to-and-fro cycles, i.e. 25 times to and 25 times fro.

5.4.4 Rinsing and drying

Rinse the test specimens in running tap water for 10 min and dry them at a temperature not exceeding 60 °C.

5.5 Assessment

Assess the change in colour of each specimen against the untested sample using the grey scale for assessing change in colour.

5.6 Number of test cycles

The series of tests described for each method constitutes one cycle. Testing may be continued, if necessary, for a specified number cycles or until a numerical rating agreed between the interested parties is reached.

6 Test report

The test report shall include the following particulars:

a) a reference to this Technical Report, i.e. ISO/TR 12116;

b) all details necessary for identification of the sample tested;

c) the method used (method 1, 2, 3 or 4);

d) the number of test cycles carried out;

e) the numerical rating for the change in colour after each test cycle, giving the ratings for the acid and alkaline perspiration solutions and for the warpwise and weftwise specimens separately;

f) the date of the test.

Annex A
(informative)

Relationship between laboratory testing and actual wear

A light-blue cotton fabric dyed with direct dyes, a deep-grey polyester/cotton fabric dyed with direct dyes and reactive dyes and a four-colour cotton fabric printed using pigments were selected for a comparative trial. The trial showed that the actual wearing times which gave the same degree of fading as one test cycle of methods 1, 2 and 3 are as given in Table A.1.

Table A.1 — Number of months of actual wearing time corresponding to one test cycle

Coloured fabric			Number of months of wearing time corresponding to one test cycle									
Dyestuff	Fibre type	Colour	Method 1 (sports clothing)				Method 2 (outdoor smock)		Method 3 (indoor apparel)			
			Acid		Alkaline		Acid	Alkaline	Acid		Alkaline	
			Warp	Weft	Warp	Weft			Warp	Weft	Warp	Weft
Direct dye	Cotton	Blue	5,6	5,7	6,0	6,3	6,7	6,9	5,6	6,3	6,3	6,5
Direct dye + reactive dye	Polyester/ cotton	Deep grey	6,7	6,8	7,2	6,5	4,8	5,0	8,0	6,8	6,8	7,7
Pigment	Cotton	Yellow	2,2	2,2	2,3	2,2	2,4	2,0	2,4	2,6	2,7	2,6
		Green	2,1	2,1	2,2	2,2	1,5	1,3	2,4	2,2	2,2	2,3
		Coffee	2,3	2,1	2,4	2,3	1,2	1,4	2,5	2,5	2,6	2,6
		Black	2,0	2,0	2,3	2,0	0,7	1,0	2,9	2,6	3,1	2,8

Bibliography

[1] GB/T 14575-1993, *Textiles — Testing method of comprehensive colour fastness*

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