Colour Fastness

Introduction:

Consumers don't like their textiles to change colors or bleed during washing, under the sun or anywhere else. But how can anyone ensure textiles keep their color over time? Color fastness testing in a laboratory can help us to ensure fabric's colors stay fresh and vibrant after many uses.

During use, textiles are usually exposed to external factors such as light, washing, ironing, sweat, friction, and chemical agents. Some printed and dyed textiles are also subjected to special finishing processes, such as resin finishing, flame retardant finishing, sand-washing, and grinding. This demands that the color of printed and dyed textiles relatively maintain a specific fastness, i.e. good color fastness performance. It is therefore important to test any dyed or printed product for the fastness of the colors that have been used in its decoration. Unlike other types of fabric testing, such as flammability, there are no mandatory legal requirements for color fastness testing. But color fastness testing is essential to ensuring customer satisfaction with fabric products.

Colour Fastness:

Colorfastness is defined as the strength of the clothes against fading or running out of clothing colors. Another name for color fastness is dye fastness. It refers to the resistance of textile colors to effects such as color change or transfer during processing and use. It is a very important factor in the assessment of the quality of clothing. Clothes that don't bleed color are always consumer's favorites.

Types of Color Fastness in Textile and Apparel Sector:

1. Colorfastness to washing,
2. Colorfastness to heat,
3. Colorfastness to water,
4. Colorfastness to friction/rubbing,
5. Colorfastness to cold,
6. Colorfastness to burning.

Dependence Factors of Color Fastness:

Many factors affect the strength of colorfastness:

1. Chemical nature of clothing,
2. Molecule structure of dye (Dye Types),
3. Molecular state of dye,
4. Amount of dye.
5. Types of Fibre and compatible Dye
6. Type of conditions to which clothing is exposed

Some Terms Related to Colour Fastness:

Discoloration: In printing and dyeing textiles under specific environmental factors, certain activities and reactions within the textile may result in color chroma, hue, and brightness changes. This effect is referred to as discoloration. Some of these occurrences within textiles include; when part

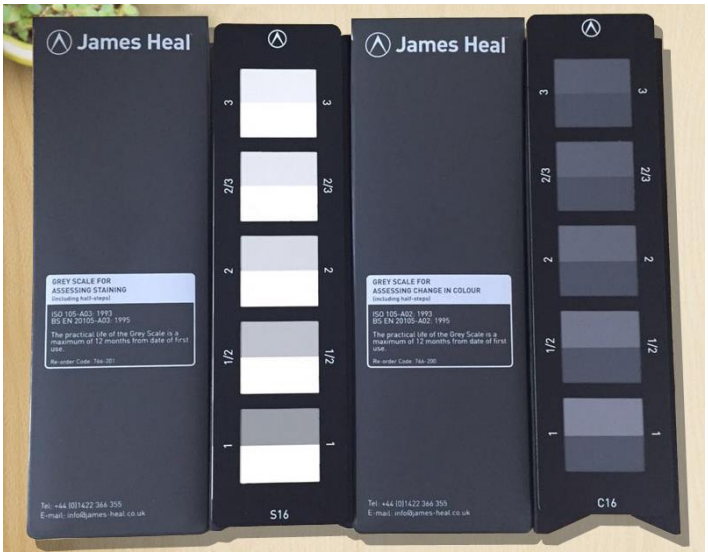
of the dye is separated from the fiber, or the luminescent group of the dye is destroyed, or a new luminescent group is generated.

Staining: Staining is a phenomenon where part of the dye on a piece of fabric is separated from its originally attached fiber and transferred to other lining fabrics when placed under various environmental factors, thereby staining the lining fabric.

For garments composed of parts with different colors, dyes sometimes migrate from one area of the fabric to another, during storage and usually from dark parts to light parts.
The color transfer is mainly due to two reasons: the first is the transfer of dyes, especially the floating color of dispersing and reactive dyes. These dyes may migrate and be released from the fiber, dyeing the fiber on another sample's surface. This usually happens with dark colors that dye light colors and stay on the other sample's surface in a granular and embossed form. The second is that the fibers fall off under the action of friction and transfer from one sample to another.

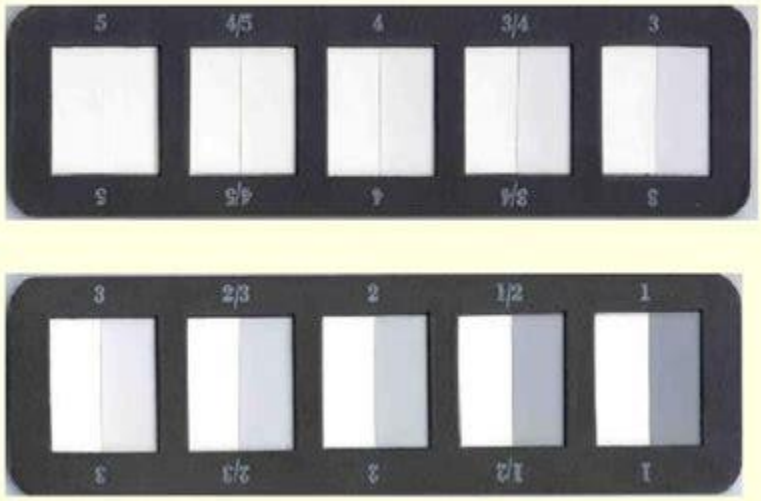
Color changing gray card: This contrast card comprises one standard scale of gray and a decreasing scale of gray chroma. The grayscale rating for the color change is determined using 5-grade levels and nine grades system with grade 5 representing the best Color Fastness and grade 1 representing the worst Color Fastness. The middle levels can be assessed as half grade such as grade 4-5, grade 4, and grade 3-4.

Stained gray card: This comprises of a standard scale of white with a corresponding group of increasing gray chroma. There are five grades and nine grades system; grade 5 implies virtually no staining occurred. Hence great Color Fastness while grade 1 signifies the worst Color Fastness, and the middle can be assessed as half grade, such as grade 4-5, grade 4, and grade 3-4. **[0]**

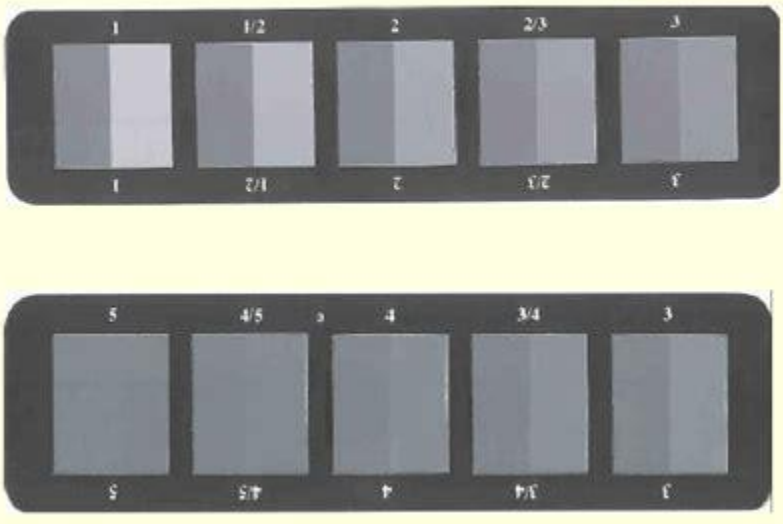



(full view)

Grey Scales for Staining



Grey Scales For Coloring



Environmental requirements for Color Fastness ratings

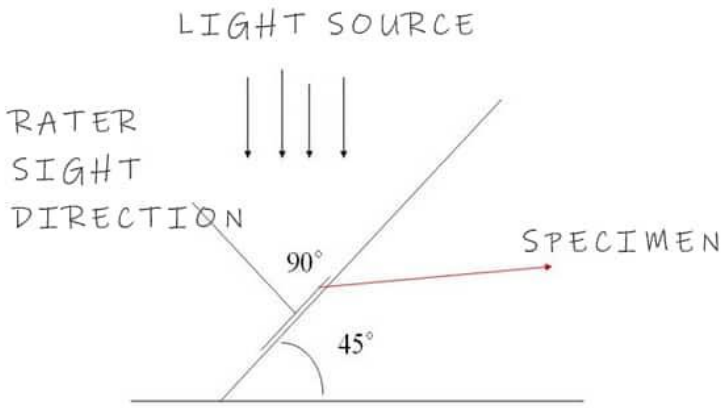
Light source and equipment: The preferred general light source is the D65 light source. Its service life tube is 2000 hours. Customers can also specify other light sources, such as the F light source, 84-P light source, UV light source, etc.

Personnel requirements: The grader should not be color-blind. They can be tested using a color-blindness detection chart or Farnsworth-Munsell 100 hue test kit.

Clothing requirements:

- Gray clothes are best.
- Avoid bright-colored clothes, bright-colored nail polish, and any items that may reflect the light source.
- Do not wear colored glasses.
- Do not rate when tired or sick. Rating is a subjective activity, and mood will affect the psychological, subjective judgment of color; for the same sample, when one is happy, it is one result and when they are down, it is another result.
- Observers must adapt to standard lighting conditions for at least 2 minutes before observation commences. This is to let the eyes adapt to the current light source environment.
- The raters require strict training and must pass the preset assessment.

Environment: darkroom: The rating process should be done in a darkroom of constant humidity and constant room temperature. The color of the darkroom wall and the objects on the wall should be painted in neutral gray as well, which is similar to the rating gray card between level 1 and level 2 (approximately Monsell color Card N5). It is required that the entire darkroom must not have any other light sources except the light source of the rating lightbox. Also, ensure that no other sundries appear on the rating platform.



Rating angle: To use the gray card to rate the samples, you need to use the correct rating angle. The standard generally used entails that the sample and the horizontal plane be at 45° while the light source for rating and the sample are kept at 45°. The grader's eyes are meant to be at 90° to the sample while the distance between the eyes and the sample should be 50-70cm. *It is necessary for different personnel to carry out eye calibration on the same sample periodically to ensure that the error between personnel is minimized. It is also necessary to carry out eye calibration between laboratories occasionally. Since each brand cooperates with many laboratories, the consistency of eyesight between laboratories is particularly important.*

How professional laboratories evaluate color fastness:

The American Association of Textile Chemists and Colorists (AATCC) and the International Organization for Standardization (ISO) color fastness standards are the most commonly used in the U.S.A and EU, respectively.
For most ISO and AATCC color fastness tests, the fabric specimen's color after testing is compared to a "Grey Scale for Color Change" and a "Grey Scale for Staining".
The Grey Scale for Color Change rates the color fading of the specimen on a scale from 1 (greatest change) to 5 (no change). The Grey Scale for Staining rates the staining of an undyed material tested with the specimen from 1 (greatest color transfer) to 5 (no color transfer).

1. COLOR FASTNESS TO WASHING (DETERGENT) [00]

Washing is one of the most common cleaning and maintenance methods for clothes. The Color Fastness to washing determines the color firmness of textiles in different detergents and different washing environments. There are many ways to test Color Fastness to washing. The general principle is to imitate the state of household or commercial washing. Under the specified time and temperature conditions, after stirring, rinsing, and drying, use a gray sample card or instrument to compare the original sample to evaluate the color change of the sample and the lining fabric's staining. Various methods may have certain differences in temperature, test solution, washing procedures, drying procedures and a decision to add steel balls or not.

Test process of Color Fastness to soap and washing:

(1) **Sample:** Take a 100mm×40mm sample with the front side in contact with a 100mm×40mm multi-fiber lining fabric, stitched along a short side to form a combined sample. Or take a 100mm×40mm sample, sandwich it between two 100mm×40mm single fiber lining fabrics, and stitch along a short side to form a combined sample.

(2) **Preparation of test solution:** Five (A,B,C,D,E) different types of washing are specified as different washing methods. 5 grams of soap per liter of tertiary water is used for tests A and B, and 5 grams of soap and 2 grams of sodium carbonate per liter of tertiary water are used tests C, D and E, respectively.

(3) **Test:** Put the combined sample and the specified number of steel balls in the container, according to the standard test conditions. Then inject the required amount of soap solution preheated to the test temperature ±2℃, so that the bath ratio is 50:1. Close the container, adjust the temperature and time according to the standard and start the machine. Remember to start timing when the container is closed.

(4) **Washing and drying:** For all tests, take out the combined samples after washing, wash them twice in tertiary water, and then wash them in running water until they are clean. Squeeze the excess water from the combined sample by hand, flatten the sample between two unused filter papers to remove the excess water, and then hang it to dry in the air of temperature not exceeding 60℃.

(5) **Grading:** Use the gray sample card or the instrument to compare the original sample to evaluate the sample's discoloration and the staining of the lining fabric.

(6) **Result report**

Features of Washing Fastness Tester:

- It is fabricated out of quality stainless steel.
- Possess electric heater to heat water in water bath.
- The microprocessor-based programmer is provided for temp. control.
- Buzzer to indicate the completion of the process cycle or step.

Factors affecting colour fastness to washing:

- The fabric structure, fiber composition and corresponding dyeing process conditions are the primary factors that affect its Color Fastness to washing.[1]
- Using different test methods, the same test method, and different links of the operating methods also have an important impact on the test results of Color Fastness to washing.[2]
- Sampling on the test results of Color Fastness to washing.[3]
- Selection of multi-fiber standard lining fabrics on the test results of washing fastness.[4]

- Different grading methods on the test results of Color Fastness to washing.[5] & [6]

Comparison of common standards of textile Color Fastness to washing:

Detergent washing testing determines the resistance of textile colors to domestic or commercial laundering procedures. The two main standards for detergent washing are ISO 105 C06 and AATCC 61. Aim for a **color change rating of 4** and a **color staining rating of 3 to 5** for detergent washing.

ISO 105 C06

There are 16 different ISO 105 C06 test procedures, ranging from A1S to E2S. The "S" in the ISO 105 C06 test number refers to a single commercial or domestic laundering. The "M" refers to multiple washes, or approximately five domestic or commercial launderings. The "2" test procedures include a peroxide-based bleach, sodium perborate (NaH_2BO_4), in the washing water. The "A" and "B" ISO 105 C06 test methods are most common, as they test fabrics at 40°C and 50°C, respectively. The "C", "D" and "E" methods test fabrics at higher temperatures with different bleaches and softeners.

AATCC 61

There are five test procedures under AATCC 61, but the most common test procedures are 1A and 2A. 1A applies to hand washing at 40°C, while 2A applies to machine washing at 49°C. The lesser used 3A procedure tests fabrics at 71°C, while 4A and 5A add a chlorine-based bleach, sodium hypochlorite, to the washing water. All AATCC 61 test procedures mimic five domestic or commercial launderings. For both the EU and U.S. standards, the lab washes the fabrics with stainless steel balls to mimic abrasion. The number of balls, the amount of detergent and the washing time vary based on the test method.

Test method	Test no.	Temp (° C) ± 2°C	Detergent (g/l)	Sodium perborate (g/l)	Liquid volume (ml)	# of steel balls	Time (mins)	Specimen size (cm)
ISO 105 C06	A1S	40	4	None	150	10	30	4x10
	A1M			None			45	
	A2S			1			30	
	B1S	50		None		25	30	
	B1M			None		50	45	
	B2S			1		25	30	
AATCC 61	1A	40	0.37% of total volume	None	200	10	45	5x10
	2A	49	0.15% of total volume	None	150	50	45	5x15

Summary of sampling methods for Color Fastness to washing:

The sampling of Color Fastness to washing must first consider the problem of lining fabric. Taking GB/T 3921-2008 as an example, this standard specifies that the choice of lining fabric can be a multi-fiber lining fabric or two single-fiber lining fabrics.

The multi-fiber lining fabrics include:

(1) Multi-fiber lining fabrics containing wool and cellulose acetate (used for tests at 40°C and 50°C, and in some cases can also be used for tests at 60°C, but needs to be indicated in the test report).

(2) Multi-fiber lining fabrics without wool and acetate (used for some 60°C tests and all 95°C tests). Single-fiber lining fabrics include cotton, wool, viscose, polyamide (nylon), polyester (polyester), polyacrylonitrile (acrylic), ramie, silk, and acetate.

The laboratory's daily test samples are roughly divided into[7]-

- Plain samples,
- Yarn-dyed samples,
- Printing samples,
- Dark and light gradient dyeing samples,
- Embroidery and car pattern samples,
- Sequins,
- Hot diamond samples,
- Yarns and loose fibers,
- Hollow fabrics, etc.

When GB/T 3921-2008 requires the sample to be fabric, the sample size is 40mm×100mm.

2. COLOR FASTNESS TO CROCKING TEST (WET AND DRY RUBBING)

"Crocking" is an industry term referring to a transfer of a colorant through rubbing. The crocking test determines the resistance of textile colors to rubbing off and staining other materials. A fabric with poor color fastness could rub colorants off on consumers, furniture, other textiles or miscellaneous items.

Color Fastness to rubbing is a type of textile Color Fastness inspection, and it is generally one of the most common inspection types in the textile

trade. It refers to the ability of the color of textiles to resist friction, and that is both dry friction and wet friction.

The test is quite sensitive and for getting consistent result, it is necessary to use

- Standard crock meter
- Cloth,
- Maintain uniform pressure for applying rubbing strokes and number of strokes.

Test template of Color Fastness to rubbing

The model generally followed to test for Color Fastness to rubbing textiles to fix the specified size textile sample on a friction tester platform with a clamping device. Then, rub it with a dry friction cloth and a wet friction cloth, respectively. In the end, the degree of staining of white cloth is used as the evaluation basis, and it is graded against a set of standard Color Fastness to staining gray scales.

The gray sample card used to determine the fastness rating is divided into five grades; the higher the grade, the better the rubbing fastness. A fabric with poor rubbing fastness could rub off dyes on basically anything, and that is undesirable for end-users.

Dry friction test

Put a piece of (50×50) mm rubbing cloth (standard white cotton cloth) on the rubbing head under standard atmosphere (temperature 20℃±2℃, humidity 65%±4%), humidity control for more than 4 hours. Make sure the direction of the friction cloth is consistent with the movement direction of the friction head. Adjust the running speed of the rubbing head to one reciprocating friction cycle per second, ten times, which amounts to a total of 10 cycles of friction. The friction stroke or reciprocating movement on the sample should be (104±3) mm, and the applied direction is vertically downward. This downward force should be (9±0.2) N. After the entire ten cycles are completed, remove the friction cloth, adjust the humidity (over 4 hours), and remove any excess fibers on the friction cloth that may affect the rating.

Wet friction test

Immerse the weighed piece of friction cloth completely in distilled water, take it out, and reweigh the friction cloth to ensure that the moisture content of the friction cloth reaches 95%-100%. Then apply the same operating method as in the dry friction test.

Textile rub resistance test rating

After performing the above test process, we need to take the moistened friction cloth to the grading room and place it in the standard light source box, then use the gray sample card to evaluate the staining grade of the friction cloth.

Fig: Crock Meter

Fig: Electronic Crock Meter

Comparison of common standards of textile Color Fastness to Rubbing:

ISO 105 X12 and AATCC 8 are the primarily standards for measuring color fastness to crocking. The standards are partly equivalent and largely similar in their test methods.

ISO 105 X12 and AATCC 8

In both the ISO 105 X12 and AATCC 8 test methods, the test samples are rubbed with a dry rubbing cloth and then a wet cloth. Both methods use a machine known as a "crockmeter" to rub the fabric. The crockmeter has a "rubbing

finger" which the lab technician rubs across the fabric by turning a mechanical lever. The rubbing fingers vary in size for pile fabrics and other textiles. The rubbing direction can also vary based on the type and design of the fabric. But the crockmeter typically rubs the fabric in the warp and weft directions separately. The direction is particularly important for striped or pattern fabrics for which results can vary. The staining of the rubbing cloth is then assessed using the Grey Scale for Staining. Many textile importers will accept a **grade 4 rating for dry rubbing** and **grade 3 rating for wet**. Color fastness to wet rubbing is typically lower than for dry rubbing for most fabrics.

ISO 105 X12 and AATCC 8 vary mostly in the amount of water used to wet the cloth rubbed on the test specimen. The amount of water is calculated as "wet pick up", or the amount of fluid by percent weight picked up by the fabric. ISO 105 X12 requires the cloth be wetter than that following the AATCC 8 standard.

Test method	Specimen size	Dimension of rubbing finger	Downward force	Wet pick up for wet rubbing	Number of cycles/turns
ISO 105 X12	50 x 140 mm	Pile fabrics: 19 x 25.4mm block	9 ± 0.2 N	95-100 %	10 complete turns at the rate of one turn/sec
AATCC 8	50 x 130 mm	Other fabrics: 16 ± 0.1mm		65% ± 5%	

Factors affecting Color Fastness to rubbing [9]

- Fabric surface morphology
- Fabric structure
- Reactive dye chemical structure
- Reactive dyeing degree
- The effect of softener

3. COLOR FASTNESS TO LIGHT TEST [09]

The lightfastness of textiles has been paid progressively more attention at home and abroad. Presently, China's textile industry product standards (especially the new standards endorsed in recent years, excluding underwear standards) all use lightfastness as one of the assessment standards. For example, the silk product standards publicized by China before did not stipulate the assessment of lightfastness. Still, the promulgated standards have now taken the lightfastness of elastic silk as the assessment index. With chemical fiber like silk fabric and cotton product standards, lightfastness is also taken as an important evaluation index, and some product standards even take lightfastness as an evaluation index.

The color fastness to light test determines the effect of natural sunlight on textile colors.

All textile colorants are susceptible to some fading in sunlight, as colorants by nature absorb certain wavelengths. But you don't want your colored fabric to fade too quickly over the course of its life.

Color fastness to light testing might be particularly important to importers of clothing worn predominately outdoors. But even retail display lighting can cause fading. So, all textile importers should consider this test for their products.

Comparison of common standards of textile Color Fastness to washing:

ISO 105 B02 and AATCC 16 are the most common international standards for color fastness to light. Both standards test fabrics under a Xenon Arc lamp that closely resembles natural sunlight. But the standards vary significantly in their assessment methods.

ISO 105 B02

ISO 105 B02 has four different exposure cycles with different humidity and temperature levels, including A1, A2, A3 and B. Many importers use A2 because it mimics extreme low humidity conditions.

ISO 105 B02 varies from AATCC 16 in that a blue wool reference material with a known reaction to light is simultaneously exposed to light during the test. The fading of the test sample is then rated in comparison to the fading of the blue wool reference. The Blue Wool Scale ranges from 1 (very low color fastness to light) to 8 (very high color fastness to light).

In ISO 105 B02 A2, the lamp can also have either a black panel (uninsulated) or black standard (insulated) sensor to control the temperature.

AATCC 16

AATCC 16 includes five different testing options. Option 3 is the most commonly used because it simulates extreme low humidity conditions and is most equivalent to the ISO 105 BO2 A2 cycle.

The Option 3 procedure subjects the fabric to continuous light, while some other AATCC 16 options subject the fabric to alternating light and dark conditions. Option 3 uses a Xenon lamp with a black panel sensor, while Option 4 and 5 use black standard sensors.

AATCC 16 differs from ISO 105 B02 in that light exposure in the former case is measured using a specialized unit of irradiance known as "AATCC Fading Unit" (AFU). Most apparel units are exposed to 20 AFU and rarely need to be exposed to more than 40 AFU. Upholstery should be exposed to 40 AFU and draperies to 60 AFU. The greatest exposure time is 80 hours on this scale. The color change of the fabric is measured using the Grey Scale for Color Change, as in other AATCC color fastness test standards. Importers will typically accept **a grade 4 rating** for this test.

Test method	Effective humidity	Relative humidity	Max black panel/standard temp.	Chamber air temperature	Irradiance at 420 nm:	Irradiance at 300-400 nm	Assessment
ISO 105 B02 – A2	Less than 15%	Determined by effective humidity	Panel: 60 ± 3º C Standard: 62 ± 3º C	N/A	1.1 ± 0.02 W/m²/nm	42 ± 2 W/m²	Blue Wool Scale 1 to 8
AATCC 16 – Option 3	N/A	30 ± 5%	63 ± 1º C	43 ± 2º C	1.1 ± 0.03 W/m²/nm	48 ± 1 W/m²	Standard Grey Scale 1 to 5

How to improve the lightfastness of textiles? Three reliable methods:

The light-fading mechanism of dyes is very complicated. But simply put, it is due to the dyes being excited after absorbing photons, and the occurrence of a series of photochemical reactions to destroy the fundamental dye structure, which ultimately leads to discoloration and fading. The lightfastness of textiles mainly depends on the chemical structure of the dye and its aggregation state, combination state and mixed color matching. Therefore, selecting dyes rationally is very important.

a. Choose dyes according to fiber properties and textile applications. [10]
b. Dyes should be selected according to the color depth.[11]
c. Dyes with good light resistance stability and compatibility should be used for color matching [12]

4. COLOR FASTNESS TO PERSPIRATION TEST

The color fastness to perspiration test determines the resistance of textile colors to human perspiration.

Fabric dyes and human perspiration can often react and cause color fading in clothing items. A color fastness test for perspiration is particularly relevant for sports apparel and swimwear, which will most likely be exposed to heavy perspiration during use.

As we all know, the composition of human sweat is complex, the main component of which is salt, of which the amount varies from person to person. Sweat is acidic and alkaline. The short-term contact between textiles and sweat may have little effect on its Color Fastness, but long-term contact with the skin and sweat will have a greater impact on certain dyes. Clothing with unqualified Color Fastness is likely to cause dyes to transfer from textiles to human skin through sweat. The human body may absorb dye molecules and heavy metal ions through the skin, and this would endanger health.

Fastness to perspiration

The fastness of colored fabric with reference to alkaline and acidic perspiration was evaluated. For the alkaline (pH-8) and acidic (pH-5.5) liquors were prepared and the composite specimens were dipped in acidic and alkaline solution separately for 30 minutes. Good and uniform penetration of the solution was ensured. The liquor was poured off and the excess water and

air bubbles, if any were removed by passing the specimens in between two glass rods. Composite specimens were then placed between glass/acrylic plates with a pressure of 12 kpa per spirometer.

The perspirometer, was kept for four hours at a temperature of 37 (±20C). Afterwards, the fabrics were removed, separated and dried in air below 60°C. The values were rated as per the grey scale.

The details of the values assigned for these properties are:

The values were rated as per the grey scale. The details of the values assigned for these properties are:-

- •5 =Negligible (Excellent)
- •4 =Slightly changed (Good)
- •3 =Noticeable changed (Fairly good)
- •2 =Considerably changed (Fair)
- •1 =Much changed (Poor)

Comparison of common standards of textile Color Fastness to Perspiration:

ISO 105 E04 and AATCC 15 are the two main standards for perspiration testing. For this test, the lab attaches a strip of multifiber fabric to the test specimen to measure staining. This multifiber fabric has swatches of different kinds of fibers, such as nylon, cotton, acetate, polyester, wool and acrylic fabrics.

The lab then compares the staining of the multifiber fabric to the Grey Scale for Staining, with a desired **grade 3 rating**. The lab compares the color of the test specimen with the Grey Scale for Color Change, with a desired **grade 4 rating**.

ISO 105 E04

During this test, the lab soaks the fabric in a simulated perspiration solution for 30 minutes under a fixed pressure and then dries it slowly at an elevated temperature.

ISO 105 E04 tests for color fastness to both acidic and alkaline perspiration. Human sweat is typically acidic, though it can become alkaline in higher temperatures or when bacteria are present.

AATCC 15

AATCC 15 only tests color fastness to acidic perspiration. The AATCC previously included alkaline test methods in the standard but removed it in 1974, as they didn't believe it reflected normal end usage.

The drying time, pressure and temperature also vary between ISO 105 E04 and AATCC 15. AATCC 15 requires the fabric to be heated for longer at a slightly higher temperature than ISO 105 E04.

Test method	Solution	$C_6H_9O_2N_3$ .HCl.H_2O	NaCl	Na_2HPO_4. $12H_2O$	Na_2HPO_4. $2H_2O$	Na_2HPO_4	Lactic acid (85%)	Specimen size	Drying conditions
ISO 105 E04	Alkaline solution: PH 8.0	0.5 g	5.0 g	5.0 g	2.5 g	N/A	N/A	100 x 40 mm	37 ± 2º C for 4 hours under a pressure of 5 kg
	Acid solution: PH 5.5	0.5 g	5.0 g	N/A	2.2 g	N/A	N/A		
AATCC 15	Acid solution: PH 4.3 ± 0.2	0.25 ± 0.001 g	10 ± 0.01 g	N/A	N/A	1 ± 0.01 g	1 ± 0.01 g	60 x 60 mm	38 ± 1º C for 6 hours under a pressure of 4.54 kg

How to improve the Color Fastness to perspiration? Examples of techniques for improving the Color Fastness of nylon fabric to perspiration

Weak acid dyes are mostly used in nylon printing and dyeing. It's important to note that dyes and fibers are mainly combined with van der Waals forces and hydrogen bonds, which accommodates poor Color Fastness. Although the commercially available acid dye fixing agents can improve the Color Fastness to soaping and rubbing, it still lacks effective perspiration fastness fixing agent. Although the Color Fastness to acidic perspiration can be improved through sufficient soaping, dye selection, optimization of the fixation process and the development of new fixing agents or fastness enhancers, the Color Fastness to alkaline perspiration is still poor.

The improver of the Color Fastness to perspiration of acid dyes is still mainly the polyamide fixing agent that is a quaternary ammonium salt. The polyamine compound and dicyandiamide polycondensation reaction are mostly used to prepare the formaldehyde-free polyamide fixing agent, such as perspiration fastness Agent SF-30A, a polycationic fixing agent. Although the quaternary ammonium salt type polyamide fixing agent can significantly improve the perspiration fastness of acid dyes, it will significantly reduce the fabric's rubbing fastness.

The purpose of this research is not to reduce the Color Fastness to rubbing, but to correspondingly improve the Color Fastness to the sweat of the quaternary ammonium salt type polyamide fixing agent. The test firstly measured the color fixation effect of perspiration fastness agent SF-30A, and then investigated the effect of perspiration fastness agent SF-30A and wet friction enhancer HS-222, adhesive SD-20B, and acrylate monomer comprehensive treatment on nylon Improved Color Fastness to rubbing and Color Fastness to perspiration of printed fabrics.

Factors influences colour fastness to perspiration [13]

- The influence of perspiration agent on the Color Fastness of nylon
- The influence of perspiration fastness agent and wet friction enhancer
- The influence of perspiration fastness agent and adhesive
- The influence of micro-polymerization of acrylic monomers
- The influence of monomer and Color Fastness additives on the Color Fastness of nylon fabric to perspiration

5. COLOR FASTNESS TO WATER TEST

Color fastness to water determines the resistance of textile colors to immersion in water.

You might think this test sounds like the washing test. But color fastness to water testing is specifically used to measure the migration of color to another fabric when wet and in close contact. The washing test also typically uses a basic PH solution due to the addition of detergent, while this test is conducted at neutral PH levels.

ISO 105 E01 and AATCC 107 are the most common standards for color fastness tests to water. The standards are technically equivalent, but the testing methods vary slightly between them.

Comparison of common standards of textile Color Fastness to Perspiration:

ISO 105 E01 and AATCC 107 procedures

For this test, the lab technician attaches a strip of multifiber fabric specimen to measure staining, as with the perspiration test. The test specimen and multifiber fabric are immersed together in water under specific conditions of temperature and time.

After soaking, the fabric is then placed between glass or plastic plates and dried under specified time, pressure and temperature conditions.

The multifiber fabric is then compared to the Grey Scale for Staining and the test specimen is compared to the Grey Scale for Color Change. **Many importers will accept a grade 3 rating for staining and a grade 4 for color change.**

ISO 105 E01 and AATCC 107 vary most in the heating time of the test specimen after immersion. AATCC 107 requires the specimen to be heated for longer than ISO 105 E01.

Test method	Specimen size	Immersion time	Water temperature	Drying conditions
ISO 105 E01	40 mm x 100 mm	Unspecified	Room temperature	37 ± 2 °C for 4 hours under a pressure of 12.5 kPa
AATCC 107	60 × 60 mm ± 2 mm	15 minutes for normal fabrics	Room temperature	38 ± 1°C for 18 hours under a pressure of 4.5 kg

Testing for thermal sublimation (dry heat) of textiles

Comparison of the main test methods for the Color Fastness to heat pressure and ironing of textiles:

The operation process of the standard three test methods is roughly the same. The preparation tools are as follows:

Take the AATCC Color Fastness test method as an example:

This test method is a test method to determine the color resistance of various textile materials and textiles and the ability of heat-resistant roller processing.

Textiles can be subjected to hot press tests in dry, wet, and wet states, usually determined by the textile's final use.

Testing process:

- **Sample size:**

AATCC 133-2009: 40*120mm (sample size for other test methods: 40*100mm)

- **Heating device:**

It is composed of a pair of smooth parallel plates equipped with a precise control electric heating system. The pressure of the sample is 4±1kpa. The heat should only be transferred from the upper parallel plate to the sample. Regardless of if the lower parallel plate is heated or not, the asbestos plate should always be covered. The m2 two-layer synthesis contains about 3mm thick wool flannel, undyed and bleached cotton fabric without mercerizing treatment.

- **Test procedure**

Dry pressing: The dry sample is pressed for a certain period of 15 seconds in a heating device at a specified temperature and pressure.
Tidal pressure: After the dry sample is covered with a wet cotton lining fabric, it is pressed for a certain period of 15 seconds in a heating device at a specified temperature and pressure.

Wet pressing: After the wet sample is covered with a piece of wet cotton lining fabric, it is pressed for a certain period of 15 seconds in a heating device at a specified temperature and pressure.

- **Hot pressing temperature**

110 ± 2℃
150 ± 2℃
200 ± 2℃
If necessary, different test temperatures can be used, but they must be noted in the report. The critical temperature is determined according to the type of fiber and the structure of the fabric. If it is a blended product, it is recommended to adapt it to the most heat-resistant fiber.

- **Rating**

Immediately after the test, use the grayscale to evaluate the sample's color change and the staining of the lining fabric. Make another assessment after 4 hours of humidity control in a standard atmosphere.

5.4.3 Regarding ironing Color Fastness, ironing tips in daily life:

1. Before ironing clothes, be aware of the fabric characteristics of the clothes, because some fabrics are not resistant to high temperatures, while others are. For instance, natural fibers like silk and wool are not suitable for high-temperature ironing, while textiles such as cotton and linen are.

2. For some special fabrics, it's advisable to iron directly on the fabric's surface, and the fabric will be shiny and white. At this time, you only need to cover the surface of the fabric with a piece of lining cloth or cloth of the same texture and then iron; it will not appear in this case.
3. Before ironing, it is best to spray the clothes evenly with water mist with a sprayer and put the clothes in a plastic bag so that the moisture can be spread evenly, and the clothes will be ironed better.
4. Hang the ironed clothes in a ventilated place to dry for a while to evaporate the water vapor, so that the clothes can be kept flat and mildewed.

CONCLUSION

Some color fastness tests might be more important to you than others, depending on the design and intended use of your textile products. Other standards also exist for color fastness to sea water, chlorinated water, hot pressing and other unique conditions.

Color fastness issues aren't usually noticeable until after sale. But textile fading and staining can cause serious headaches for your business when customers later discover these issues (**related:** 3 Ways to Manage Garment Quality Control).

So, if color resilience is important to your customers, don't take unnecessary risks. Hire a professional laboratory to test your fabrics and ensure optimum color fastness levels before your next shipment.

Your fabrics will retain their vivid and vibrant colors for long after the initial sale, keeping your customers satisfied and coming back for more.

How to improve the Color Fastness of textiles (general rules)[14]

The dye fastness of the fabric is related to fiber, yarn structure, fabric structure, printing and dyeing method, dye type and external force.
The following are the general principles for improving the Color Fastness of textiles. When it comes to individual Color Fastness, there will be targeted improvement methods.

Start with the following three aspects:

1. Selection of dyestuff

How fast a product is heavily dependent on the choice of dyestuff. If the choice of dyeing materials is inappropriate, no matter how good the auxiliary agent and the best dyeing process are, there is no way to dye high-quality

Color Fastness. Only by choosing the right dye can we talk about the next step.

- Choose dyes according to fiber characteristics.
- Choose dyes according to the color depth.
- Select the dye according to its Color Fastness grade.
- The dye uptake rate of the fiber.
- There should be good compatibility between dyes.

2. Selection and use of additives

- Choose suitable additives.
- Minimize the amount of retarder.
- Selection of fixing agent.
- Soaping and washing.
- Use of softener.

3. Improvement in the dyeing and finishing process

Fully reduce the crystallinity of the crystalline part of the fiber macromolecular structure and increase the non-crystalline area's crystallinity. The crystallinity of the various areas inside the fiber tends to be consistent. This is so that after the dye enters the fiber, the fiber's combination is more-so evenly.

To sum up:

Many factors affect the dyeing fastness of textiles. For internal factors, all production processes are in place to ensure that the product can have excellent Color Fastness indicators to meet the requirements of daily use and reprocessing; for external factors, We must pay attention to the washing temperature, detergent and washing method, friction strength, exposure time and other factors that can reduce the Color Fastness according to the use requirements of the product, so that the product can be used better.

Reasons for poor Color Fastness of silk fabrics and their care [15]