Lightfastness Testing of Textiles

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Q-Lab's Southeast Asia Webinar Series

Today is the 2nd of a six-part webinar series on weathering and corrosion testing topics

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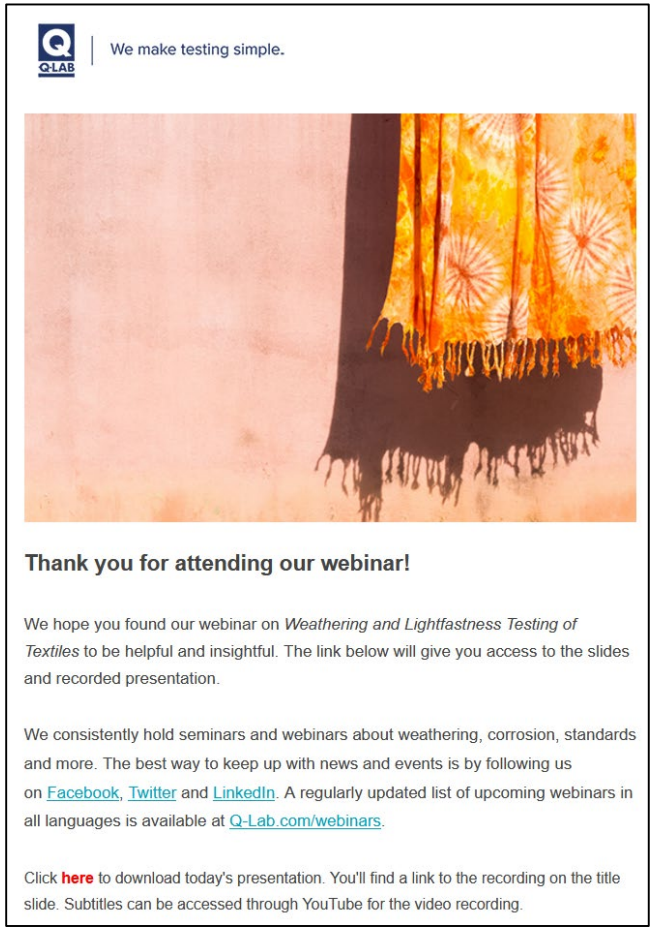
Date	Topic
22 Apr	Xenon Arc Laboratory Testing
20 May	Lightfastness of Textiles
17 Jun	Lightstability of Home and Personal Care Products
16 Sep	How to Run ASTM G155 for Xenon Arc Testers
21 Oct	Correlation in Accelerated Testing
18 Not	Laboratory Corrosion Testing

Administrative Notes

You'll receive a follow-up email from info@email.q-lab.com with links to a survey, registration for future webinars, and to download the slides

Use the **Q&A feature in Zoom** to ask us questions today!



We make testing simple.

Thank you for attending our webinar!

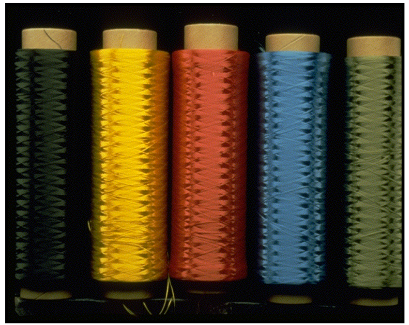
We hope you found our webinar on *Weathering and Lightfastness Testing of Textiles* to be helpful and insightful. The link below will give you access to the slides and recorded presentation.

We consistently hold seminars and webinars about weathering, corrosion, standards and more. The best way to keep up with news and events is by following us on Facebook, Twitter and LinkedIn. A regularly updated list of upcoming webinars in all languages is available at Q-Lab.com/webinars.

Click **here** to download today's presentation. You'll find a link to the recording on the title slide. Subtitles can be accessed through YouTube for the video recording.

What is lightfastness of textiles?

- Ability of a textile to resist color change due to exposure to light
- Lightfastness is specific to a particular dye and varies greatly.
  - Lightfastness depends on the structure of dye
  - Varies greatly from dye to dye
  - Reactive dye and Vat dye



Lightstability vs. Weathering

- Lightfastness (lightstability)
  - Less durable materials, limited outdoor exposure
  - Many tests look only for rapid color degradation

- Weathering
  - outdoor, durable materials
  - Long term fading and fiber degradation

Colorfastness to Light

- Exposure to light radiation, temperature and humidity affects the fading / color change performance of a colored textile material

- Changes are initiated due to photo- chemical processes of absorbed ultraviolet and visible radiation and the interactions with temperature and humidity.

Wide range of lightfastness

- One hat is new; the other was worn all summer in a hot environment
- The dyed thread in the “Q” remained lightfast; the rest of the hat faded

Standard reference materials for lightfastness testing

Blue wool

Red azoic and purple cloth

Standard Reference Materials

Material recognized by a standards organization as having well-understood weathering performance that is repeatable under identical conditions

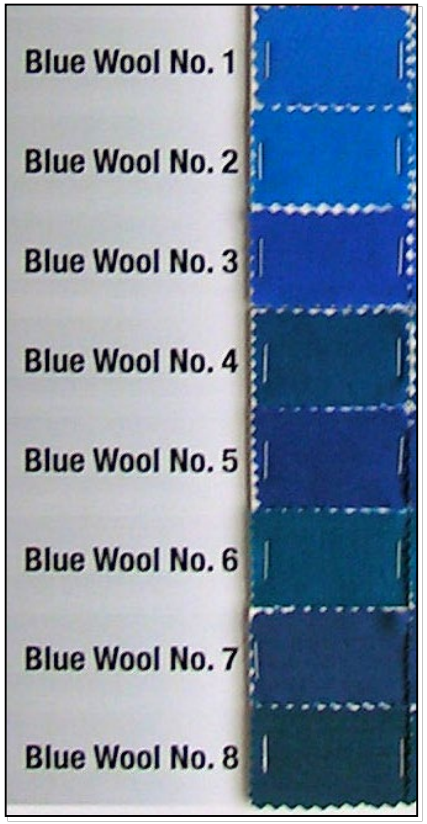
- AATCC Blue Wool
- ISO Blue Wool
- DIN Blue Wool
- JIS Blue Wool
- ISO Red Azoic Cloth

Blue Wools

- Set duration of exposure
- Evaluate color fading
- Verify chamber test conditions
- Improve repeatability and reproducibility
- Use predates modern chamber controls and instrumental color evaluations

ISO Blue Wool

- Numerically designated 1-8
- Increased light stability as numbers increase
- Used for comparison to evaluate specimens
- Used to set test duration
- Each blue wool made from a different dye
- Blue wools do not start out with identical colors

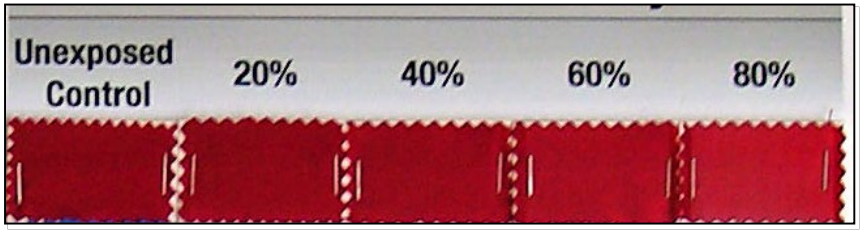


AATCC Blue Wool

- Numbered L2 to L9
- Blend of durable and non-durable dye
- Each successive number requires twice exposure to fade an equivalent amount
- L2 is most common

Other Standard Reference Materials

ISO Red Azoic Cloth



Fading based on relative humidity

AATCC Purple Cloth (Xenon Reference Fabric)

Fading based on temperature

Evaluations for lightfastness testing

Colorimeter

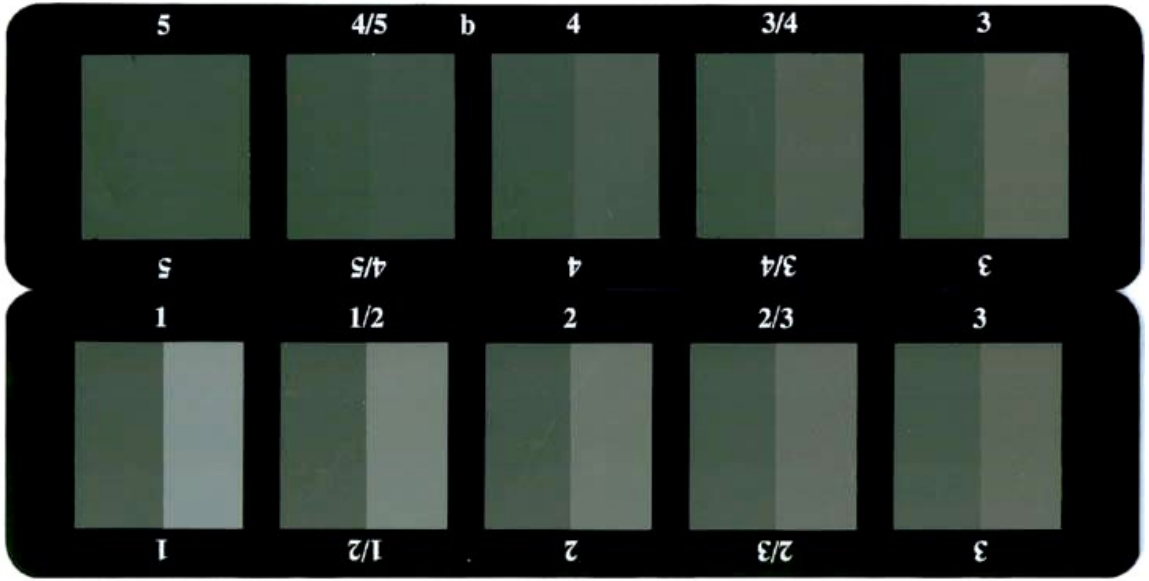
Grey scale

Blue wool comparison

ISO Blue Wool for Evaluation

Fastness grade	Degree of fading	Light fastness
Grade 8	None	Outstanding
Grade 7	Very, very slight	Excellent
Grade 6	Slight	Very good
Grade 5	Moderate	Good
Grade 4	Appreciable	Moderate
Grade 3	Significant	Fair
Grade 2	Extensive	Poor
Grade 1	Very extensive	Very poor

ISO Grey Scale for evaluation



- Used for visual evaluations
- Along with blue wools used to time tests
- Color gray scales different from staining gray scales

Lightfastness major test standards

ISO 105-B02

AATCC TM 16

ISO 105-B series and others

Products and Test Standards

Product	Test type	Major test standards
Apparel and Design Fabrics	Lightfastness	• ISO 105-B02 • ISO 105-B04 (like B02 but with water) • AATCC TM 16 (Option 3) • Other derivatives like Marks & Spencer
Automotive and high-temp	Lightfastness	• ISO 105-B06 • VDA (DIN) 75202 • SAE J2412 • IUF 402 – Int'l Union of Leather Technologists and Chemists Societies
Outdoor and Industrial Textiles	Weathering	• AATCC TM 169 (xenon) • AATCC TM 186 (fluorescent UV) • ISO 105-B03 (outdoor)

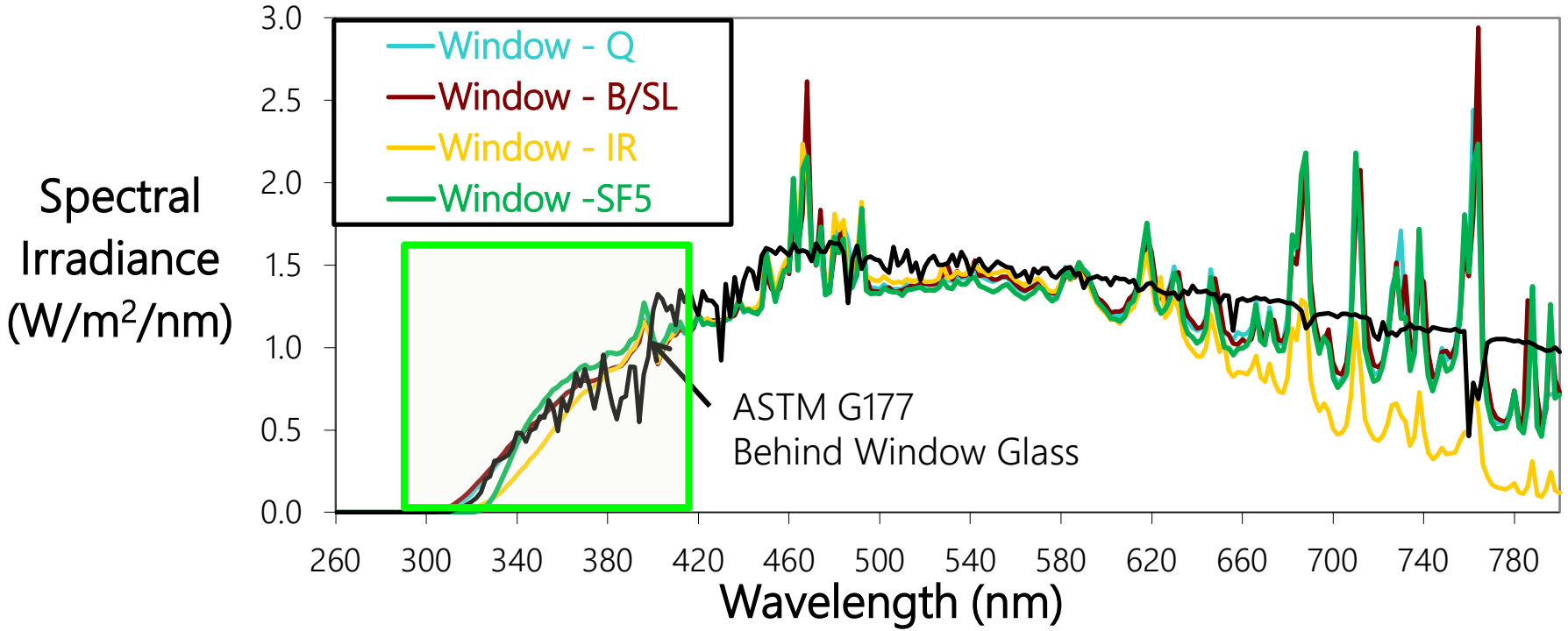
Textile Lightfastness Exposure

Methods for Xenon arc

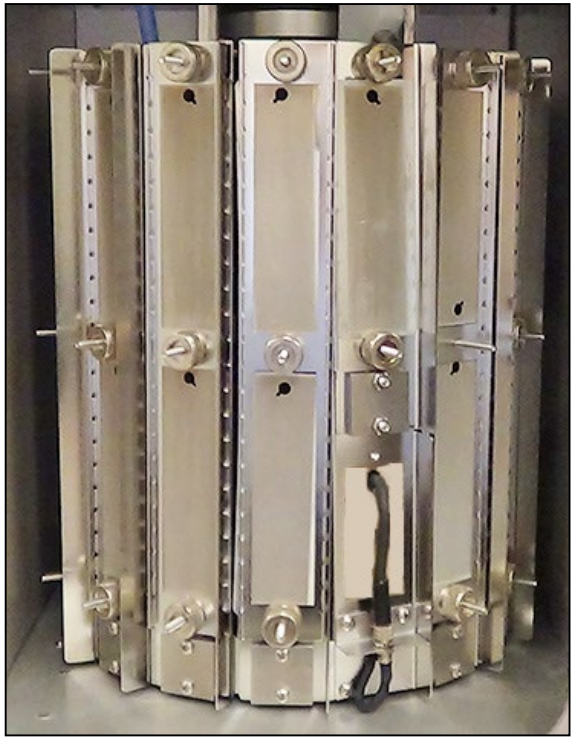
- Xenon arc light source and “Window” glass optical filtration
- Specimen mounting
- Blue wools and gray scales are used
  - Set duration of test
  - Evaluate exposed specimens

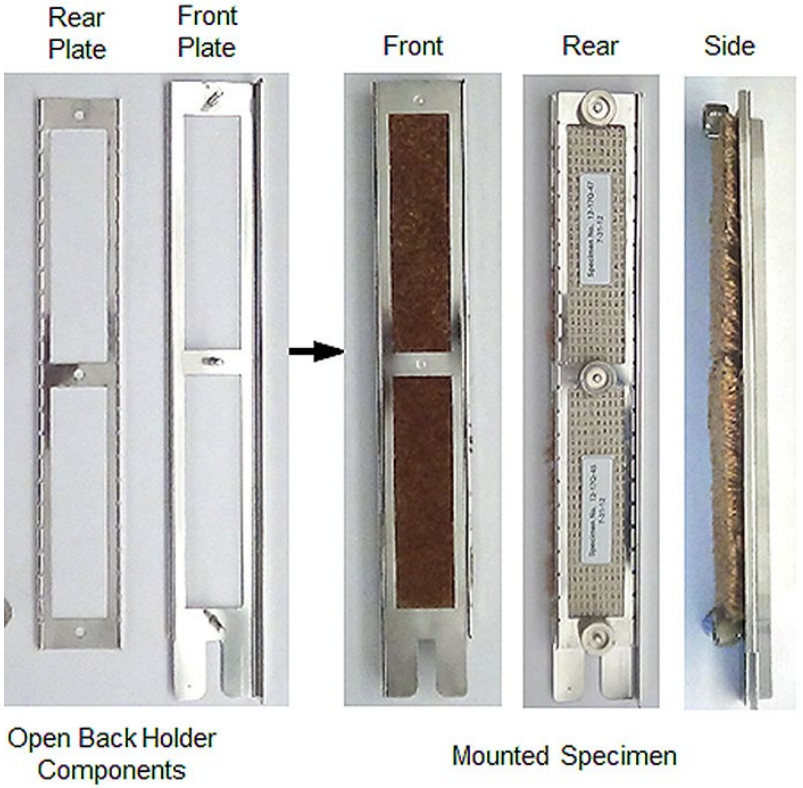
Light source for textile testing

Xenon Arc with Window Filters



Open-Backed Specimen Holders





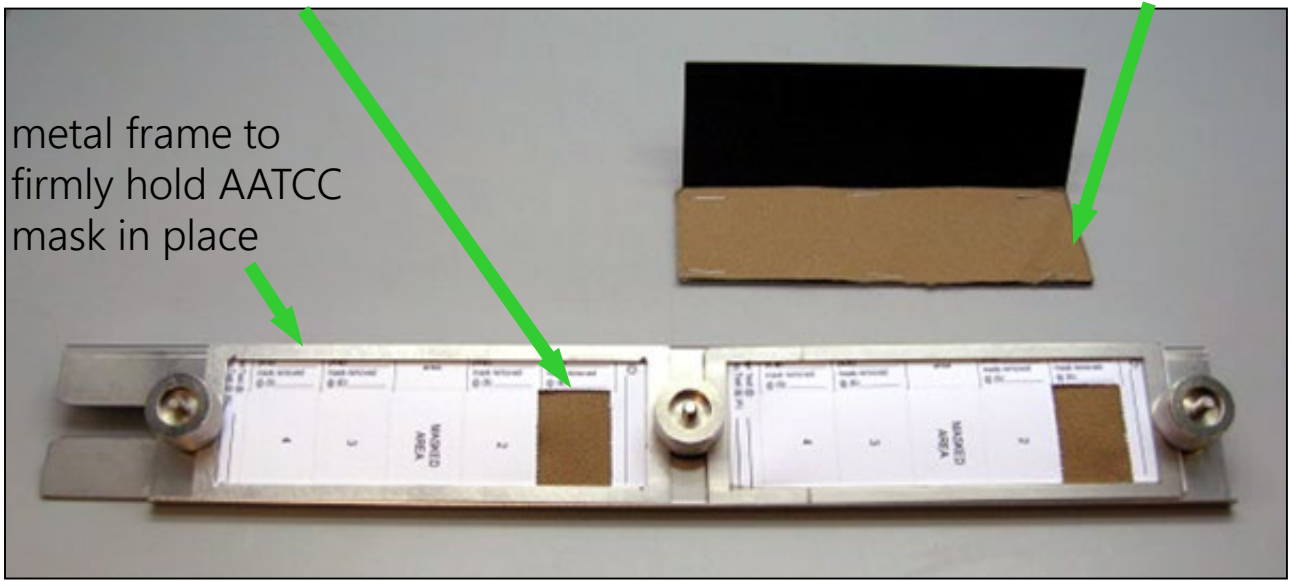
Solid-Backed Specimen Holders

Sample holder with optional center nut for mounting 2 smaller samples.

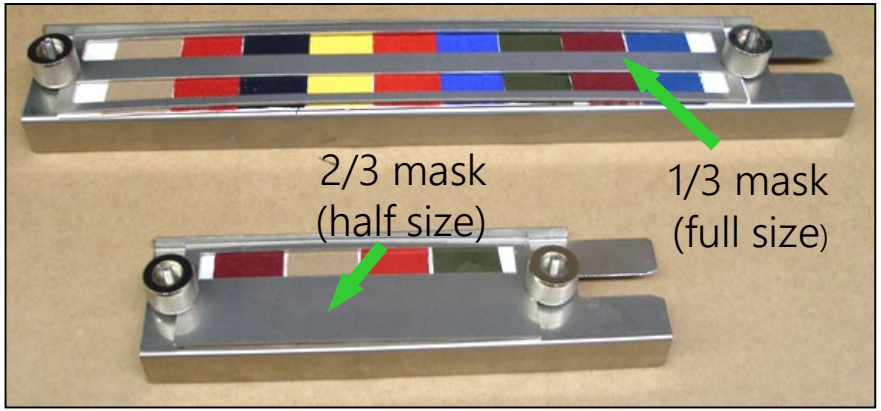
Textile Masking

AATCC mask mounted in specimen holder with one section removed

Textile specimen stapled inside AATCC mask

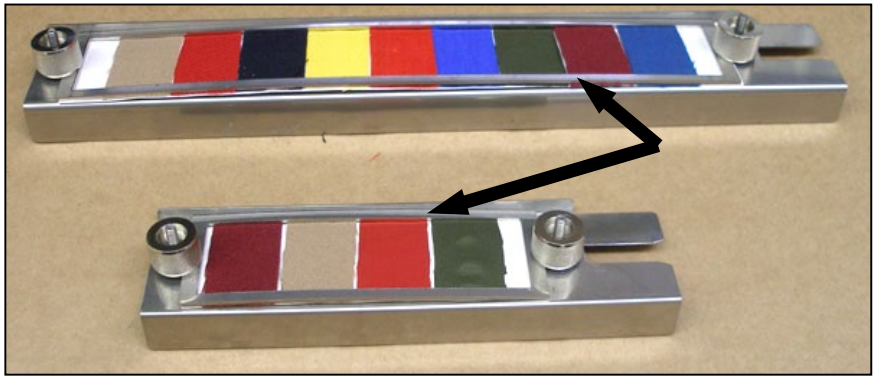


Textile Masking



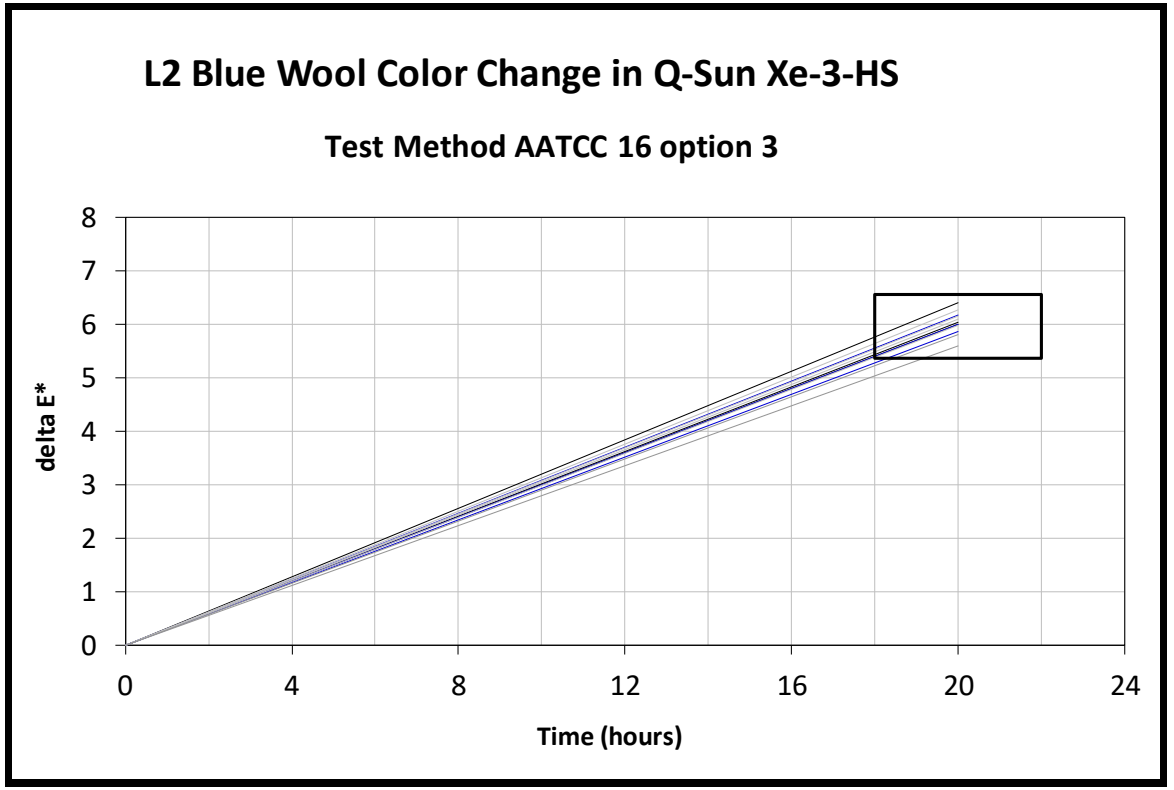
ISO 105-B02

- 1/4, 1/2, 3/4
- 1/3, 2/3



AATCC TM
16 picture
frame masks

Timing lightfastness tests with Blue Wool



ISO 105-B02

The world's most common lightfastness test for textiles

ISO 105-B02 Exposure Cycle

"Normal Conditions"

- Irradiance Controlled at 1.10 W/m^2/nm @ 420nm;
  - Window Glass IR Filter
  - Filters must be changed at regular intervals
- Continuous Light only @ 47 °C IBP Temperature
- 39 °C Chamber Air Temperature *
- 40% Relative Humidity *

**Method to determine value is complicated; these values are commonly used*

Methods in ISO 105-B02

Method	Reference Material		Duration
	Material	Purpose	
1	Blue Wool 1-8	Evaluation	Specimen reaches Grey Scale 3
2	Blue Wool 1-8	Duration, Evaluation	Most resistant specimen reaches Grey Scale 3 OR Blue Wool 7 reaches Grey Scale 4
3	Single Blue Wool	Duration, Evaluation	Blue wool reaches Grey Scale 3
4	Known specimen	Duration, Evaluation	Reference material reaches Grey Scale 3
5	None	N/A	Specific radiant dosage measured

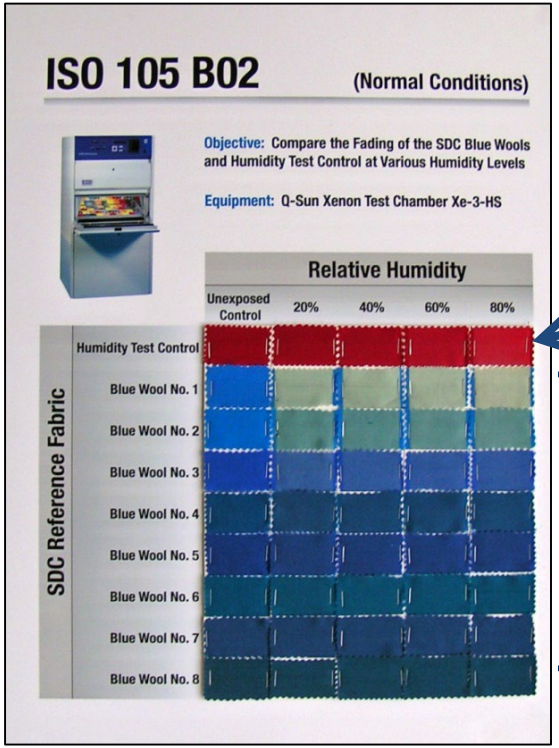
Different exposure conditions used for different testing goals

Methods in ISO 105-B02

Method	Description
1	Most exact and time-consuming test, used for R&D
2	Comparison of multiple lots of a material
3	Quality control testing of known materials
4	Lower-resolution comparison test to reference lot
5	Standardized test to prescribed dosage

Different exposure conditions used for different testing goals

ISO 105-B02: Standard reference materials



Red azoic dye

Blue Wool 1-8

ISO 105-B02

Test Protocol

- **Duration** determined by comparing blue wool or specimen to gray scale (Depending on Method)
- **Evaluation** - exposed specimens are graded against the 8 blue wools
- Alternative Methods use 2 blue wools in a pass/fail test, agreed upon reference without blue wool, or radiant energy

Test Duration and Evaluations

- ISO 105-B02 contains several options for setting the duration and rating specimens
- Example: Expose several specimens and complete set of blue wools
  - Run until blue wool #1 fades to gray scale 4—specimens that have faded to gray scale 4 are rated as “1”
  - Run again until blue wool #2 fades to gray scale 4—specimens that have faded to gray scale 4 are rated as “2”
  - And so on (2 and 4 are common apparel specifications)

AATCC TM 16

American Association of Textile Chemist and Colorists

Options in AATCC TM 16

Method	Description
1	Enclosed carbon arc, continuous light
2	Enclosed carbon arc, light/dark cyclic
3	Xenon arc, continuous light
4	Xenon arc, light/dark cyclic
5	Xenon, continuous light, higher irradiance, lower temperature

Different exposure conditions used for different testing goals

AATCC TM 16 Option 3 and ISO 105-B02

Exposure conditions comparison

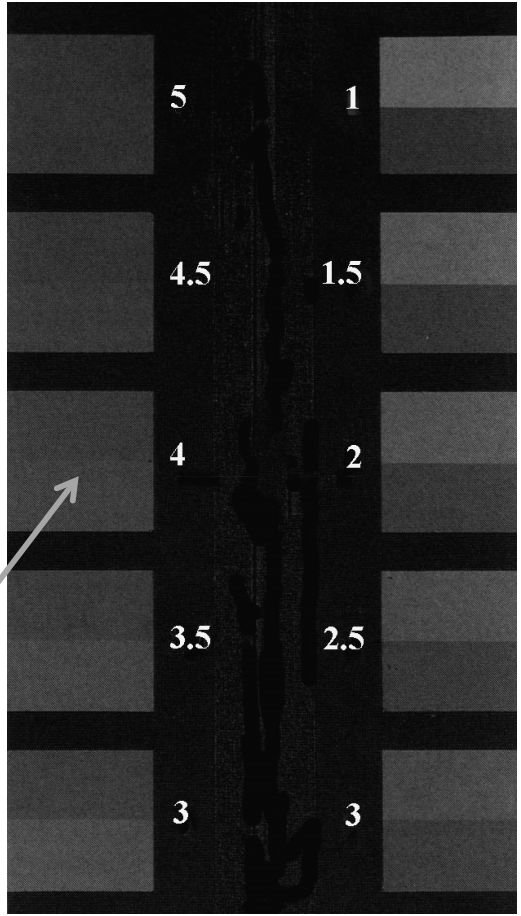
Parameter	AATCC	ISO 105-B02
Light source	Xenon arc	Xenon Arc
Irradiance ($W/m^2/nm$ @420nm)	1.10	1.10
BP temp (°C)	63	47
Chamber air temp (°C)	43	39
RH (%)	30	40
Optical Filter	Window B/SL	Window-IR

Assessment of AATCC 16

- Compare contrast on specimens to the Grey Scale steps for Assessing change of color

- Grade specimen to corresponding Grey Scale step

L4 blue wool should fade to contrast 4 after 85 kJ of energy at 420 nm



AATCC fading unit (AFU)

- Duration of the exposure determined by a specified amount of AATCC Fading Units (AFU), or radiant energy (kJ/m^2)
- A specific amount of exposure made under the conditions specified in various test methods.
- One AFU is 1/20th of the light exposure required to produce a color change equal to step 4 on the Gray Scale using L4 of AATCC.

AFU Equivalence

- Table II provided in AATCC TM 16
- L2 Blue wool also includes suggested color change when exposed to 20 AFU
- Each AFU is roughly 1 hour of TM 16 Option 3

Table II—AATCC Fading Unit and Light Exposure Equivalents for AATCC Blue Wool Lightfastness Standards (see 32.18)[a]

AATCC Blue Wool Lightfastness Standard	AATCC Fading Units	Xenon Only kJ/(m²nm) @ 420 nm	Xenon Only kJ/(m²nm) 300-400 nm
L2	5	21	864
L3	10	43	1728
L4	20	85[b]	3456
L5	40	170	6912
L6	80	340[b]	13824
L7	160	680	27648
L8	320	1360	55296
L9	640	2720	110592

[a] For color change of 1.7 ± 0.3 CIELAB units or Step 4 on the AATCC Gray Scale for Color Change.

[b] Verified by experiment using Daylight Behind Glass and Xenon-Arc, Continuous Light. All other values are calculated (see 32.18).

ISO 105-B series

Advances in performance-based textile lightfastness standards

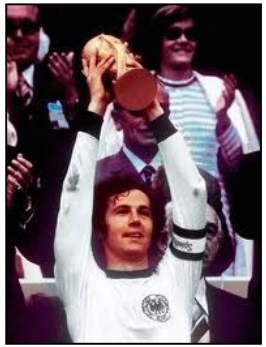
ISO 105-B Series

Commonly known, well-understood, successful tools for textile testing

Different materials require different test methods



Textiles are becoming more high-tech …
but the test methods are still the same.

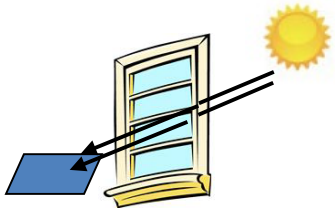
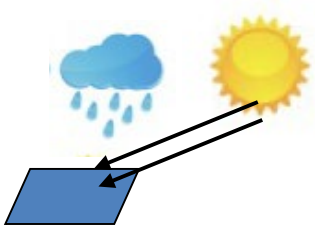
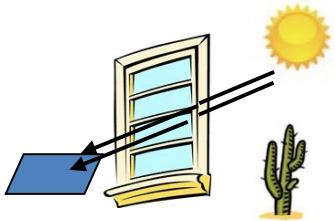
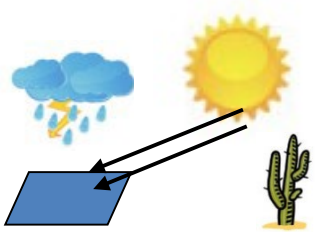

1974


2013

- Are existing test methods still suitable to cover all aspects of modern textile testing?
- Do we need a new test method?
- Do we need new test equipment?

ISO 105-B02, -B04, -B06 & -B10

A variety of test protocols

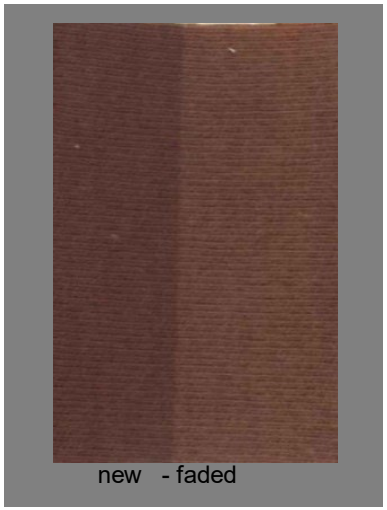
Aspect	B02	B04	B06	B10
Environment	Indoor	Outdoor	Indoor	Outdoor
Irradiance (W/m^2 TUV)	42	42	45	60
Cut-on wavelength (nm)	315	300	310	290
UV light	Low	Medium	Low	High
IR light	Suppressed	Suppressed	High	High
Water cycle	Dry only	Cyclic dry/spray	Dry only	Cyclic dry/spray option
Graphic				

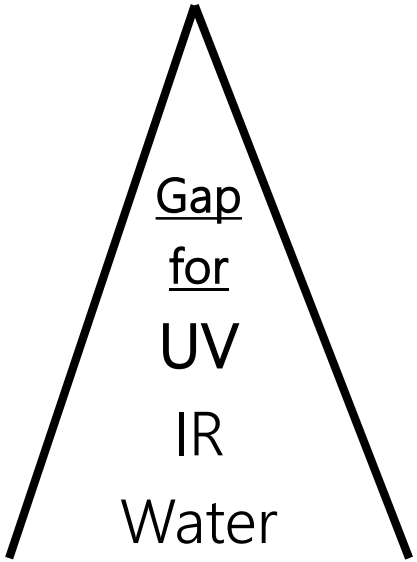
ISO 105-B02 and -B04

Do not cover all aspects of Outdoor Textiles & blends

ISO 105-B02

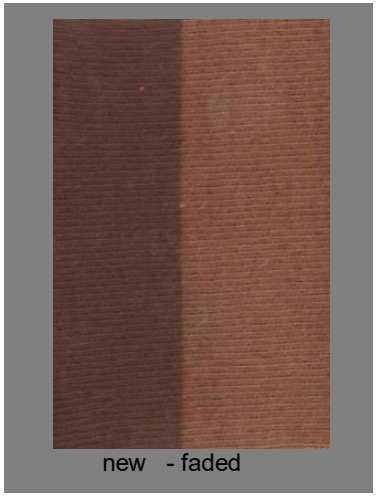
Target group: Color Fading of textiles





ISO 105-B04

Target groups: Color Fading of textiles and material aging



Target group: Outdoor/functional wear

Accelerated testing of fibre blends (natural/synthetics)

Future developments for ISO 105-B

- ISO 105-B10 offers several new accelerated weathering methods
  - Higher temperatures and increased amount of UV-radiation
  - allows higher acceleration level
  - Once thought to replace B04, instead will be better distinguished
- B02, B04, B06, and B10 are now *performance-based* standards
  - Hardware-based standards exclude new techniques/innovation
  - Hardware-based standards are ineffective and not flexible for update
  - Performance-based standards are open for innovation
  - Performance-based standards strictly define requirements, but do not describe a specific machine or technique

A choice of xenon tester

Modern textile test methods ISO-B02, B04, B06, and B10 are *performance*-based standards, open to flatbed and rotating rack testing devices:

- An important change after 60 years of hardware exclusivity
- All test parameters are the same regardless of apparatus
- Performance conditions and reference materials can both be used to validate test equipment

This means more choices for users and more freedom to innovate!

Summary – Lightfastness testing of textiles

- Lightfastness of textiles is their resistance to color fade under sunlight- especially UV light – and heat
- Accelerated weathering testing of textiles can be performed in xenon arc weathering testers
- Standard reference materials are used to validate tester performance and to evaluate material lightfastness
- Major test protocols include ISO 105-B02 and AATCC TM 16
- Modern test standards are nearly all performance-based instead of hardware-based

Thank you for your attention!

Questions?

Send your inquiry to:
info.cn@q-lab.com