Fundamentals, Challenges, and New Directions in Testing of Textiles

Joint Virtual Seminar

Q-Lab Corporation

TÜV Rheinland

AATCC

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Basic Awareness on Textile Testing

TUV Rheinland India

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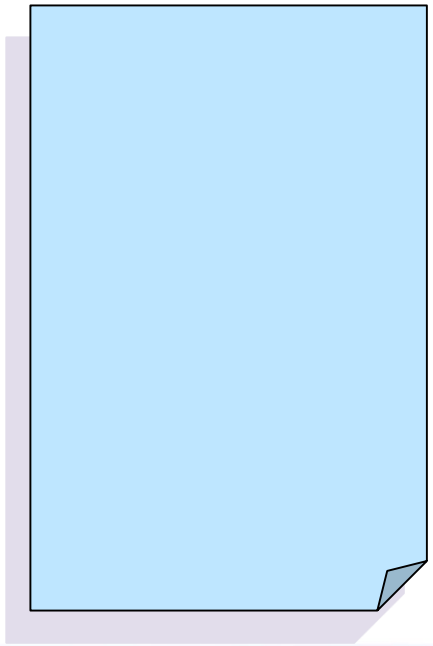
Agenda

- Introduction to Testing
- Colourfastness Testing
- Physical testing/Performance to Care
- Chemical testing
- Restricted Substance Testing



- Introduction to Testing
- Colourfastness Testing
- Physical testing/Performance to Care
- Chemical testing
- Restricted Substance Testing

What is Testing???

Testing is the analysis and evaluation of a raw material or product to assess its quality or performance.

Textile materials are variable products-
Apparels, Accessories, Home textiles including
Bed Sheets, Duvets, Pillows, Cushions etc
Curtains, Blankets, Towels etc.

Why Testing is needed ?

- To confirm Compliance on Regulatory standards/ Product Safety Requirement
- To confirm that Raw materials and Finished goods are of the similar quality
- Approved samples a part of Production
- To Avoid Returns & Recalls of Products
- Brand Protection

II. Pass or Fail Criteria

•No Test Method specifies what is Pass or Fail.

• Pass or Fail criteria is determined by the Buyer Seller agreements.

• Pass or Fail Designations depend on Regulations, & Performance Requirements

NEED OF TESTING

Legal:

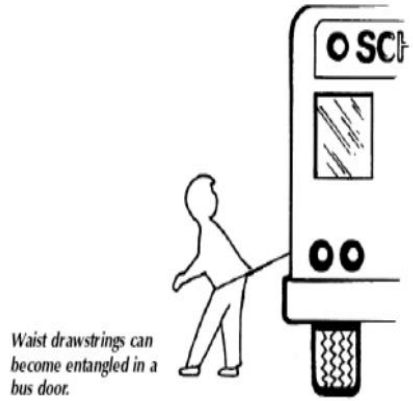
- Restricted Chemicals
- Flammability
- Fibre content
- Care Label

Safety :

- Small part
- Sharp point
- Sharp edge
- Button, Snap etc.
- Drawstring, Tie etc.

Performance Testing:

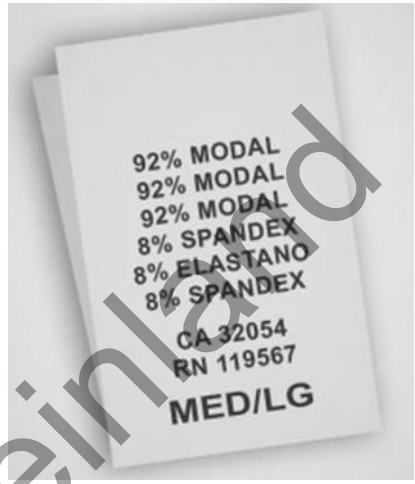
- Color fastness
- Physical
- Dimensional stability
- Chemical



Waist drawstrings can become entangled in a bus door.

U.S. Consumer Product Safety Commission

REGULATORY



100% SILK

- WASH SEPARATELY
- COOL HAND WASH IN SEPCIALIST SILK DETERGENT
- IRON ON REVERSE SIDE
- DRY AWAY FRM DIRECT SUNLIGHT

KEEP AWAY FROM FIRE

100% COTTON

- MACHINE WASH COLD
- DO NOT BLEACH
- DO NOT SOAK
- TUMBLE DRY LOW
- WASH SAPERATELY
- WARM IRON

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International Standards

- AATCC : American Association of Textile Chemists and Colorists
- ASTM : American Society for Testing and Materials
- ISO : International Organization for Standardization
- BS : British Standards
- DIN : Deutsches Institut fur Norman
- CAN : Canadian Norms
- JIS : Japanese Industrial Standards
- EN : European Norms
- GB : Chinese Standards
- IS : Indian Standards
- AS : Australian Standards

- Introduction to Testing
- **Colourfastness Testing**
- Physical testing
- Performance to Care
- Chemical testing
- Restricted Substance Testing

Colour Fastness

Colour fastness is the resistance of a colour to fading in presence of any kind of external agent.

Colour Fastness

- This is the property of the dyestuff on the fabric which measures how durable the colour is towards a variety of external influences.
- Colour fastness is measured using largely subjective assessment of colour change or fading.

- Colour fastness is usually assessed separately w.r.t. to :
- Change in colour of the specimen being tested, that is colour fading.
- Staining of undyed material which attaches to the specimen during the test.

Colour Fastness : Assessment

- The scale consists of 9 pairs of grey colored contrast numbered from 1 to 5 and the intermediate numbers.
- Number 5 has two identical greys, number 1 shows the greatest contrast.
- The tested specimen is compared with the original & any loss in color is graded with reference to the Grey Scale.

Acetate

Cotton

Nylon

Polyester

Acrylic

Wool

✓The source under which the comparison is made is- D65 - daylight

✓The specimen should be placed on a flat, uniform surface having no distortions. The surrounding field shall be uniform grey.

Evaluation and interpretation of grading

Grade	Colour Change	Colour Staining
Grade 5 :	No change	No Staining
Grade 4 :	Slight change	Slight Staining
Grade 3 :	Noticeable change	Noticeable Staining
Grade 2 :	Distinct change	Distinct Staining
Grade 1 :	Severe change	Severe Staining

Colourfastness to Washing

- This test evaluates the color fastness to laundering of textiles which are expected to withstand frequent home or commercial launderings.
- The fabric color loss & surface changes resulting from detergent solution & abrasive action of typical hand, home or commercial laundering , is roughly approximated.

Colourfastness to Washing

Sometimes, wet clothing or products may be left in the washing machine or in a basket for a period of time & remain in contact with other fabrics before drying & stain the adjacent areas & other garments.

A need arises to do a test which defines this property of dyes

……

i.e.

FASTNESS TO WATER to check transfer of color from wet textile to the surface of other textile material or adjacent area of the same fabric when the two surfaces are in prolonged contact with each other

Colour fastness to Water

Application:

- This method is used to measure the resistance to water of dyed, printed or otherwise colored textile yarns or fabrics.
- The specimen, backed by multifibre fabric , is immersed in water under specific temperature and time and then placed between glass or plastic plates under specific pressure, temperature and time.
- The change in the color of specimen and staining of multifibre / adjacent fabric is assessed.

Test Method:

- ISO 105 E01

- Introduction to Testing
- Colourfastness Testing
- **Physical testing/Performance to Care**
- Chemical testing
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Pilling

- Pills are those tenacious little fuzz balls that sometimes appear on our garments. Pilling is a process of formation of pill because of entanglement of surface fibres during wear.

Visual Assessment

Grade	Description
5	No change.
4	Slightly surface fuzzing and/or partially formed pills
3	Moderate surface fuzzing and/or moderate pilling. Pills of varying size and density partially covering the specimen surface.
2	Distinct surface fuzzing and/or distinct pilling. Pills of varying size and density covering a large proportion of the specimen surface.
1	Dense surface fuzzing and/or severe pilling. Pills of varying size and density covering the whole of the specimen surface.

Tensile strength

Tensile Strength Test:

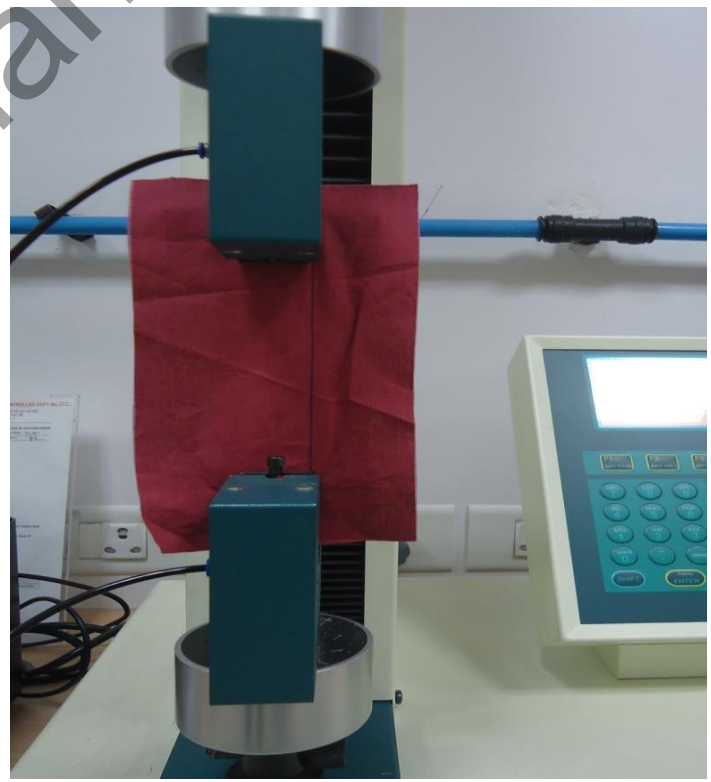
- A textile material is stretched in one direction to determine the load-elongation characteristics, the breaking load, or the breaking elongation.
- Mainly for woven fabrics
- Not recommended for knitted fabrics and other textile fabrics which have high stretch.
  Apparatus = Tinious Olsen / Instron (CRE) / Hounsfield
  (A testing machine in which the rate of increase of specimen length is uniform with time.)
  CRE : Constant-rate-of-extension

Tensile strength

- Tensile strength test type:
  - **Grab Test (1-inch / 2-inch) :ISO 13934-2**
  - Strip Test (1-inch / 2-inch) : ISO 13934-1

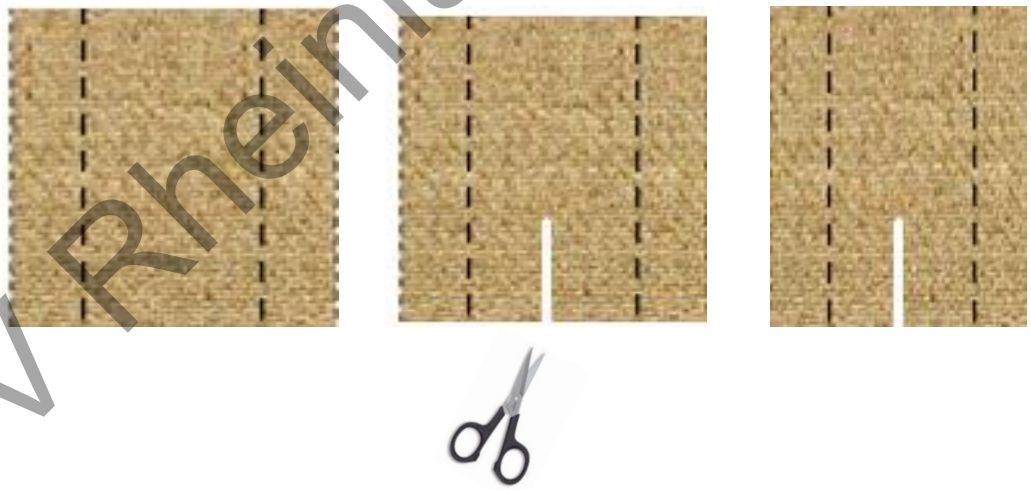
Breaking force - the maximum force applied to a material carried to rupture.

Elongation - the ratio of extension of a material to the length of the material prior to stretching, expressed as percentage.



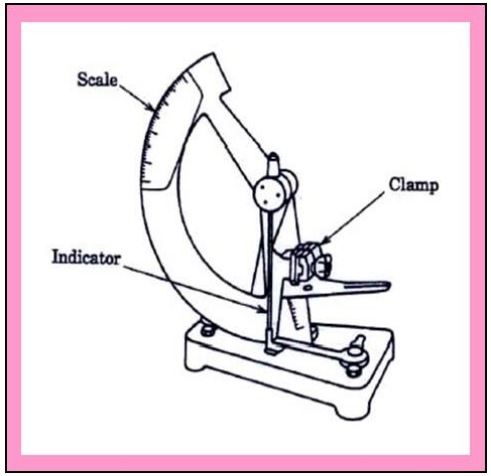
Tear Strength

- This force required to tear a fabric, starting from a cut in the fabric.

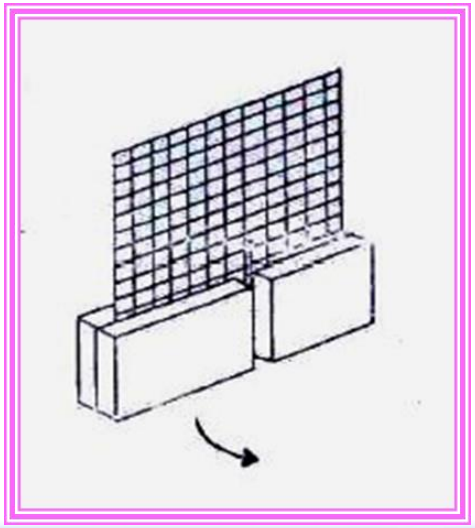


Tear Strength

- Defined as force required to continue or propagate a tear in fabric under specified conditions.

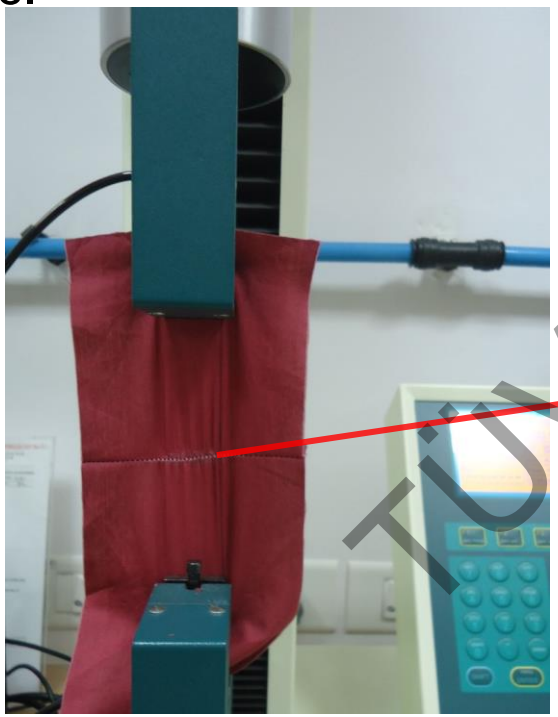


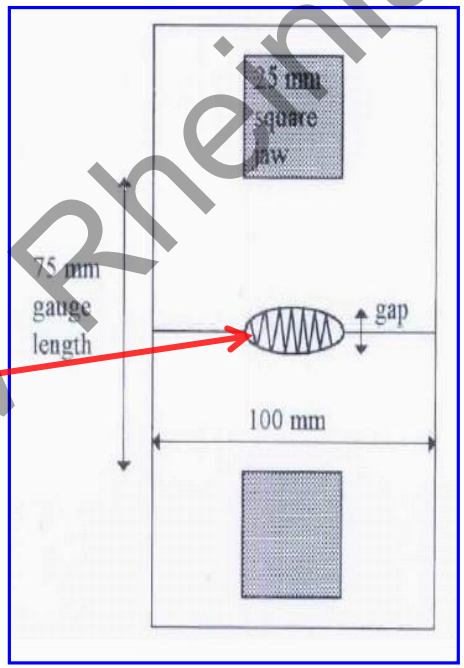
- Elmendorf / Falling-pendulum test
- Aims at determining the force required to propagate a tear.
- Suitable for all types of woven fabrics (treated or untreated).
- Not suitable for knit fabrics, felts, non-woven fabrics and embroidered fabric.
- Higher the results better the strength of fabric



Seam Properties

- To determine the resistance to slippage of weft yarns over warp yarns, or warp yarns over weft yarns, using a standard seam
- Seam performance on stress areas e.g. Armhole, Back rise, Front rise etc.





Seam Properties

Seam Slippage

- To indicate the tendency of yarns to slip at a seam
- Such slippage results in garment failure at a seam, which is not readily repairable by re-seaming

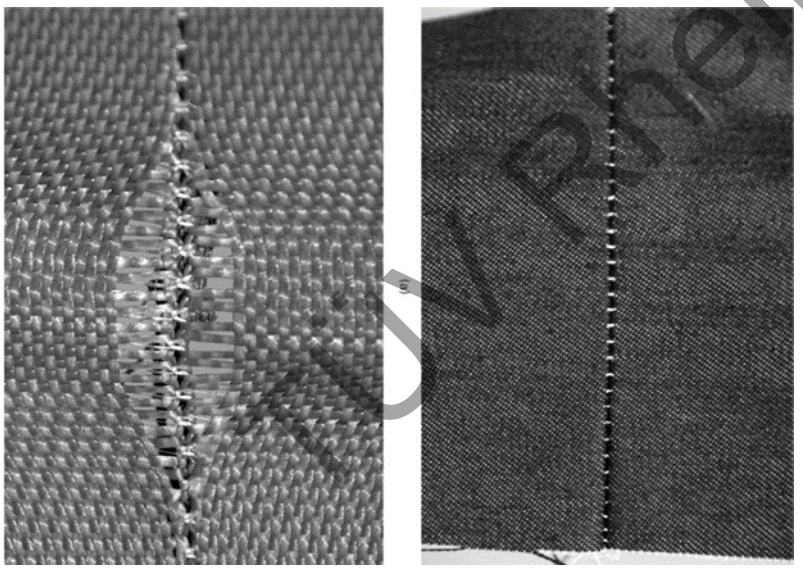
Seam Strength

- To determine of the breaking load of sewn seams
- The sewn seams may be obtained from garments or prepared from fabric samples.

Seam Properties

Record the maximum force and whether the rupture is caused by

STB: Sewing threads break,
FTS: Fabric Tears at Seam,
FTJ: Fabric Tears at Jaw,
FT: Fabric Tears



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Manufacturers concerns are with residual shrinkage and relaxation shrinkage. Residual shrinkage is what takes place over a period of time from laundering and care.

Relaxation shrinkage occurs when the strained yarns relax after the stress placed on them is released. When washing these goods the fabric tension is relaxed and they come to relaxed state.

Test Method

✓ ISO 3759/ ISO 6330/ ISO 5077

Important bench mark locations for different garments

✓Shirt - Collar, Collar Band, Body Lengths, Sleeve Lengths, Width at chest and Cuffs

✓Trousers - Front rise, Back rise, Inseams, Outseams, Waist and Seat

✓Pajama Top - Lengths, Sleeves, Hem and Chest

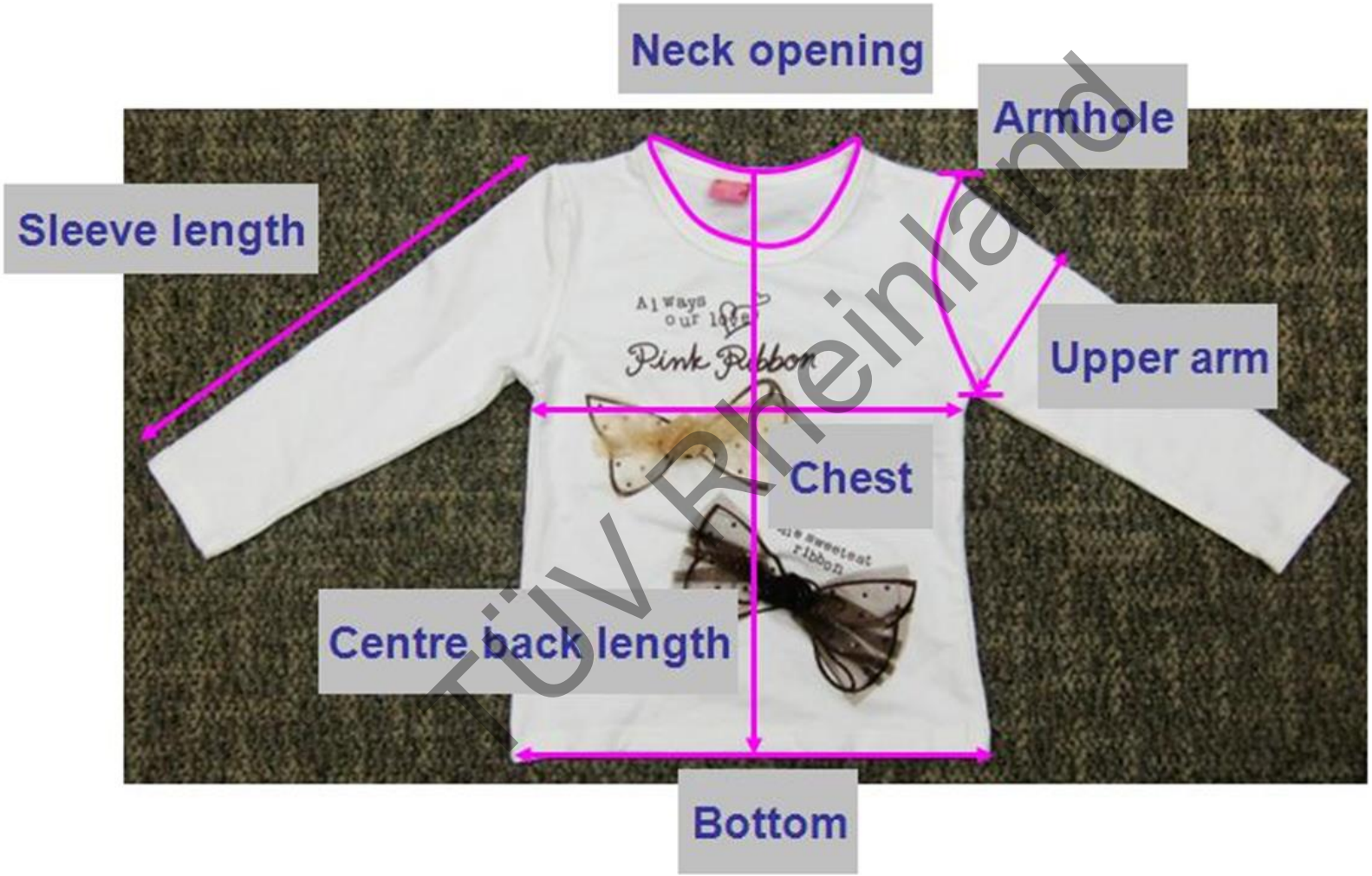
✓Pajama Bottom - Inseams, Lengths, Hip and Waist

✓Uniform/Dress - Bodice lengths, Skirt lengths, Sleeve lengths, Shoulders, Chest, Waist, Hip and Hem

✓Blouse - Lengths, Sleeve Lengths, Shoulders, Chest and Waist

✓Skirt - Lengths, Hem, Hip and Waist

Dimensional Stability to Washing



Calculation

✓ Wash and dry the sample once for ISO .
✓ Condition the sample. After conditioning lay each test specimen without tension on a flat smooth horizontal surface. Measure and record distance between each pair of benchmarks.
✓ Calculate the difference between the before wash and after wash measures and report in %.

$$DC\ \% = 100\ (B - A) / A$$

DC = Dimensional Change
A = Original Dimension
B = Dimension after Laundering

✓ Shrinkage is denoted as '-' which is decrease in dimensions
✓ Elongation is denoted as '+' which is increase in dimensions.

Dimensional Stability to Washing

Drying Methods:

1. **Line dry** - Specimen is hanged by two corners with the fabric length in vertical direction.
2. **Drip dry** - Dripping wet specimen is hanged by two corners with the fabric length in vertical direction.
3. **Flat dry** - Specimen is dried by spreading on a horizontal screen or perforated surface removing wrinkles without stretching and distorting it.
4. **Tumble dry**: Mechanical drying process with the suitable heat settings.

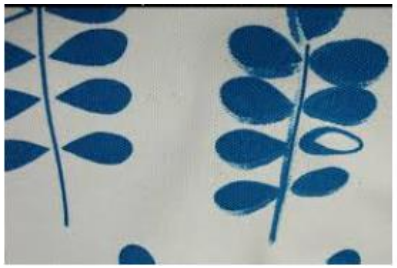
APPEARANCE AFTER WASH

Appearance of Textile end Products, is the overall visual impression of a textile end product quantified by comparison of individual Components with appropriate reference standards

Appearance test gives us the information on the performance of the textile er

Evaluation:

- Color Bleeding/ Self staining
- Color Change
- Surface Appearance- Wrinkles/ Smoothness Change
- Pilling
- Holes or Excessive Abrasion
- Hand feel
- Trim / Embroidery / Appliqués- Appearance Change
- Shape Distortion



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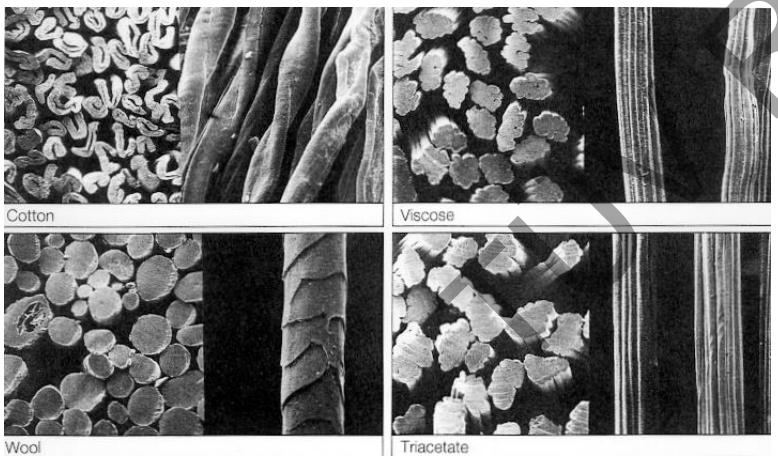
Fiber Identification

- The identification of fibres is carried out by subjecting specimen to a variety of selected tests until enough information is obtained to make satisfactory judgement as to the generic class of specific type.

➢ Burning Test

➢ Microscopic analysis

➢ Chemical analysis



1. Fiber identification

Burning Behaviour - Reaction to Flame

Fibre	Melts Near Flame	Shrinks from Flame	Burns in Flame	Continues to Burn	Odor	Flame characteristics	Appearance of Ash
Natural Fibres							
Silk	yes	yes	yes	slowly	burning hair	burns slowly	soft black bead which crumples between fingers
Wool	yes	yes	yes	slowly	burning hair	do not burn freely but chars on applicaion of flme	black ash which can be brushed away
Cellulose	no	no	yes	yes	burning paper	burn rapidly with yellow flame	light greyish ash
Man-Made Fibres							
Acrylic	yes	yes	yes	yes	acid smell	smoky flame	hard black irregular shaped bead
Acetate	yes	yes	yes	yes	Vinegary / burnt wood smell	unsteady flame, difficult to extinguish by blowing	hard black irregulat shaped bead
Polyester	yes	yes	yes	yes	sweet smell	shiny yellow/orange sooty flame	hard black round bead
Nylon	yes	yes	yes	yes	burnt plastic	burns rapidly	hard grey round bead
Rayon	no	no	yes	yes	burning paper	burn rapidly with yellow flame	none
Metallic	yes	yes	no	no	-	-	metal bead
Spandex/Elastane	yes	no	yes	yes	-	-	fluffy black or grey

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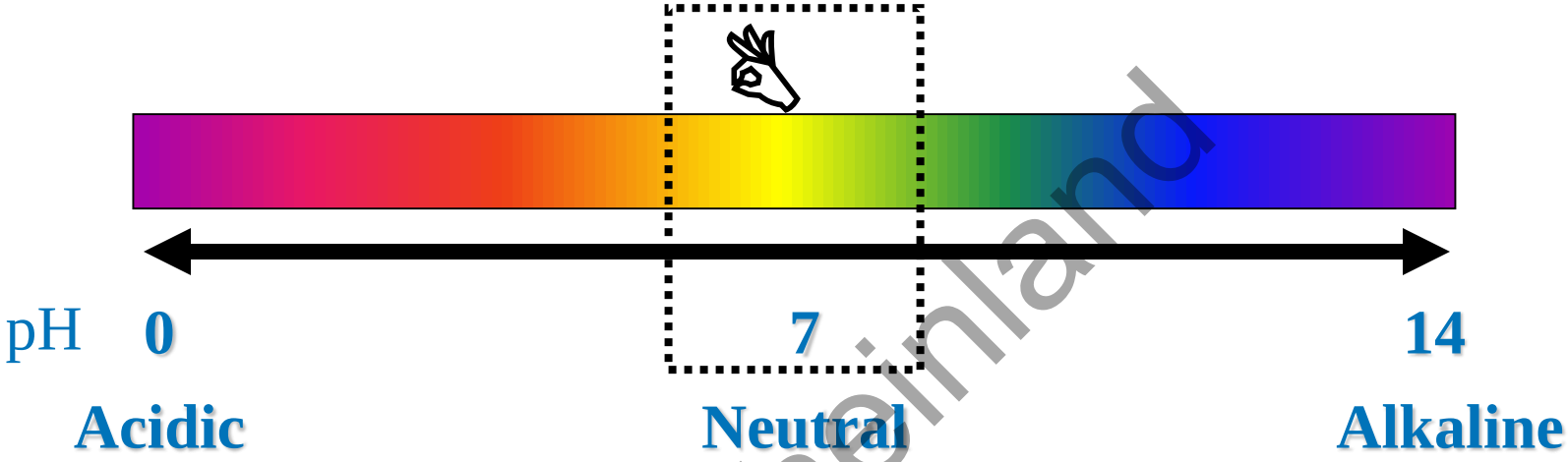
pH Value



- Human skin has a light acid coating to inhibit the development of many diseases
- pH of textiles lies in the neutral (pH 7) or slightly acid region (below 7) will be friendly to the skin
- Under extreme pH condition fabric will be damaged.

pH Value

Test Method:

Non-Leather: DINEN ISO 3071
Leather: DINEN ISO 4045

Effect: Contact with materials with a pH outside the accepted range turns the skin flora (microorganisms which reside on the skin) out of balance and causes irritations.

Limits: 4,0 - 7,5 (Children),
4,0 - 8,5 (direct skin contact),
4, 0 - 9,0 (indirect skin contact)

Legal requirements exist in China

Organotin Compounds

Organotin compounds are organic compounds of Tin that are **widely used** in the textile and leather industries due to their **biocides properties** (**antibacterial and antifungal agents)**

Additionally, they have also been used due to their properties **as thermal stabilizers** for **plastics** and **as catalysts** in **polymer synthesis**.

The risk of the presence of organotin compounds arises from the use of manufacturing processes in which chemical products containing these substances, have been used. The organotin compounds can be found in a wide variety of products used in the textile and leather industries

Test Methods : CEN/TS 16179 (mod.)

Organotin Compounds

Why Organotins are Restricted

- Legislation in major markets around the world restricts the presence of organotins in finished products.
- Some **organotins** are classified as **persistent, bioaccumulative, toxic, very persistent** and **very bioaccumulative**.
- Certain organotins can be **toxic to aquatic life.**
- Some organotins may act as **immunotoxins**.
- Certain compounds are **endocrine disruptors** and **pose toxicity to reproduction**.

GC - MS

Chlorinated Parrafins

Chlorinated paraffin's are a group of chemical substances used in the leather industry due to their properties as **greasing products**. Additionally, they are also used in the textile industry due to their fireproof and plasticizer properties in polymeric materials.

Test Methods : DIN EN ISO 18219 (mod.)

GC - MS

Chlorinated paraffins		
Short-chain chlorinated paraffins C10 - C13 (SCCP)	100	mg/kg
Medium-chain chlorinated paraffins C14 - C17 (MCCP)	1000	mg/kg

CAS Number	Substance
85535-84-8	Short-chain chlorinated Paraffins (SCCP) (C10-C13)
85535-85-9	Medium-chain chlorinated Paraffins (MCCP) (C14-C17)

4. Azo Dyes

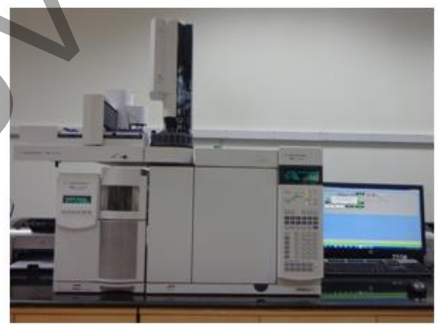
What is AZO Dyes?
AZO dyestuffs are compounds containing one or more **“–N=N-”** groups within AZO dyes.

Are all Azo dyes are restricted?
It would be wrong to say that all AZO dyestuffs are prohibited. Only those that contain arylamine are carcinogen among AZO dyestuff.

What is hazards?
AZO dyestuffs are the carcinogenic substances that particularly can penetrate the body through perspiration.

Critical Components:
All materials especially dark coloured/ locally dyed textile and leather.

GC-MS



HPLC

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Lightfastness Texting of Textiles

References, Standards, and Evaluations

Smrithi Kumar
Q-Lab Corporation

Lightfastness Testing

- What Is Lightfastness and Why Do We Test?
- Reference Materials and Evaluations
- Xenon Arc Laboratory Lightfastness Testing
- Key Lightfastness Test Standards

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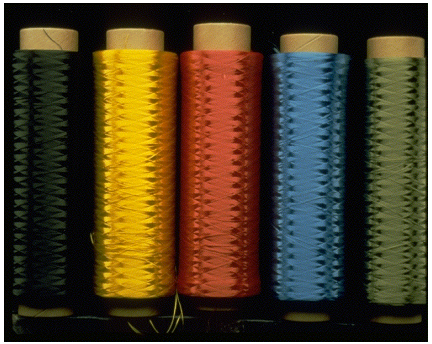
Lightstability vs. Weathering

- 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

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



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

Why Test?

- Meet specifications
- Avoid catastrophes
- Enhance your reputation
- Verify supplier claims
- Improve product durability
- Save on material costs
- Expand existing product lines
- Enter new markets
- Outrun the competition
- Stay ahead of regulations

Laboratory Testing is a Tool for Directional Decision-Making

Laboratory Accelerated tests can help you

- Make decisions better and/or faster.
- Reduce risk of making bad decisions
- Reduce risk of making decisions too slowly

What Kind of Test Should I Run?

Accelerated Test Type	Result	Test Time	Results compared to
Quality Control	Pass / fail	• Defined • Short	Material specification
Qualification / validation	Pass / fail	• Defined • Medium-long	Reference material or specification
Correlative	Rank-ordered data	• Open-ended • Medium	Natural exposure (Benchmark site)
Predictive	Service life Acceleration factor	• Open-ended • Long	Natural exposure (Service environment)

Lightfastness Testing

- What Is Lightfastness and Why Do We Test?
- Reference Materials and Evaluations
- Xenon Arc Laboratory Lightfastness Testing
- Key Lightfastness Test Standards

Standard Reference Materials

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

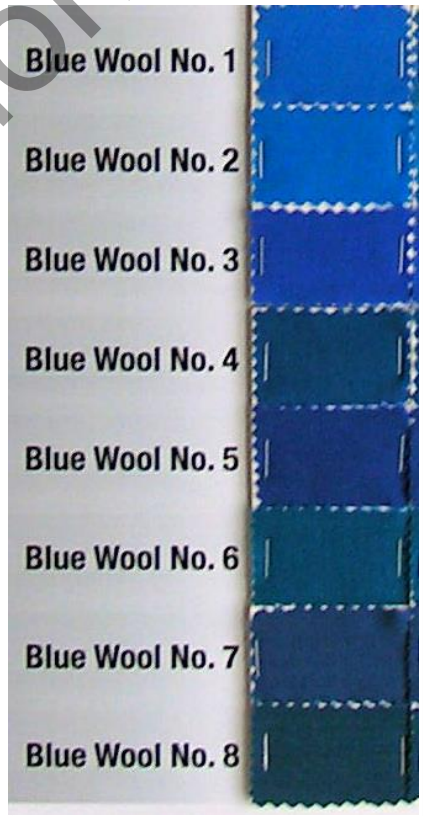
- AATCC Blue Wool
- ISO Blue Wool
- DIN Blue Wool
- JIS Blue Wool
- ISO Red Azoic Cloth

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

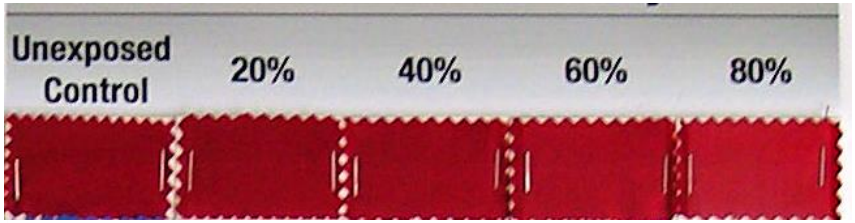


AATCC Blue Wool

- 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

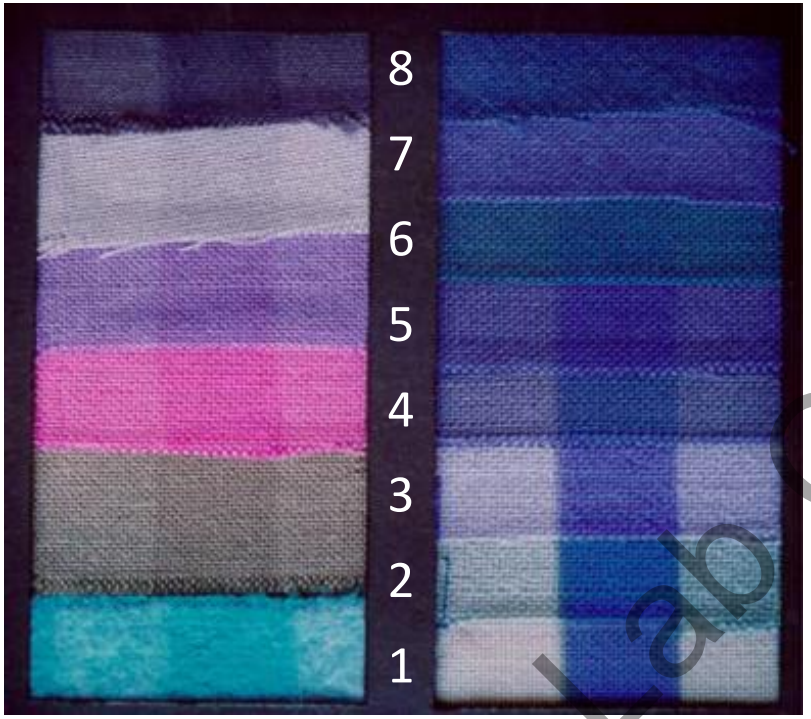


Fading based on relative humidity

AATCC Purple Cloth (Xenon Reference Fabric)

Fading based on temperature

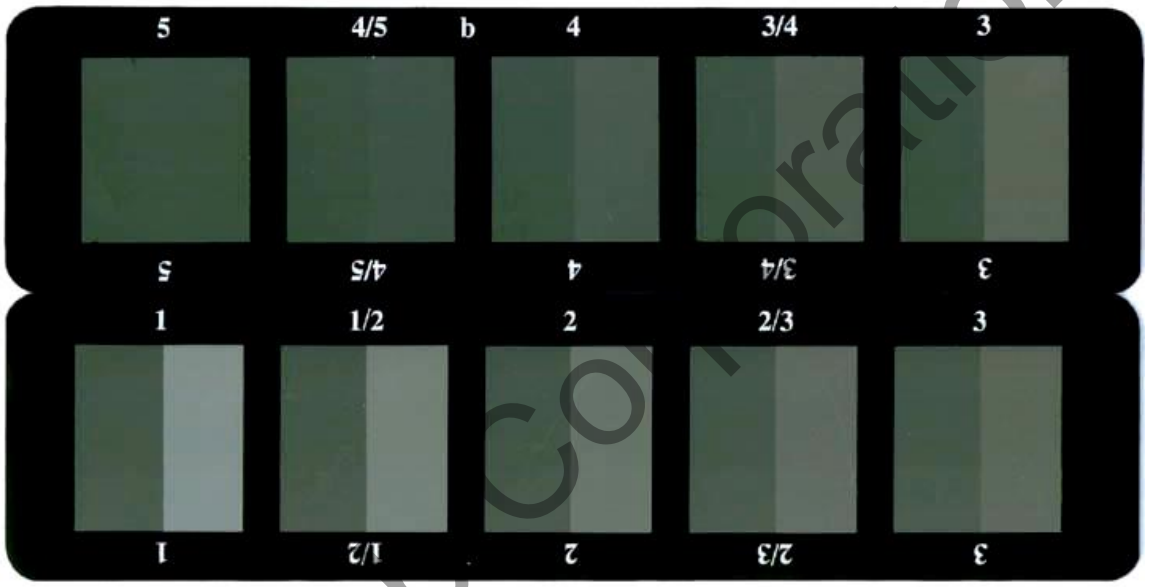
ISO Blue Wool for Evaluation



Specimen Blue Wool

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

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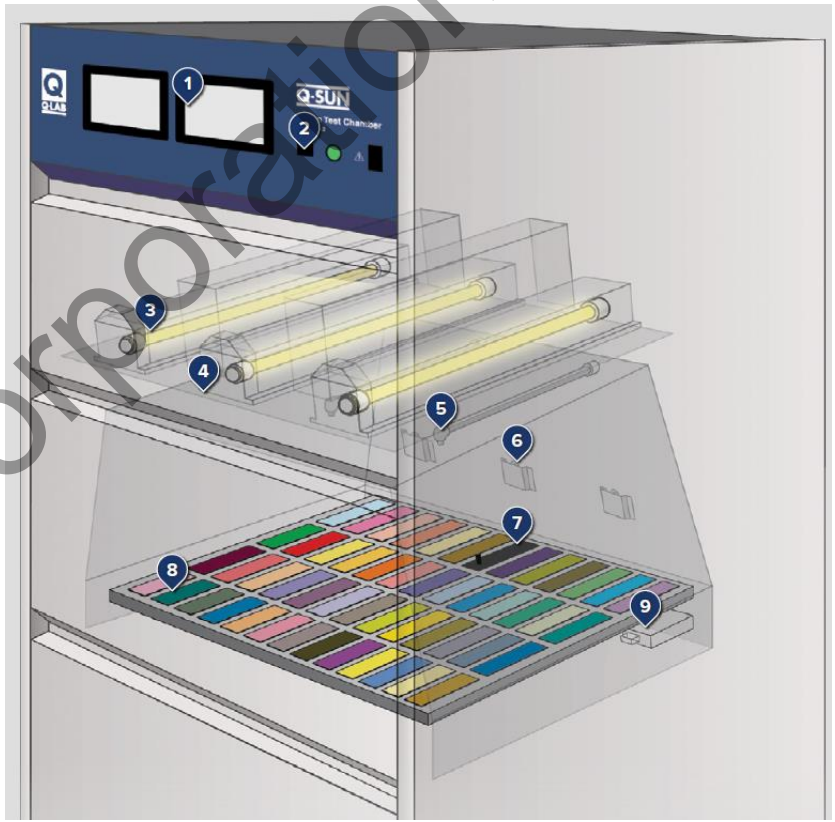
Xenon Arc Test Chamber: Flat Array

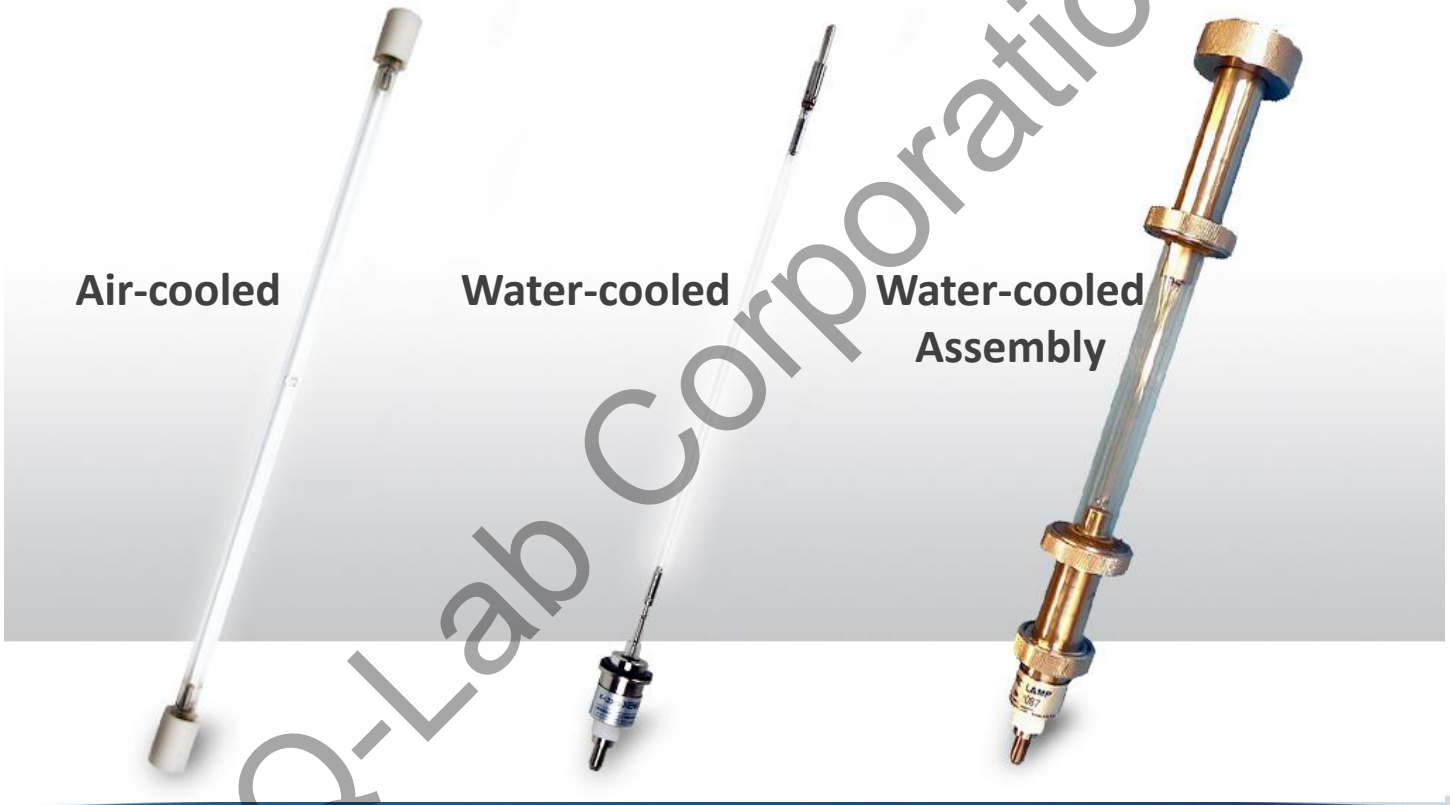
1) Simple user interface
2) USB port for data transfer
3) Xenon lamps with irradiance control
4) Optical filters
5) Water spray
6) Onboard irradiance sensors
7) Black Panel Temp sensor
8) Specimen holders
9) Relative Humidity/CAT sensor



Xenon Arc Test Chamber: Rotating Rack

1) Simple user interface
2) USB port for data transfer
3) Xenon lamps with irradiance control
4) Optical filters
5) Water spray
6) Onboard irradiance sensors
7) Black Panel Temp sensor
8) Specimen holders
9) Relative Humidity/CAT sensor

Xenon Arc Lamps



Textile Lightfastness Exposure Methods for Xenon arc

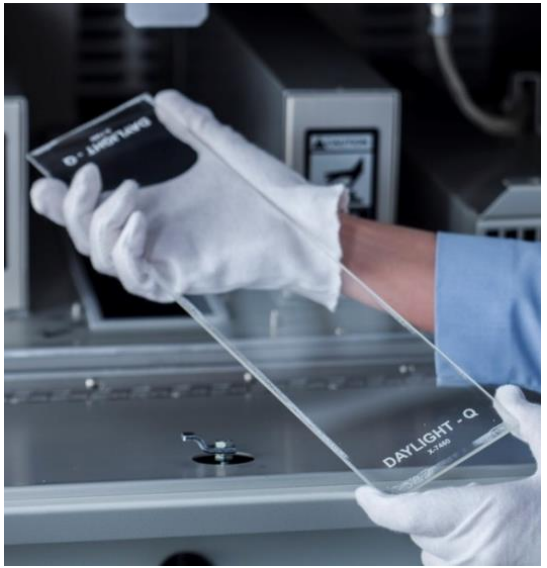
- Xenon arc light source and “Window” glass optical filtration
- Specimen mounting
- Blue wools and gray scales are used
  - Set duration of test
  - Evaluate exposed specimens

Optical Filters

- Daylight
- **Window**
- Extended UV

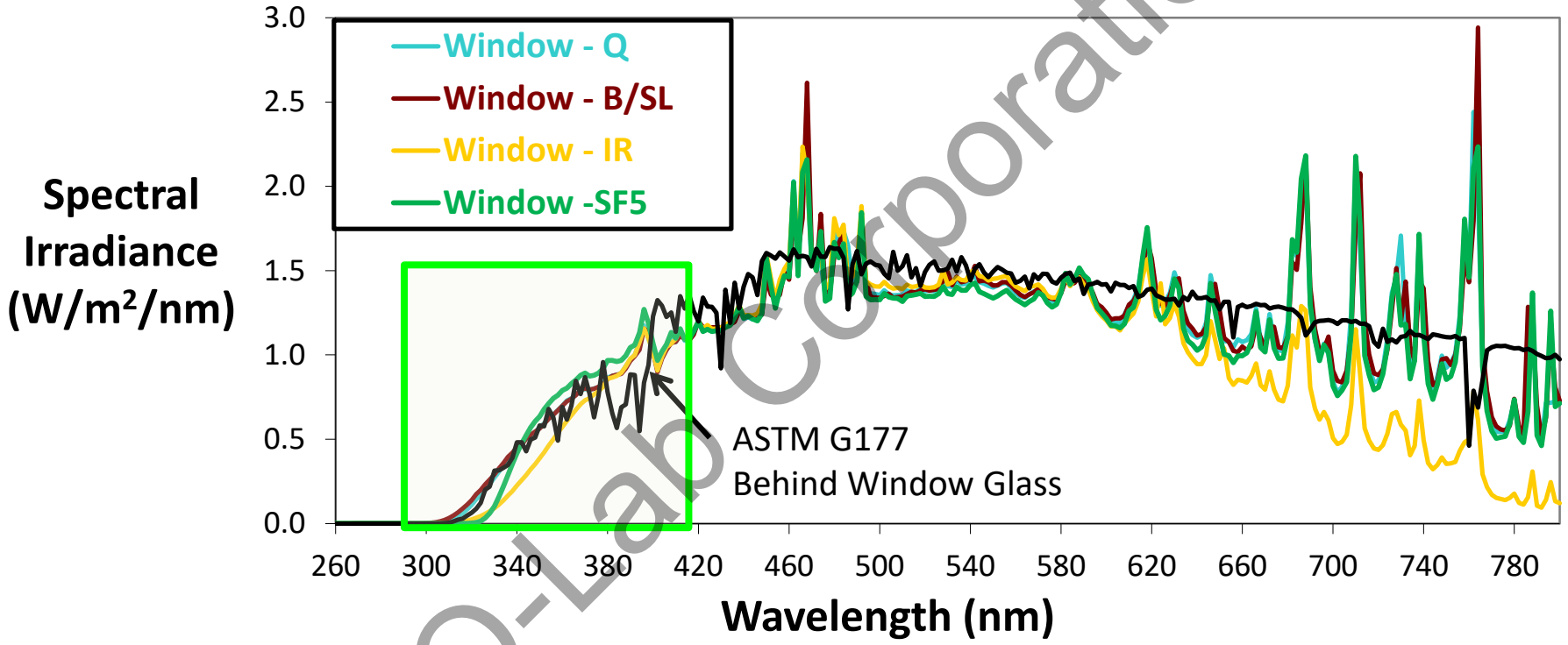
Rotating drum "lantern"

Flat array filter



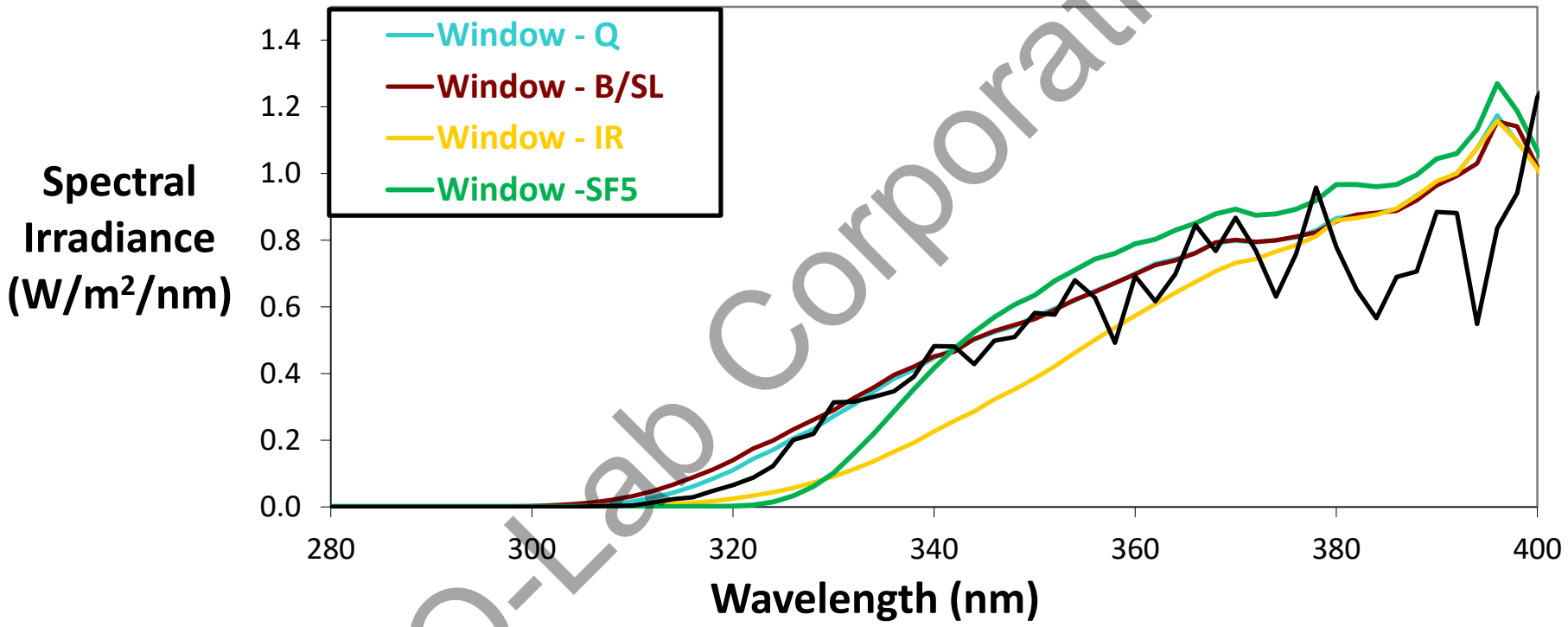
Light source for textile testing

Xenon Arc with Window Filters



Light source for textile testing

Xenon Arc with Window Filters



Q-SUN SOLAR EYE Irradiance Control

- Feedback Loop Control
  - Xenon-arc lamp
  - Light sensor
  - Control module
- Wavelength at which irradiance is controlled is referred to as Control Point

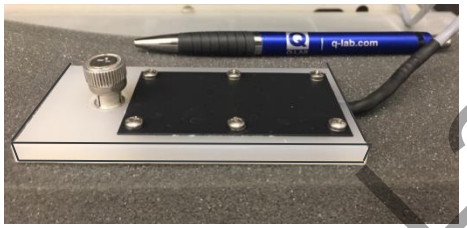
Heat behind Window Glass

Temperature of automobile interior fabrics behind window glass can exceed 100 °C

Black Panel Temperature Control

- Most common in test standards
- Approximates maximum textile surface temperature
- Can be used in combination with chamber air temp sensor and control

Black Panel Temperature Sensors

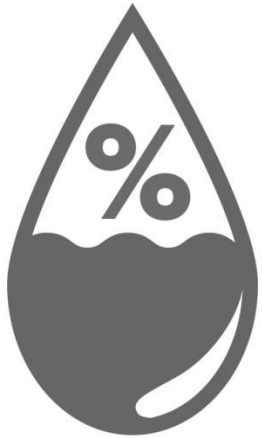
Panel	Construction	ASTM Designation	ISO Designation
	Black painted stainless steel	Uninsulated Black Panel	Black Panel
	Black painted stainless steel mounted on 0.6 cm white PVDF	Insulated Black Panel	Black Standard

Chamber Air Temperature Control

- Required by certain test methods
- Necessary for control of relative humidity (RH)
- Sensor must be shielded from light
- BP temp always hotter than chamber air temp from absorbing radiant heat

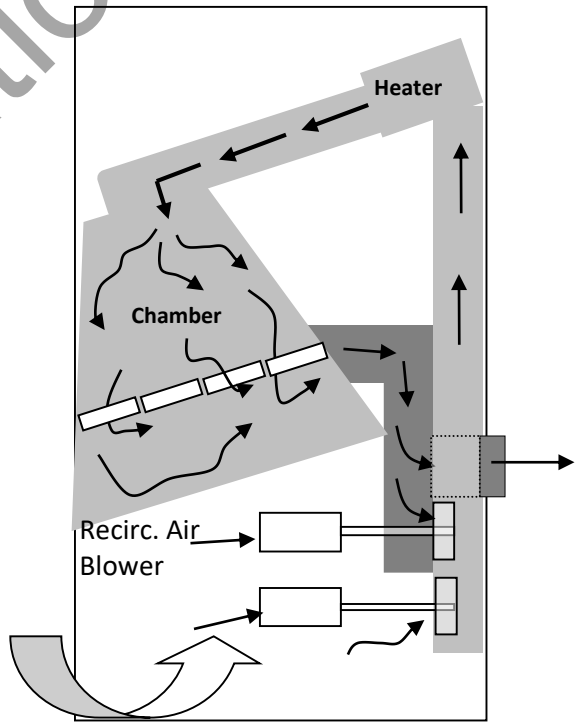
Humidity

- **Measure of amount of water in air**
- Can lead to physical stress
- Humidity affects fabrics both indoors and outdoors
- Often expressed as Relative Humidity (RH), where 100% is the most water that air of a given temperature can hold

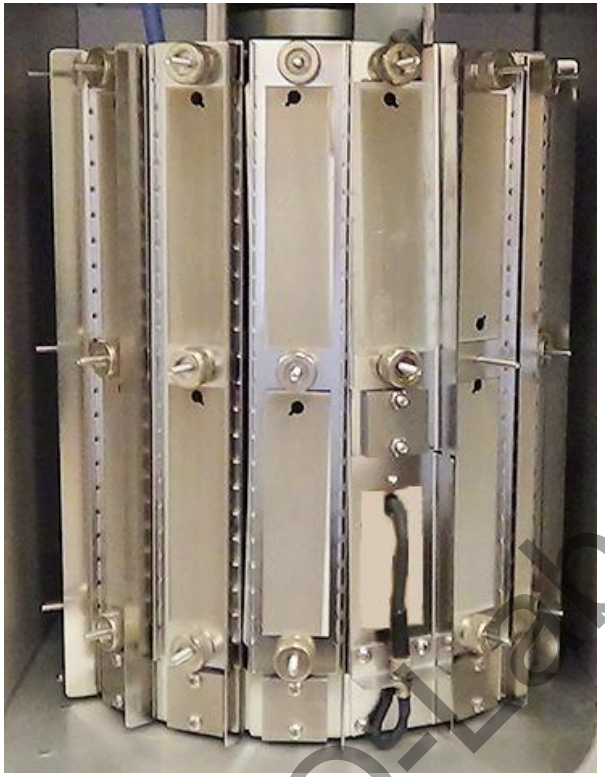


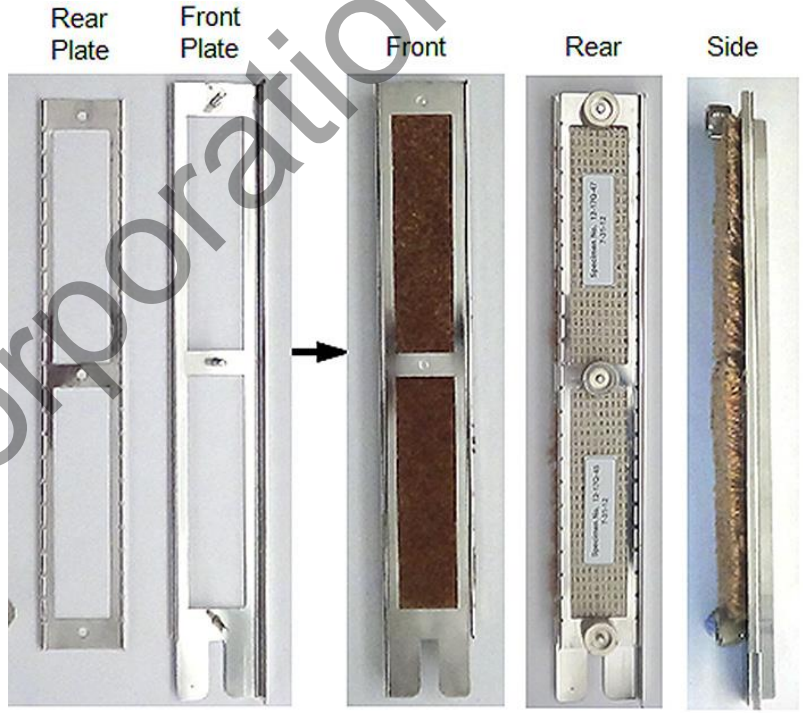
Relative Humidity Control

- Required by many test methods
  - Plastics, textiles, general use
  - Automotive (SAE)
- Many xenon testers can generate and control relative humidity
- High RH can significantly increase time of wetness and is typically specified and controlled in lightfastness testing



Open-Backed Specimen Holders





Open Back Holder Components

Mounted Specimen

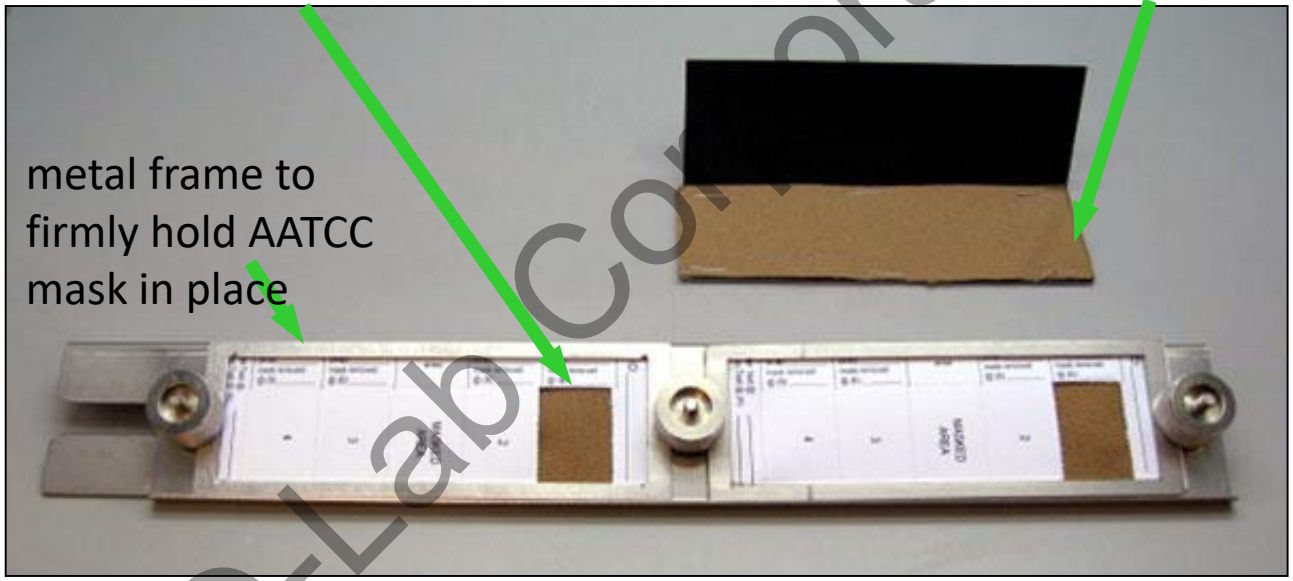
Solid-Backed Specimen Holders

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

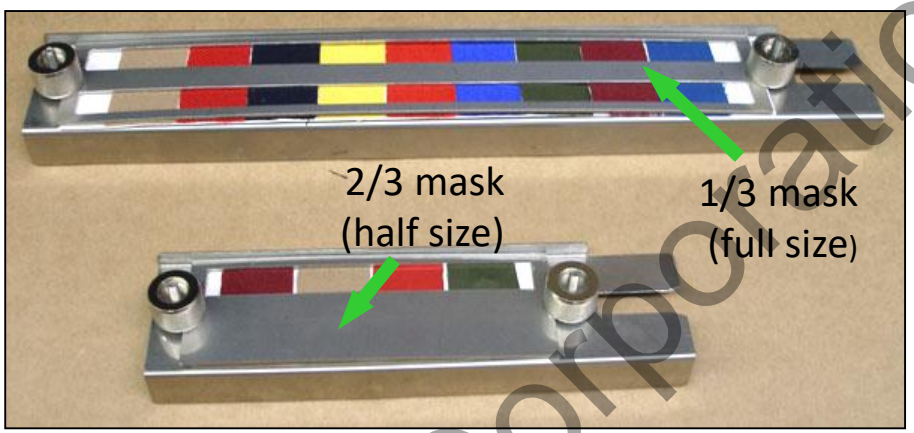
Textile Masking

AATCC mask mounted in specimen holder with one section removed

Textile specimen stapled inside AATCC mask

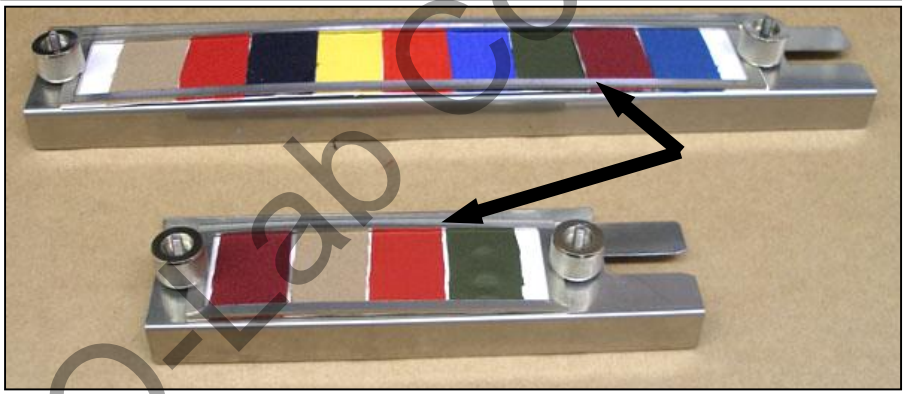


Textile Masking



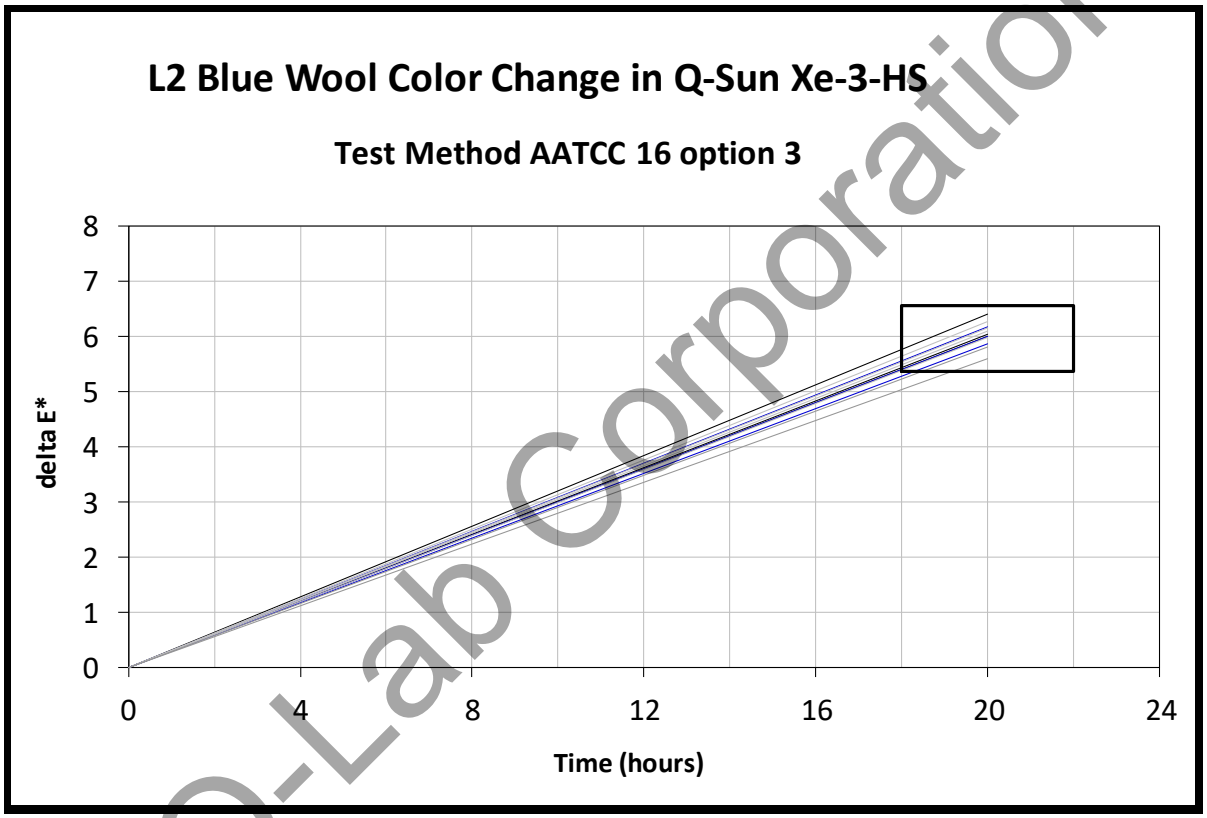
ISO 105-B02

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



AATCC TM 16
picture frame masks

Timing lightfastness tests with Blue Wool



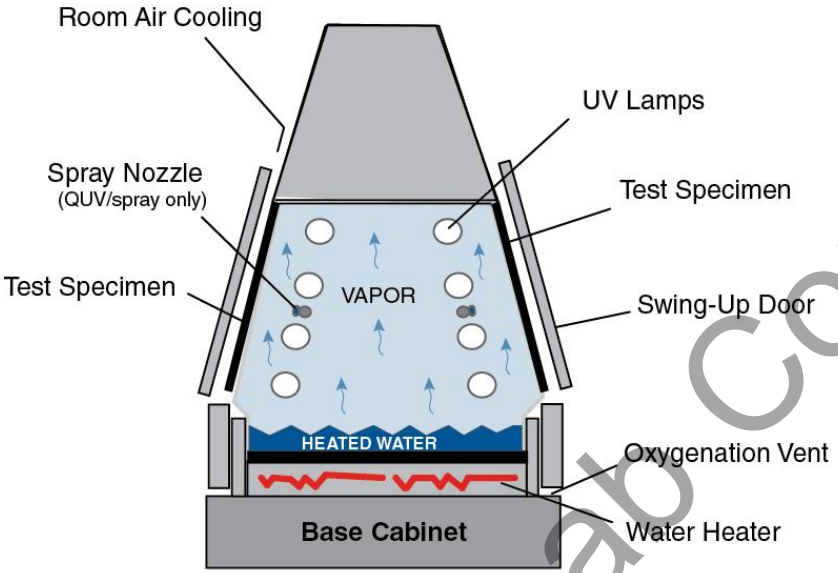
Lightfastness Testing

- What Is Lightfastness and Why Do We Test?
- Reference Materials and Evaluations
- Xenon Arc Laboratory Lightfastness Testing
- Key Lightfastness Test Standards

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)

Fluorescent UV Testing



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 *

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

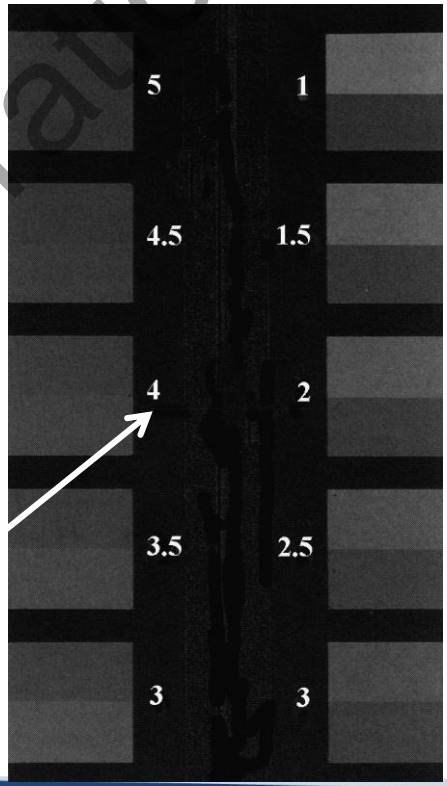
Parameter	AATCC	ISO 105-B02
Light source	Xenon arc	Xenon Arc
Irradiance ($W/m^2/nm$ @420nm)	1.10	1.10
BP temp (°C)	63	47
Chamber air temp (°C)	43	39
RH (%)	30	40
Optical Filter	Window B/SL	Window-IR

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 $1/20^{th}$ 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.

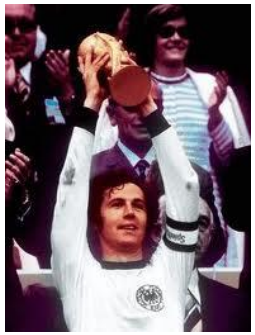
[b] Verified by experiment using Daylight Behind Glass and Xenon-Arc, Continuous Light. All other values are calculated (see 32.18).

ISO 105-B series

Additional performance-based textile lightfastness standards

Different materials require different test methods

Textiles are moving forward to a new high-tech level.
The test methods are still the same.



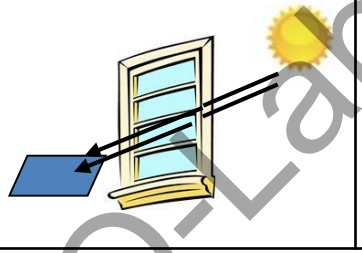
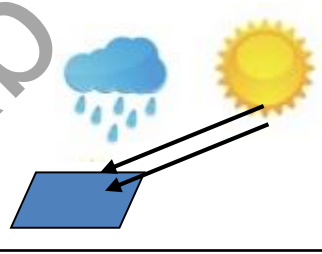
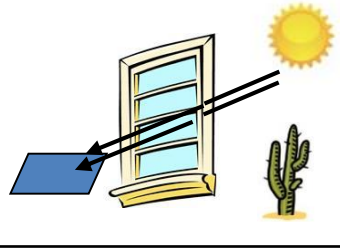
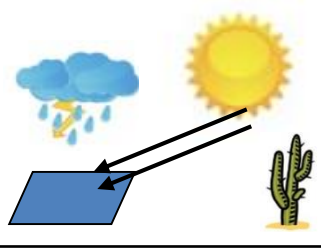
1974

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/m² 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				

Future developments for ISO 105-B

- ISO 105-B10 offers several new accelerated weathering methods. It might replace B04?
  - Higher temperatures and increased amount of UV-radiation
  - allows higher acceleration level
- 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 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 standard 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!

For further question, contact

info@q-lab.com

NEW DEVELOPMENTS IN TEXTILE TESTING

1

AATCC

AATCC supports the people, products, and processes growing a sustainable textile industry.

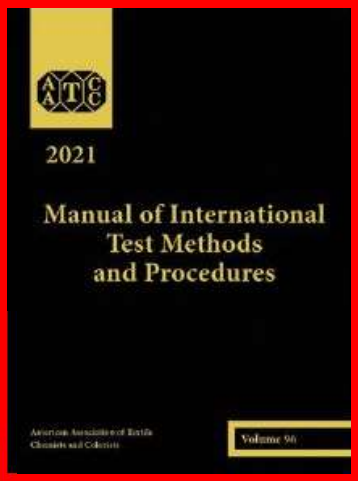
- **Connecting** people
- **Enabling** durability, safety, and analytical testing
- **Sharing** emerging technology

2

New Volume. New Title!

https://members.aatcc.org/store/2021a/3238/

- 1 new standard
- 14 technically revised standards
- 3 editorially revised standards
- 13 reaffirmed standards



AATCC

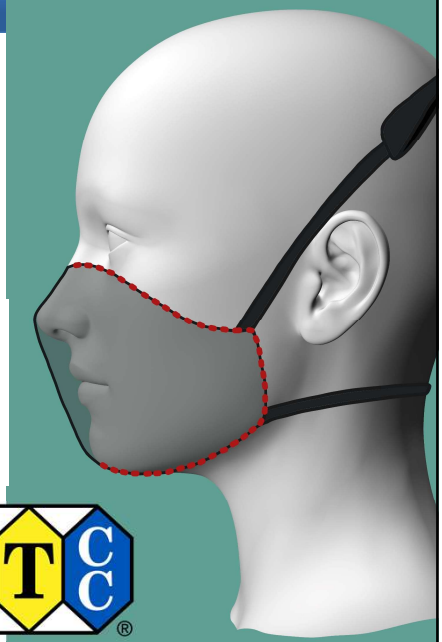
3

Face Covering Guidance

- AATCC M14 published August 2020
- Referenced by WHO
- Guidance for manufacturers & consumers
  - Material selection
  - Design
  - Breathing resistance
  - Filtration
  - Labeling

World Health Organization

www.aatcc.org/covid



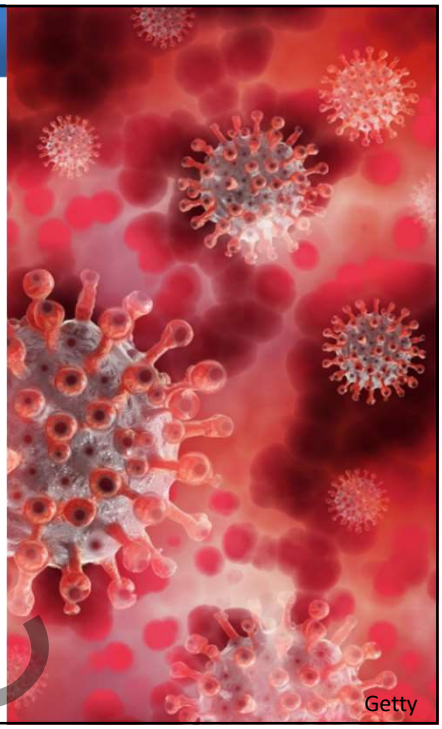
AATCC

4

More COVID Resources

www.aatcc.org/covid

- Digital lab PPE series
  - Free for AATCC members
- Free standards
- Educational articles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5

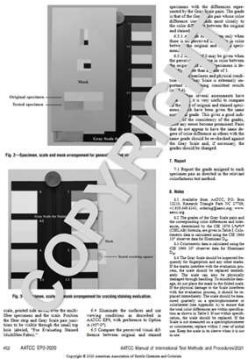
Revised Gray Scale Standards

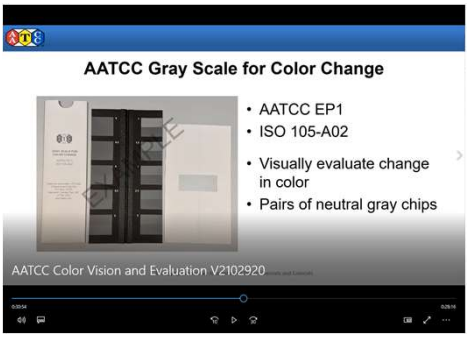
- AATCC EP1-2020, Evaluation Procedure for Gray Scale for Color Change
- AATCC EP2-2020, Evaluation Procedure for Gray Scale for Staining


AATCC

6

Revised Gray Scale Standards



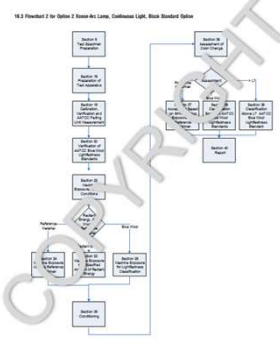


www.aatcc.org/events/online/testing

7

Revised Lightfastness Standard

- AATCC TM16.3-2020, Test Method for Colorfastness to Light: Xenon-Arc



8

ISO/TC 038/SC 01/WG 01

- "Light and weathering“ working group
- ISO 105-B02:2014
  Colour fastness to artificial light:
  Xenon arc fading lamp test

9

ISO/TC 038/SC 01/WG 01

- ISO 105-B06:2020
  Colour fastness and **ageing** to artificial light at **high temperatures**:
  Xenon arc fading lamp test

Specify option & instrument

10

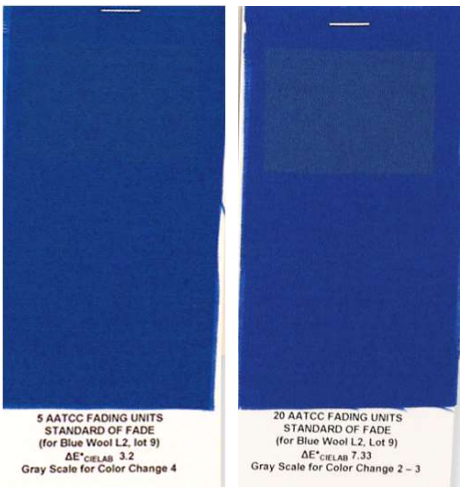
SAE J2412

- Accelerated Exposure of Automotive Interior Trim Components Using a Controlled Irradiance Xenon-Arc Apparatus
- Previously J1885
- Approved AATCC Blue Wool as reference standard
  - More repeatable than polystyrene

11

AATCC Blue Wool

5 AFU
GSCC 4.0



20 AFU
GSCC 2.5

12

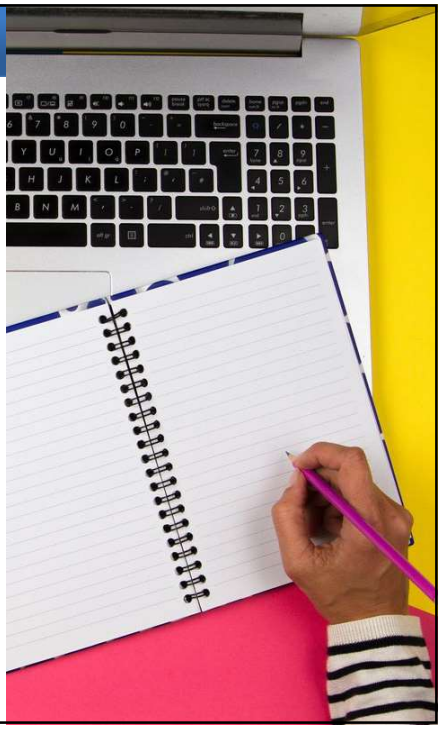
AATCC RA50 Projects

- TM16.1 Colorfastness to Light: Outdoor
- TM16.2 Colorfastness to Light: Carbon-Arc
- TM111 Weather Resistance of Textiles: Exposure to Daylight and Weather
- TM125 Colorfastness to Perspiration and Light
- TM169 Weather Resistance of Textiles: Xenon Lamp Exposure
- TM186 Weather Resistance: UV Light and Moisture Exposure
- TM192 Weather Resistance of Textiles: Sunshine-Arc Lamp Exposure With and Without Wetting

13

Revised Style Guide

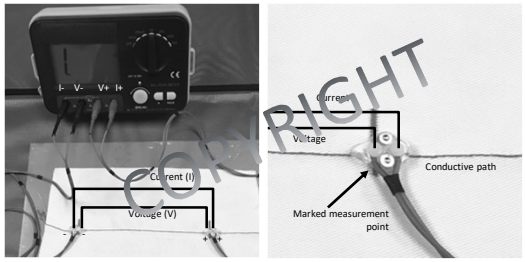
- AATCC M12-2020, AATCC Style Guide for Writing Test Methods and Procedures



14

E-Textile Standards

- AATCC EP13-2018e, Evaluation Procedure for Electrical Resistance of Electronically Integrated Textiles



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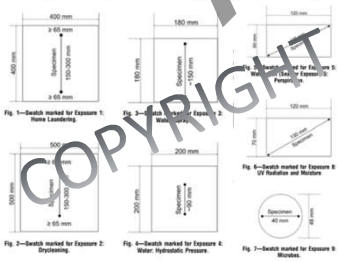
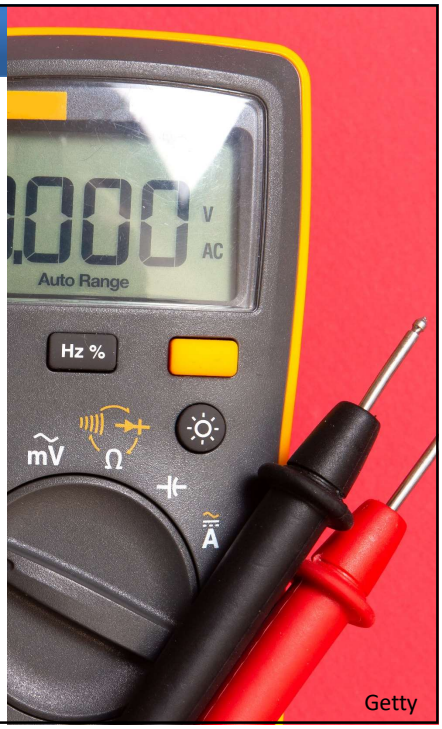
E-Textile Standards

- AATC aluation Proce Resistance of Ele ed Textiles



- AATCC TM210-2019, Test Method for Electrical Resistance Before & After Various Exposure Conditions



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16

Laundering Standards

- LP1 Laboratory Procedure for Home Laundering: Machine Washing
  - TM88B, TM88C, TM124, TM130, TM135, TM150, TM179, TM207

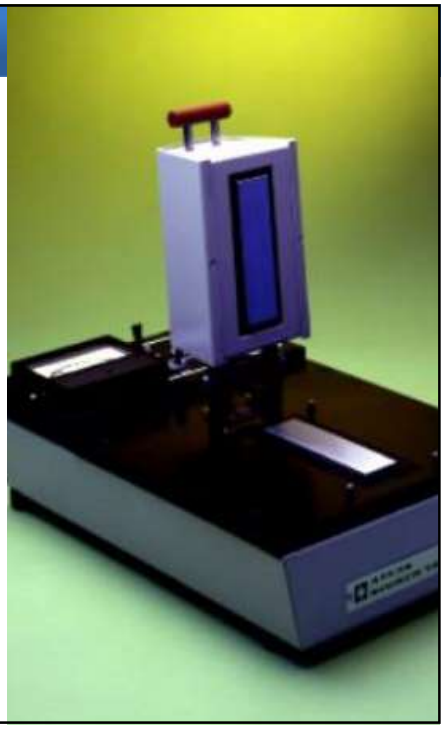
www.aatcc.org/events/online/testing

17

More Revised Standards

www.aatcc.org/testing/methods/updates

- AATCC **TM20A**-2020, Test Method for Fiber Analysis: Quantitative
- AATCC **TM26**-2020, Test Method for Ageing of Sulfur-Dyed Textiles: Accelerated
- AATCC **TM94**-2020, Test Method for Finishes in Textiles: Identification
- AATCC **TM97**-2020, Test Method for Extractable Content of Textiles
- AATCC **TM112**-2020, Test Method for Formaldehyde Release from Fabric, Determination of: Sealed Jar Method
- AATCC **TM118**-2020, Test Method for Oil Repellency: Hydrocarbon Resistance Test
- AATCC **TM133**-2020, Test Method for Colorfastness to Heat: Hot Pressing
- AATCC **TM169**-2020, Test Method for Weather Resistance of Textiles: Xenon Lamp Exposure
- AATCC **TM183**-2020, Test Method for Transmittance or Blocking of Erythemally Weighted Ultraviolet Radiation through Fabrics
- AATCC **TM206**-2020, Test Method for Free and Hydrolyzed Formaldehyde: Water Extraction



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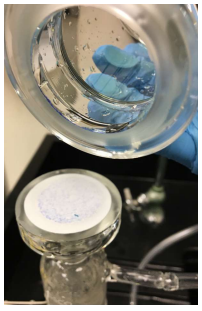
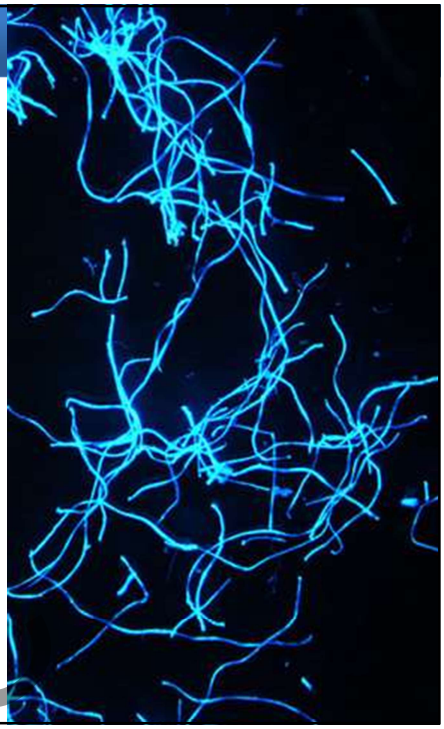
Draft Standards

- AATCC TMXXX-2021, Test Method for Fiber Fragment Release During Home Laundering: Accelerated





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Draft Standards

- Laundering with Bleaches
- Face Coverings for Children
- Electrical Resistance during Stretch

www.aatcc.org/testing/committees

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Upcoming Meetings

- April 13-16 Admin Meetings
- May 11-13 Research Meetings
  www.aatcc.org/events/committees

- Members-Only Events
  www.aatcc.org/events/membership-events

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Questions?

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