

HACKTEX VIRTUAL TRAINING MATERIALS

ADVANCED TEXTILES MANUFACTURING INDUSTRY

Learning unit 4: Standards and characterization of functional and smart textiles

Lesson 2

Textile properties of smart textiles and their characterisation

Mònica Ardanuy / Universitat Politècnica de Catalunya

Heura Ventura / Universitat Politècnica de Catalunya



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Innovative smart textiles & entrepreneurship / 2021-1-RO01-KA220-HED-000027527



TEXTILE PROPERTIES OF SMART TEXTILES AND THEIR CHARACTERISATION

LU4.2



Contents

- Strength-related textile properties
- Haptic-related properties
- Comfort-related properties

STRENGTH-RELATED TEXTILE PROPERTIES



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TENSILE TEST



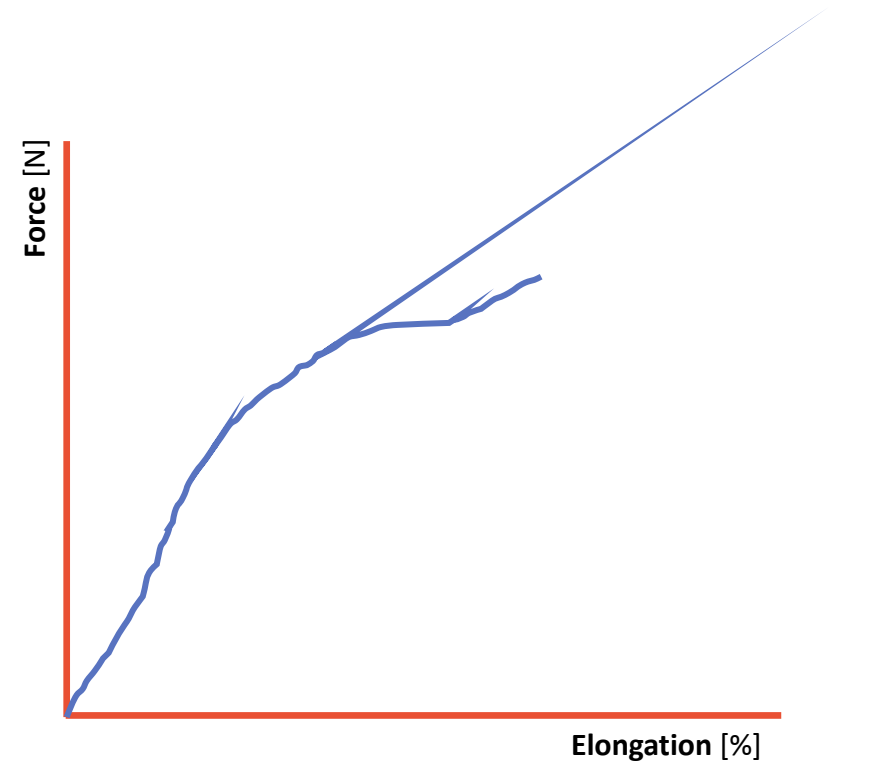
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Tensile test



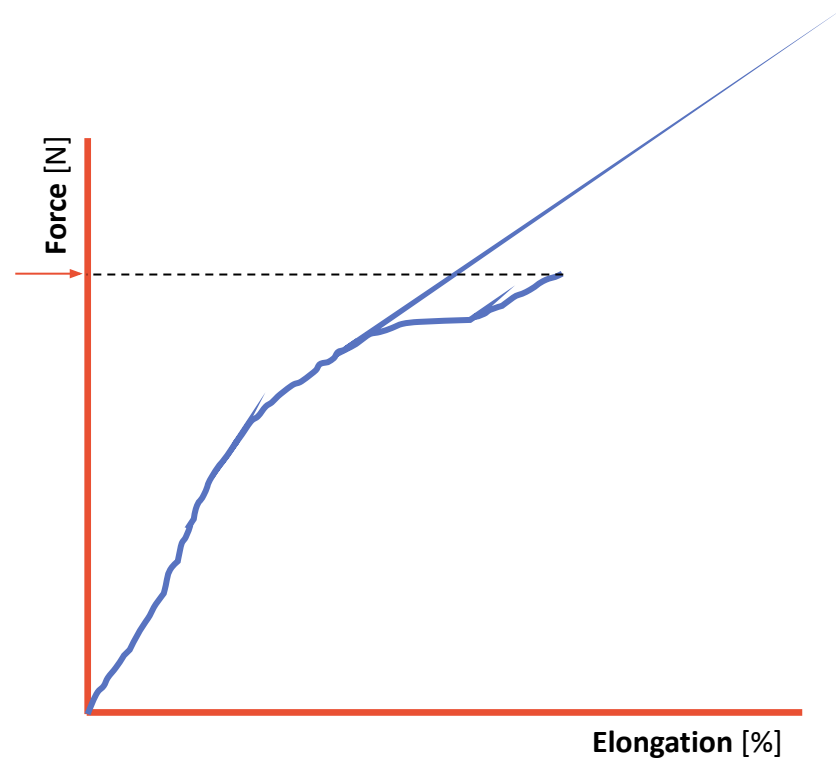
Tensile test



Tensile test



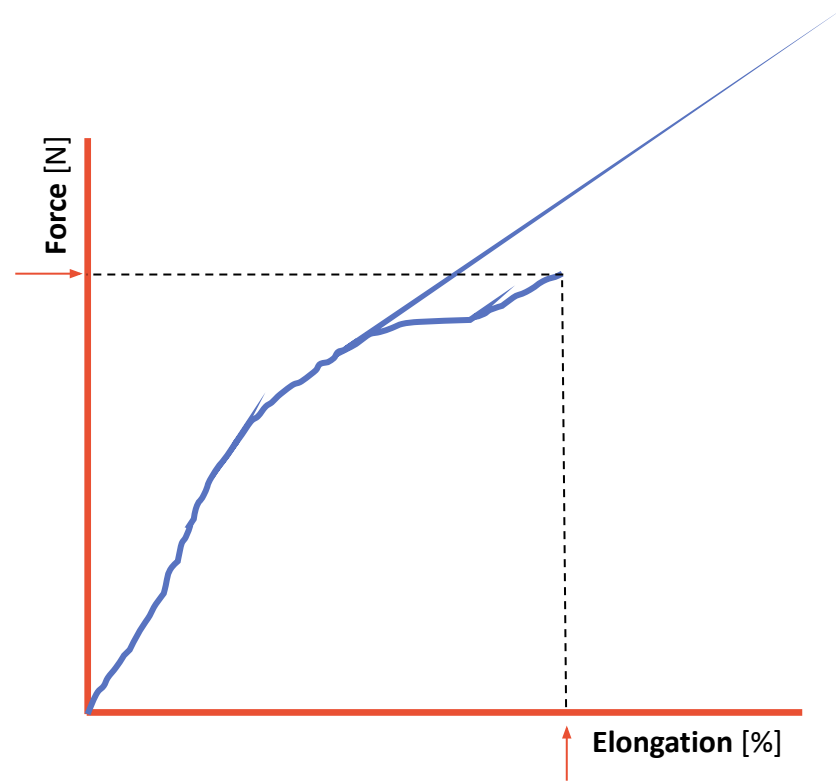
Maximum force
(and force at rupture)



Tensile test



Maximum force
(and force at rupture)



Elongation at maximum force
(and elongation at rupture)

Tensile test

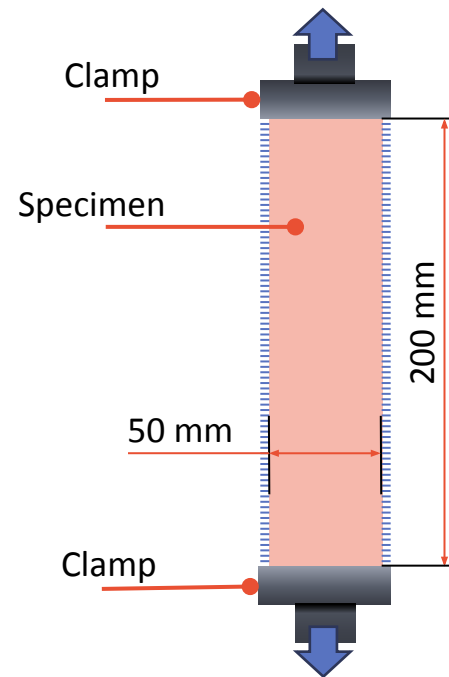
Strip method

Grab method

Tensile test

Strip method

- *Woven fabrics*
ISO 13934-1:2013
- *Nonwoven fabrics*
ISO 9073-3:1989

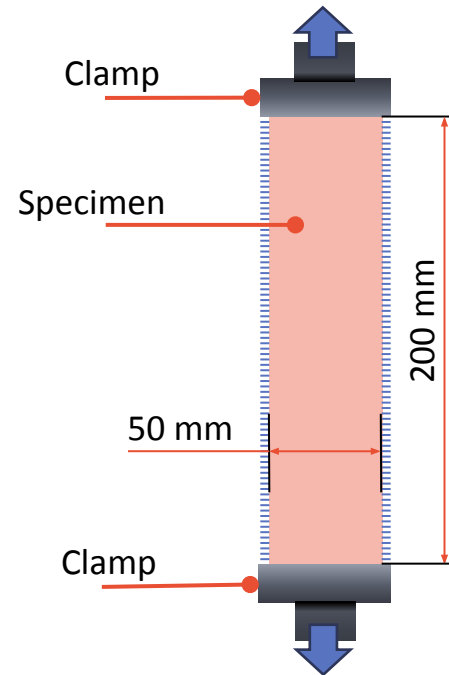


Grab method

Tensile test

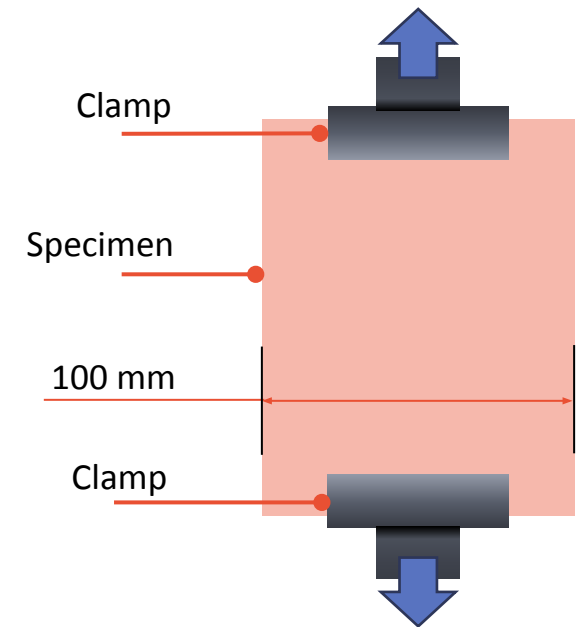
Strip method

- *Woven fabrics*
ISO 13934-1:2013
- *Nonwoven fabrics*
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Grab method

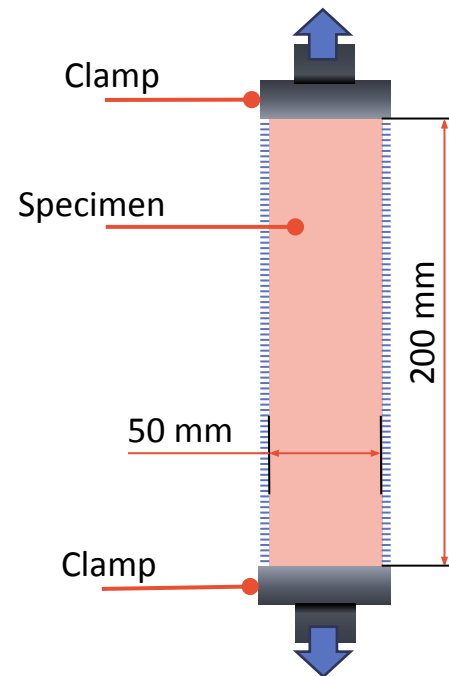
- *Woven fabrics*
ISO 13934-2:2014
- *Nonwoven fabrics*
ISO 9073-18:2008



Tensile test

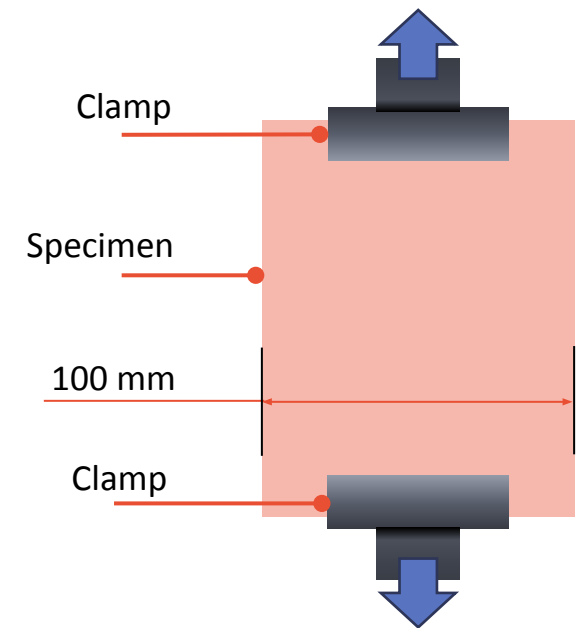
Strip method

- *Woven fabrics*
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- *Nonwoven fabrics*
ISO 9073-3:1989



Grab method

- *Woven fabrics*
ISO 13934-2:2014
- *Nonwoven fabrics*
ISO 9073-18:2008



Testing
conditions

- 5 specimens in both warp and weft (or machine and cross) directions
- Clamping distance and speed will depend on the type of test and fabric

TEARING TEST



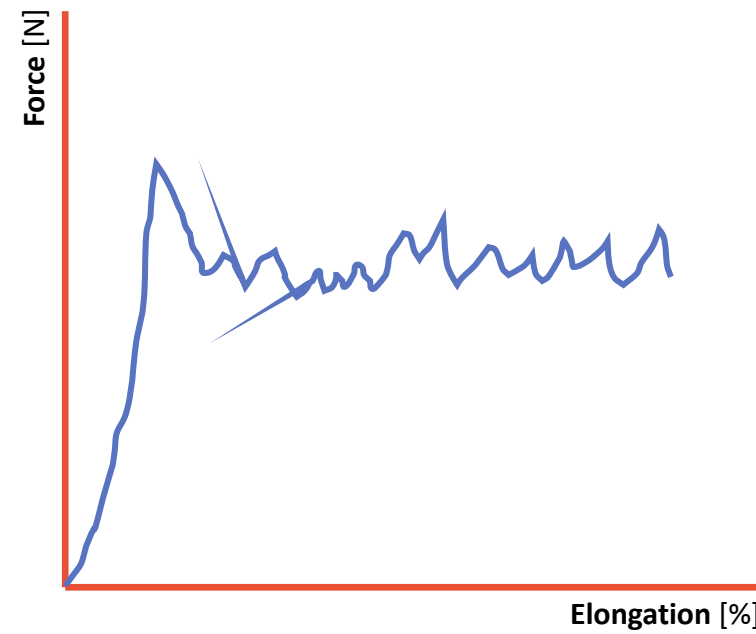
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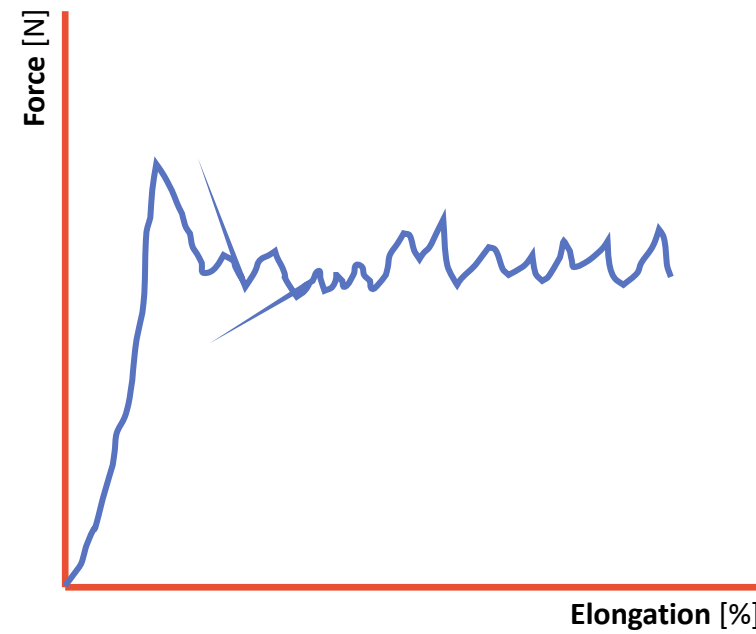
Tearing test



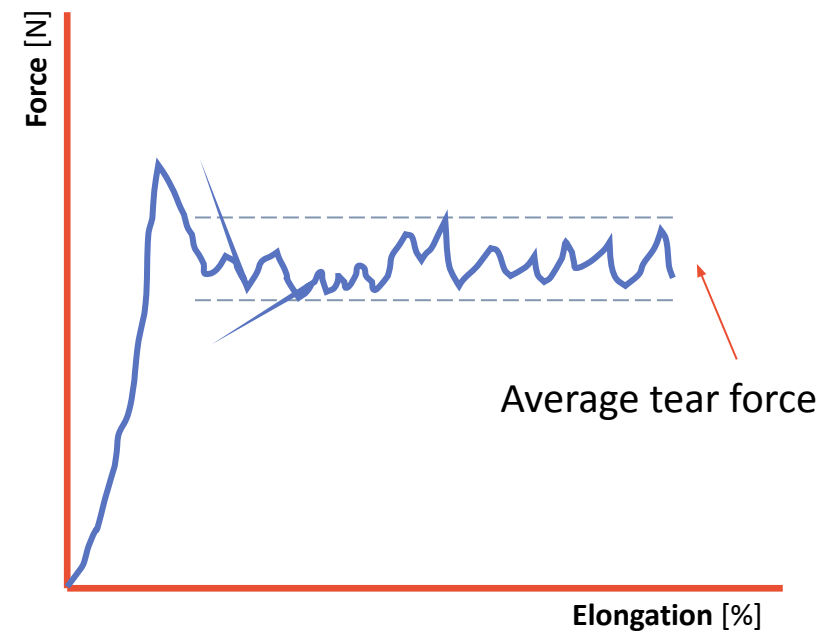
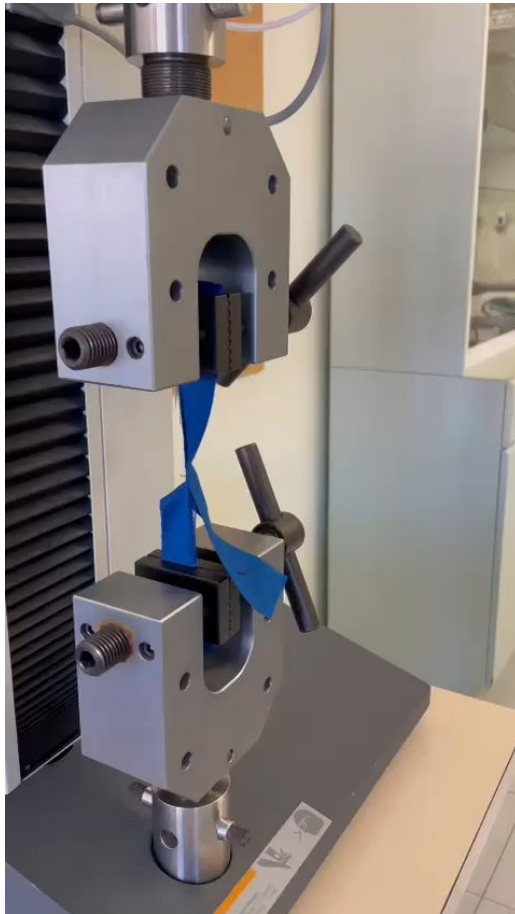
Tearing test



Tearing test



Tearing test



Tearing test

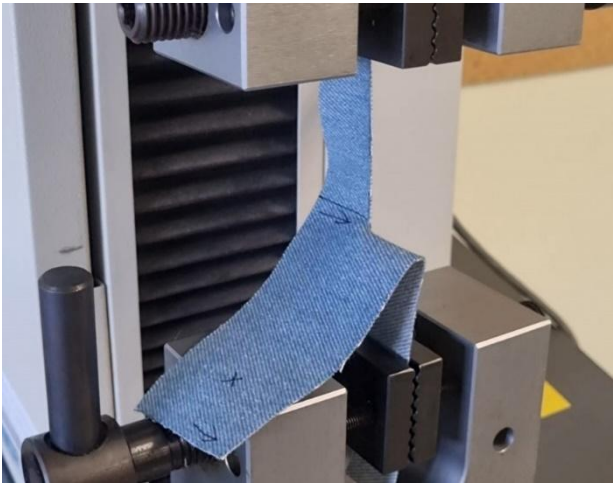
Single tear method

Double tear method

Tearing test

Single tear method

- Trouser-shaped specimens
- ISO 13937-2:2000

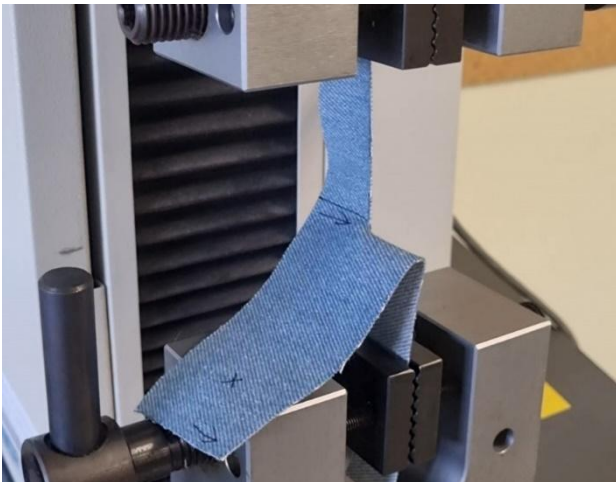


Double tear method

Tearing test

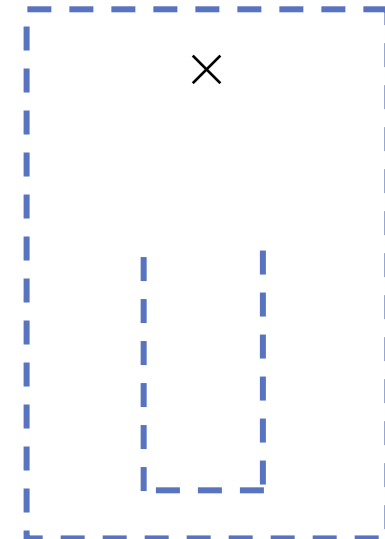
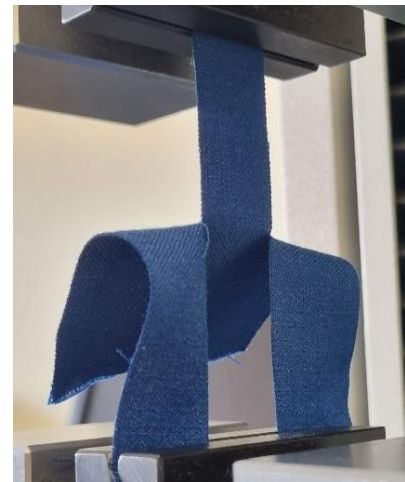
Single tear method

- Trouser-shaped specimens
- ISO 13937-2:2000



Double tear method

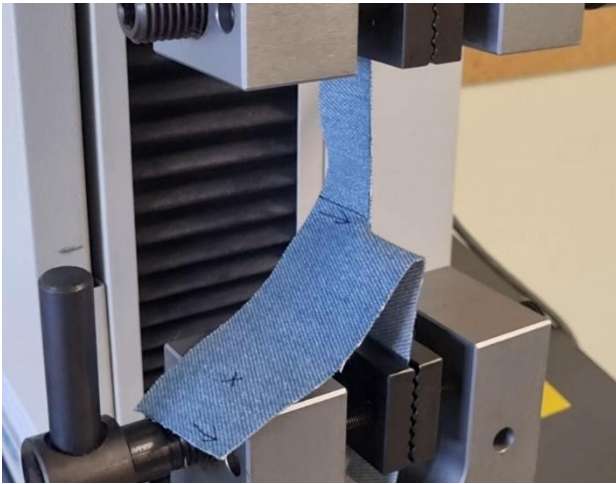
- Tongue-shaped specimens
- ISO 13937-4:2000



Tearing test

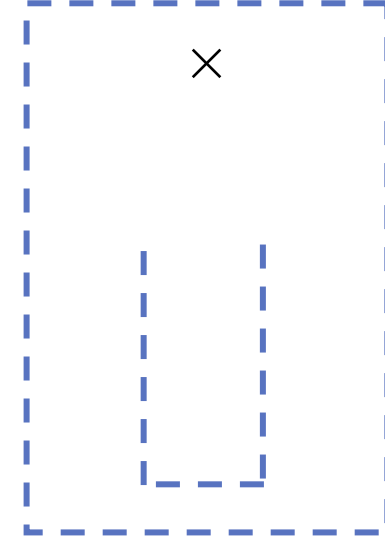
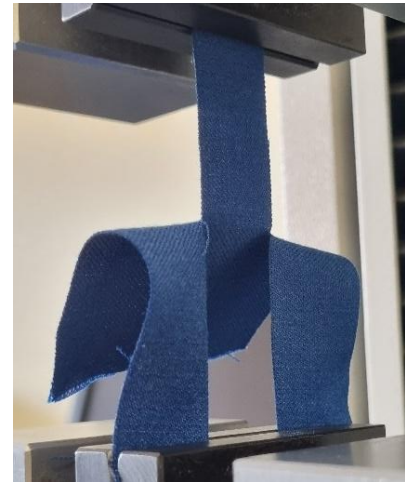
Single tear method

- Trouser-shaped specimens
- ISO 13937-2:2000



Double tear method

- Tongue-shaped specimens
- ISO 13937-4:2000



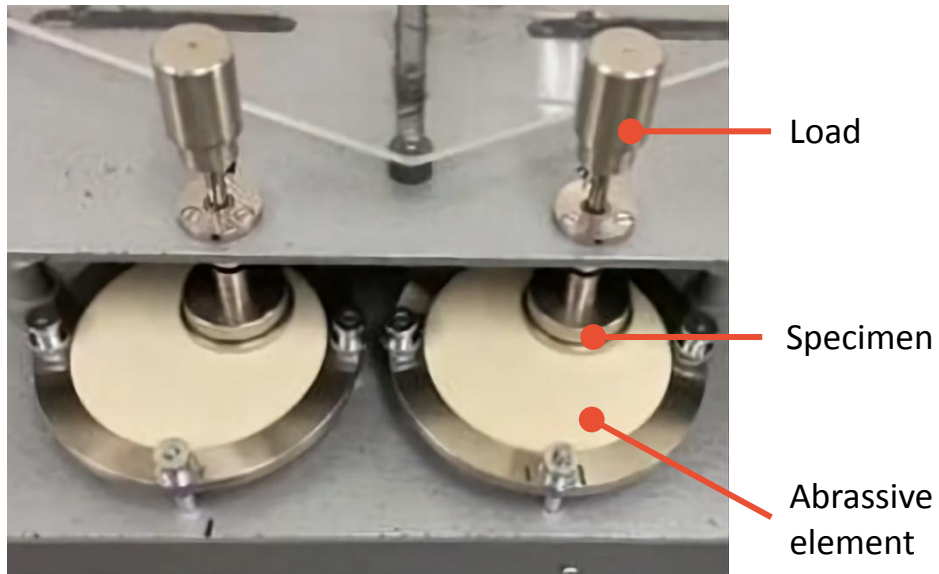
Testing conditions

- 5 specimens in both warp and weft (or machine and cross) directions
- 100 mm/min

ABRASION TEST

Abrasion test

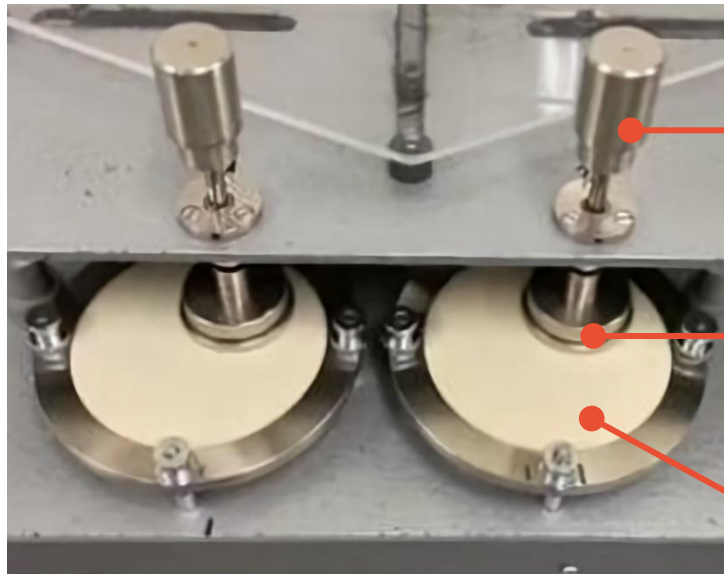
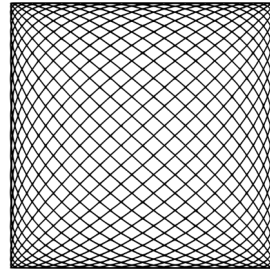
Martindale method



Abrasion test

Martindale method

Lissajous curve



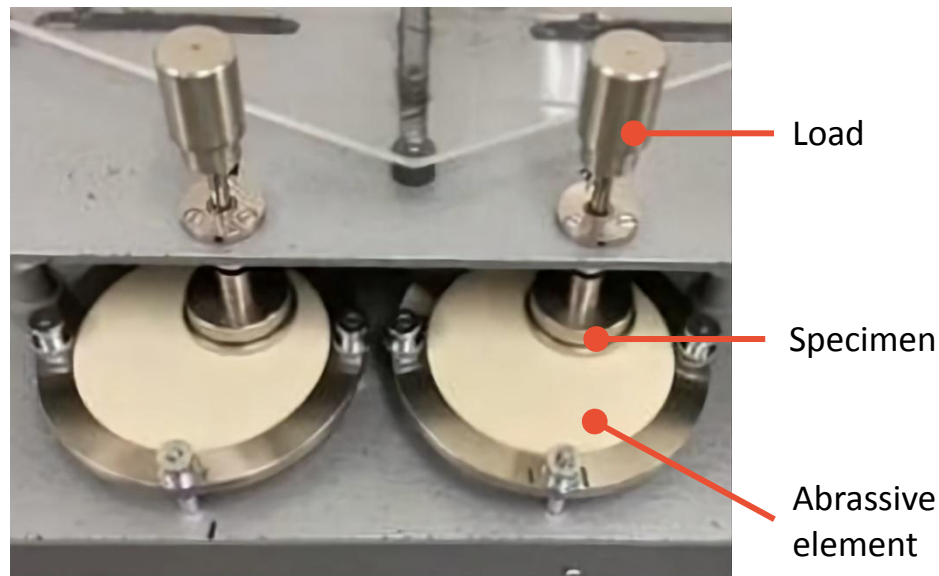
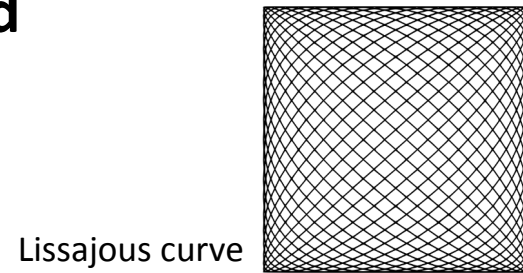
Load

Specimen

Abrasive
element

Abrasion test

Martindale method



Determination of:

- Number of cycles necessary to produce failure (wear-off observed in the fabric)
- or
- Loss of weight suffered by the test piece after a certain number of abrasion cycles

Standards:

- ISO 12947-1,3,4:1998
- ISO 12947-2:2016

PILLING TEST

Pilling test

Container methods

Flat methods

- The appearance of the specimens tested is compared with a scale of photographic patterns and the level of pilling is classified from 0 to 5

Pilling test

Container methods

Low speed

- ICI/M&S Pilling tester
- ISO 12945-1:2020

High speed

- Random Tumble Pilling Tester
- ISO 12945-3:2020

Flat methods

- The appearance of the specimens tested is compared with a scale of photographic patterns and the level of pilling is classified from 0 to 5

Pilling test

Container methods

Low speed

- ICI/M&S Pilling tester
- ISO 12945-1:2020

High speed

- Random Tumble Pilling Tester
- ISO 12945-3:2020

Flat methods

- Martindale principle
- ISO 12945-2:2020



- The appearance of the specimens tested is compared with a scale of photographic patterns and the level of pilling is classified from 0 to 5

HAPTIC-RELATED PROPERTIES

TAILORABILITY



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Tailorability (FAST)

- Mechanical properties when the fabrics are subjected to small forces
- To predict the resistance of the fabric to overcome industrial clothing operations

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- Mechanical properties when the fabrics are subjected to small forces
- To predict the resistance of the fabric to overcome industrial clothing operations

Compressibility

Flexural stiffness

Extensibility

Relaxation shrinkage (ER) &
hygroscopic expansion (EH)

Tailorability (FAST)

- Mechanical properties when the fabrics are subjected to small forces
- To predict the resistance of the fabric to overcome industrial clothing operations

Compressibility



Thickness difference at 2 compressive loads

Flexural stiffness

Extensibility

Relaxation shrinkage (ER) & hygroscopic expansion (EH)

Tailorability (FAST)

- Mechanical properties when the fabrics are subjected to small forces
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Compressibility



Thickness difference at 2 compressive loads

Flexural stiffness



Cantilever length

Extensibility

Relaxation shrinkage (ER) & hygroscopic expansion (EH)

Tailorability (FAST)

- Mechanical properties when the fabrics are subjected to small forces
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Compressibility



Thickness difference at 2 compressive loads

Flexural stiffness



Cantilever length

Extensibility



Extension under different weights

Relaxation shrinkage (ER) & hygroscopic expansion (EH)

Tailorability (FAST)

- Mechanical properties when the fabrics are subjected to small forces
- To predict the resistance of the fabric to overcome industrial clothing operations

Compressibility



Thickness difference at 2 compressive loads

Flexural stiffness



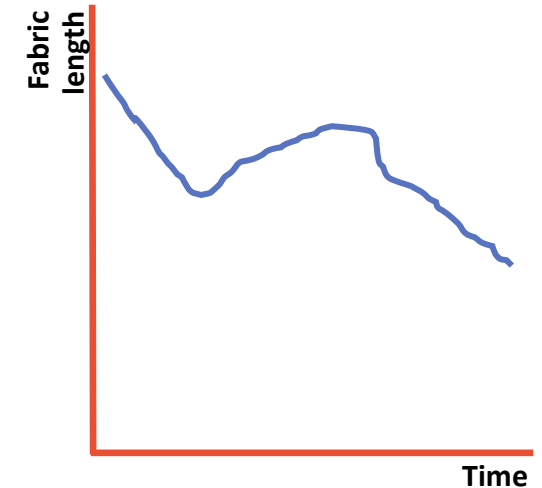
Cantilever length

Extensibility



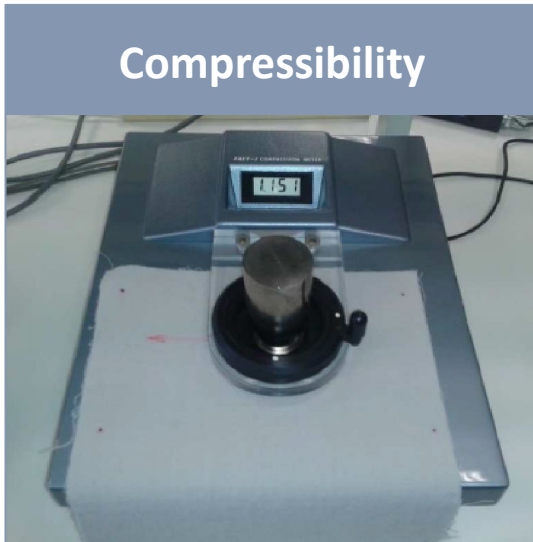
Extension under different weights

Relaxation shrinkage (ER) & hygroscopic expansion (EH)



Tailorability (FAST)

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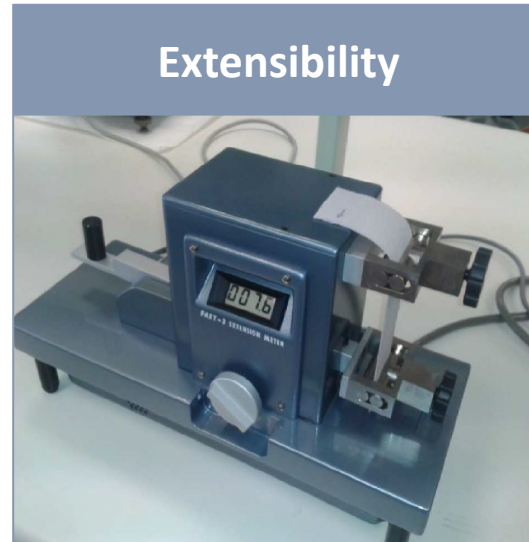
Compressibility

Thickness difference at 2 compressive loads



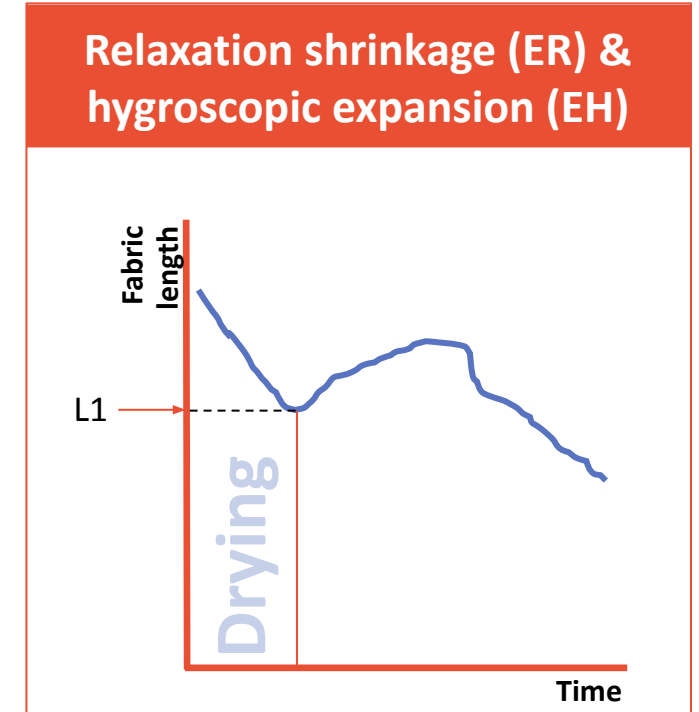
Flexural stiffness

Cantilever length



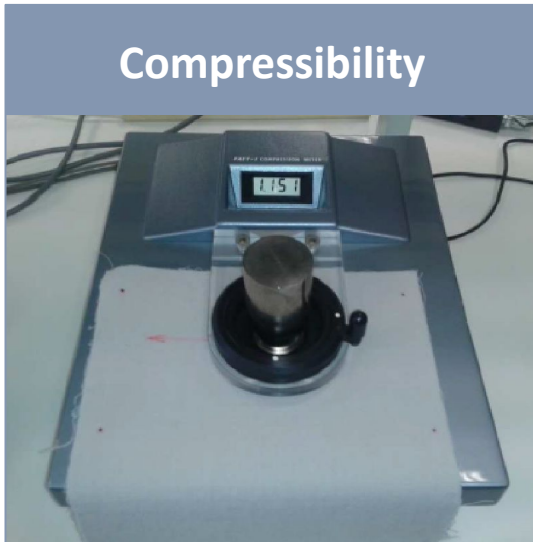
Extensibility

Extension under different weights



Tailorability (FAST)

- Mechanical properties when the fabrics are subjected to small forces
- To predict the resistance of the fabric to overcome industrial clothing operations



Compressibility

Thickness difference at 2 compressive loads



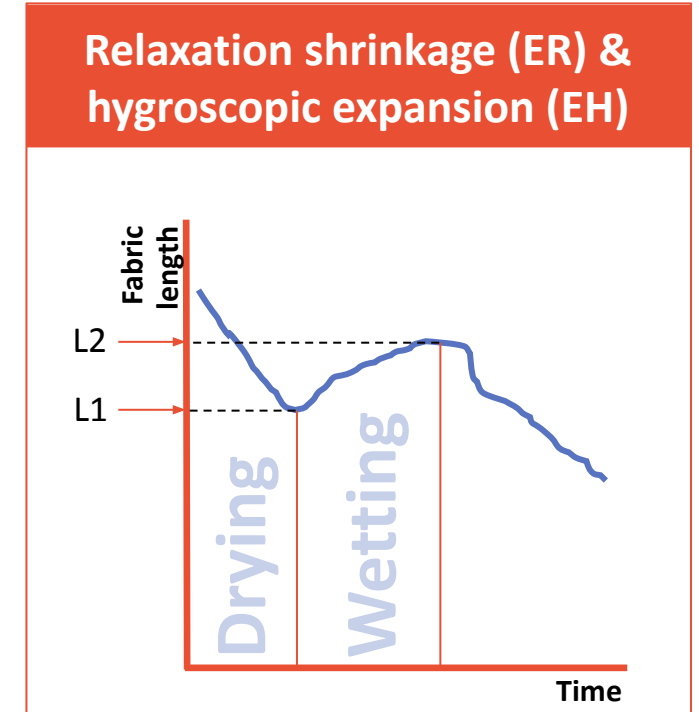
Flexural stiffness

Cantilever length



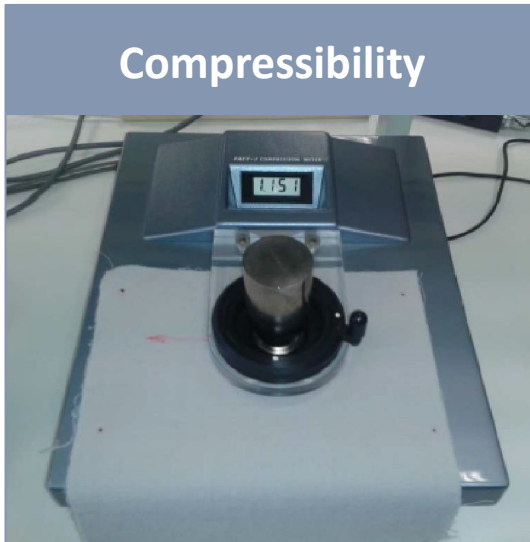
Extensibility

Extension under different weights



Tailorability (FAST)

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Compressibility

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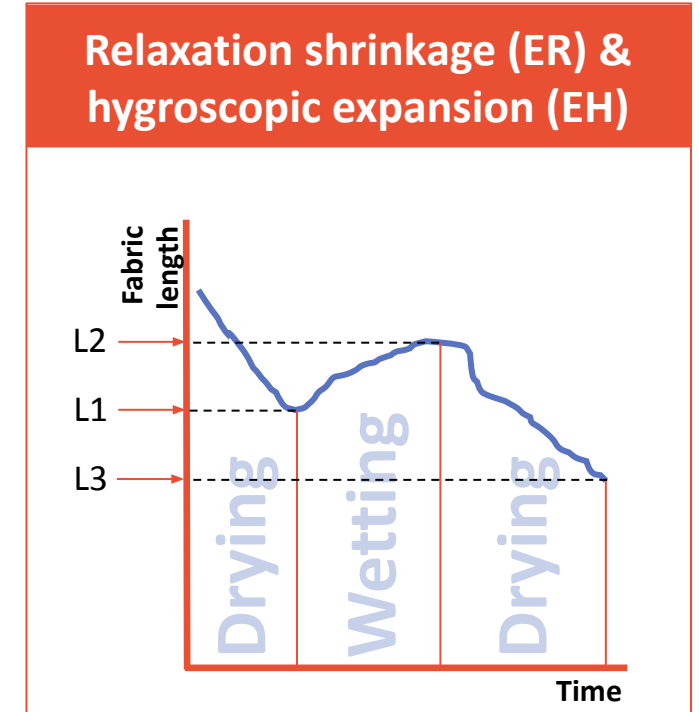
Flexural stiffness

Cantilever length



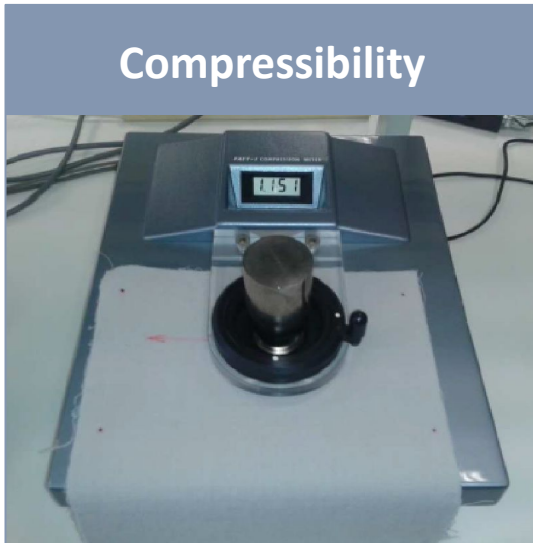
Extensibility

Extension under different weights



Tailorability (FAST)

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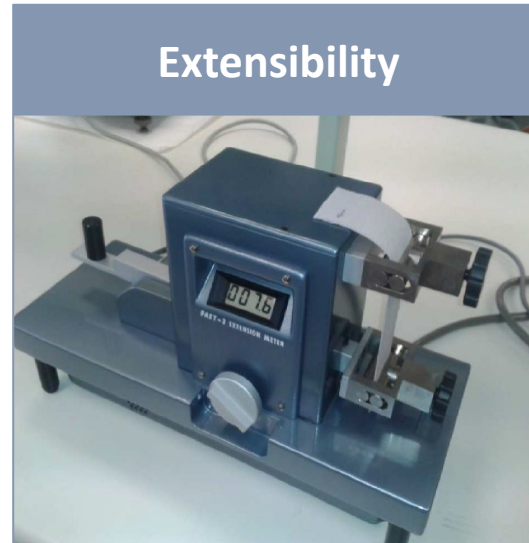
Compressibility

Thickness difference at 2 compressive loads



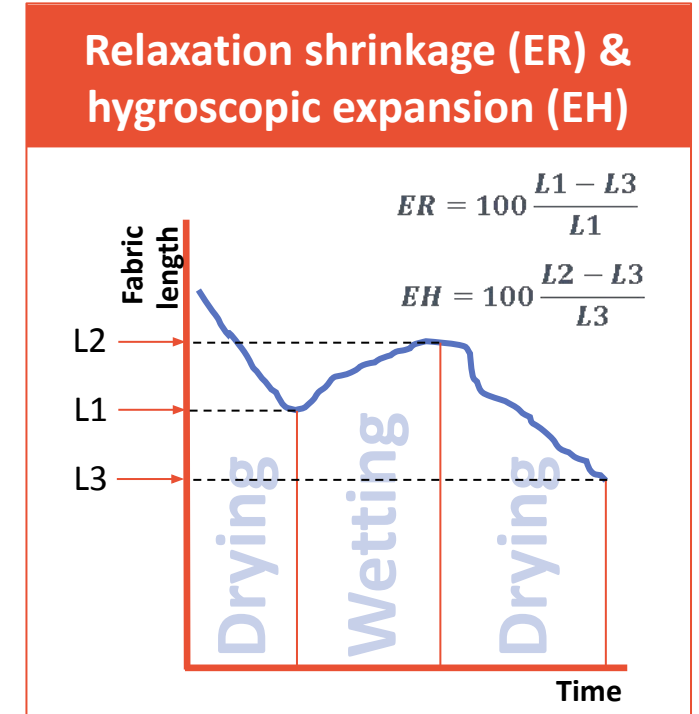
Flexural stiffness

Cantilever length



Extensibility

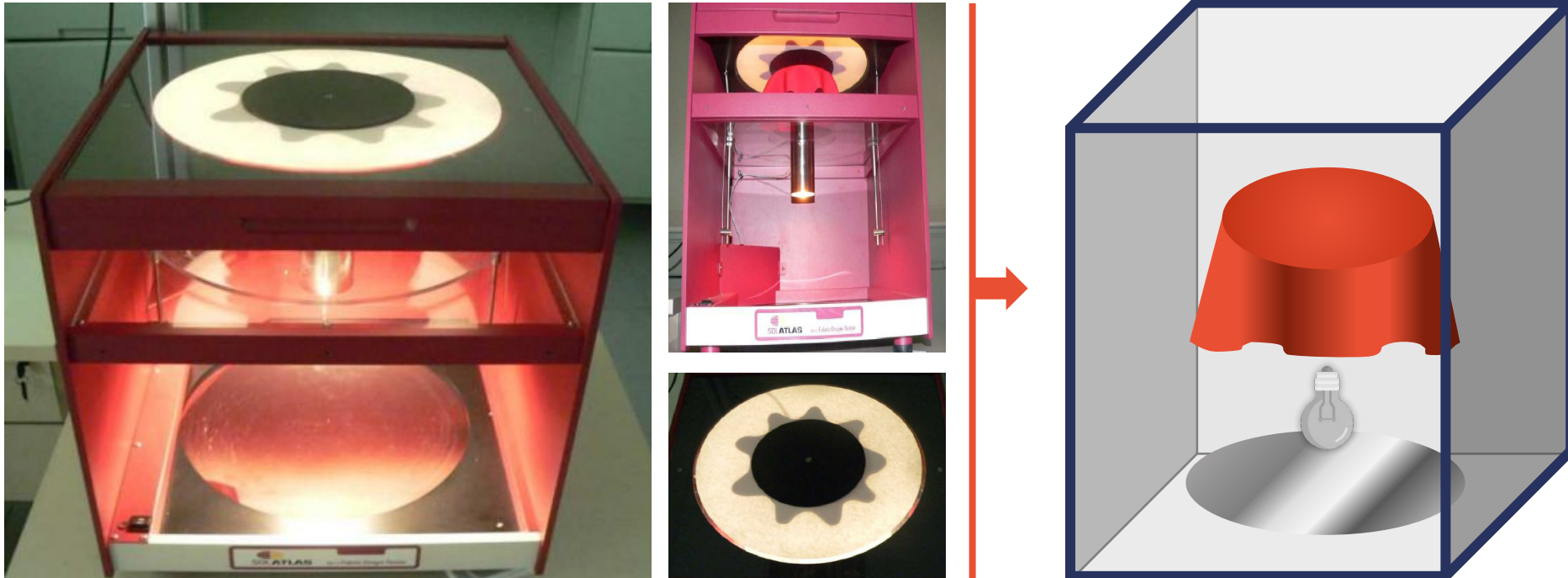
Extension under different weights



DRAPABILITY

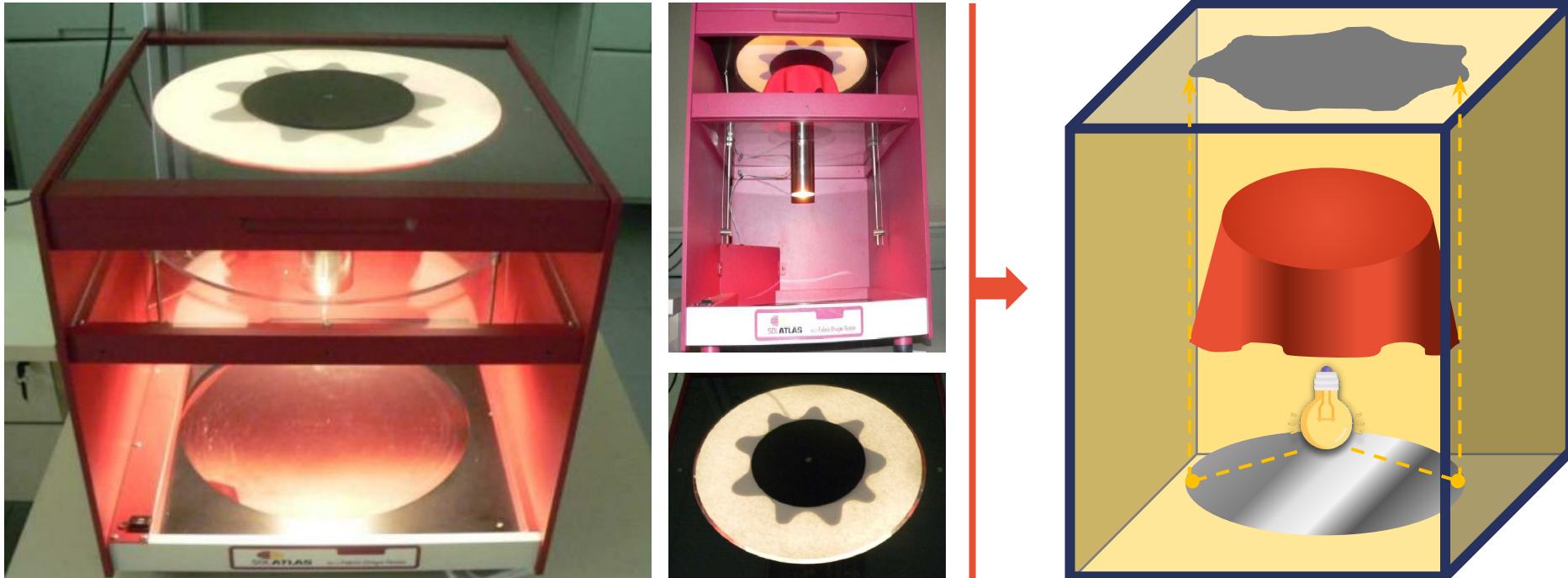
Drapability

Kawavata test (KES-F)



Drapability

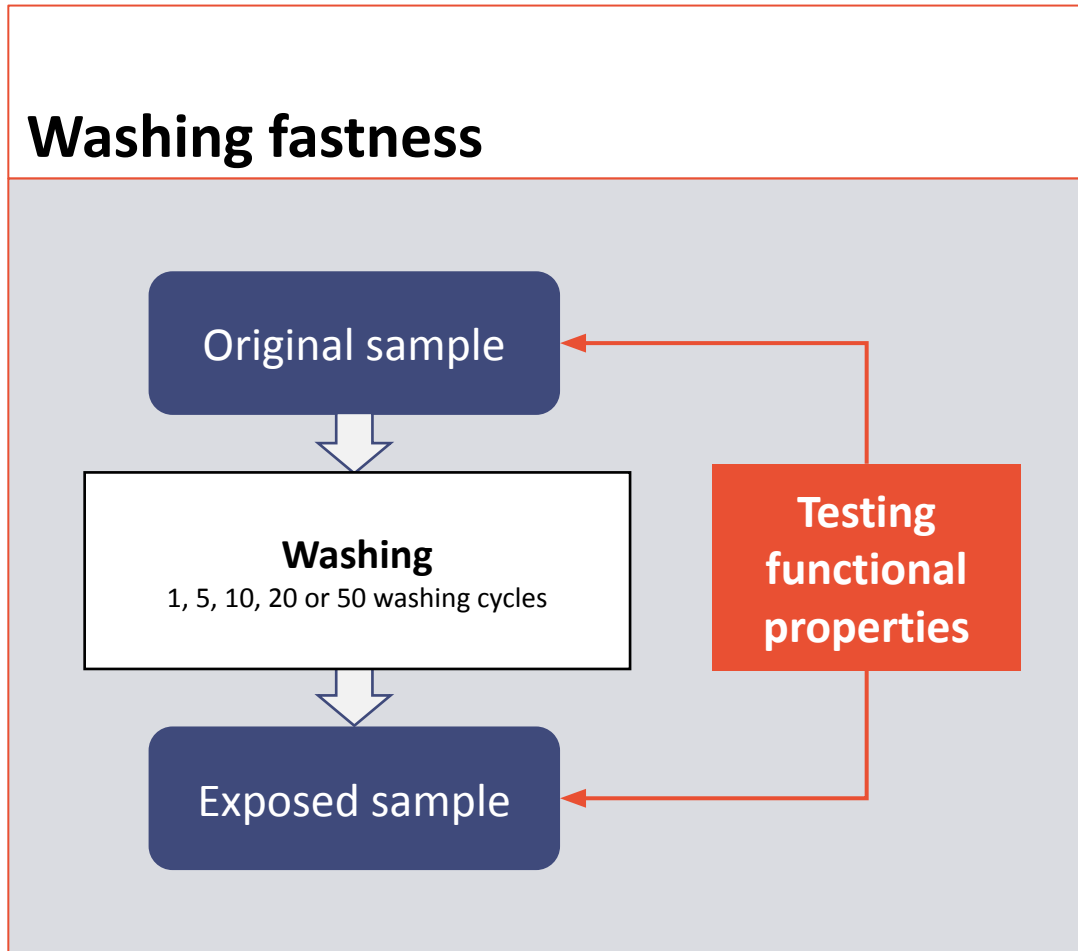
Kawavata test (KES-F)



FASTNESS

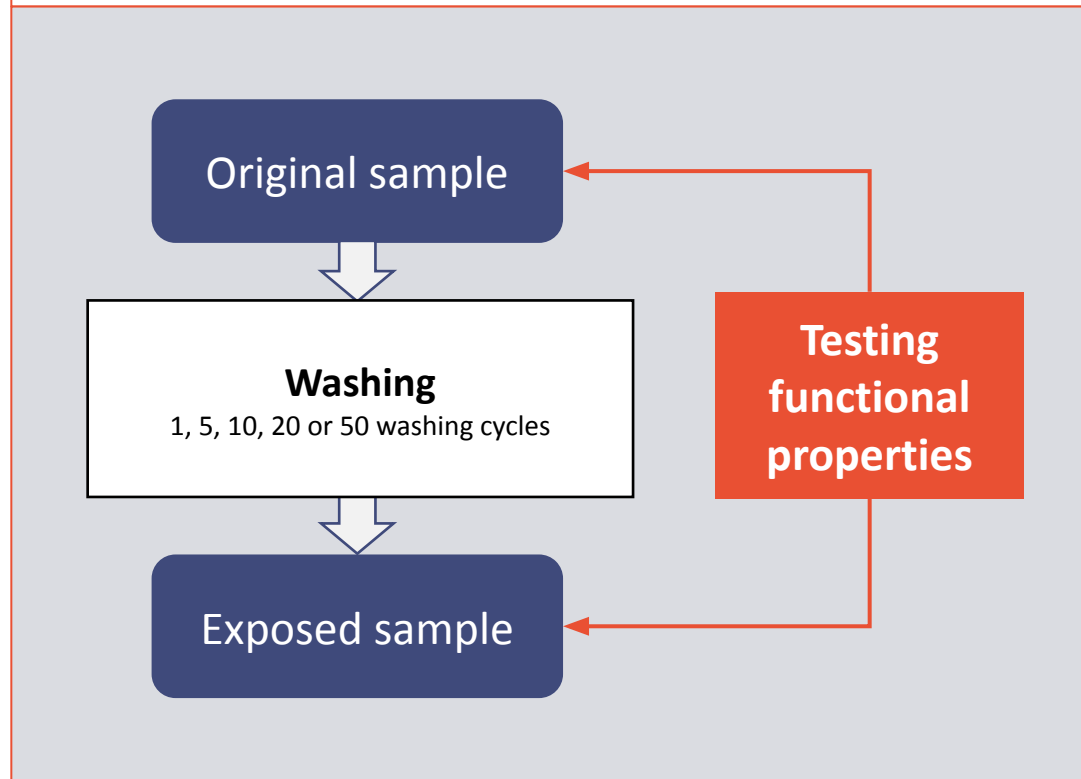
Fastness

Washing fastness

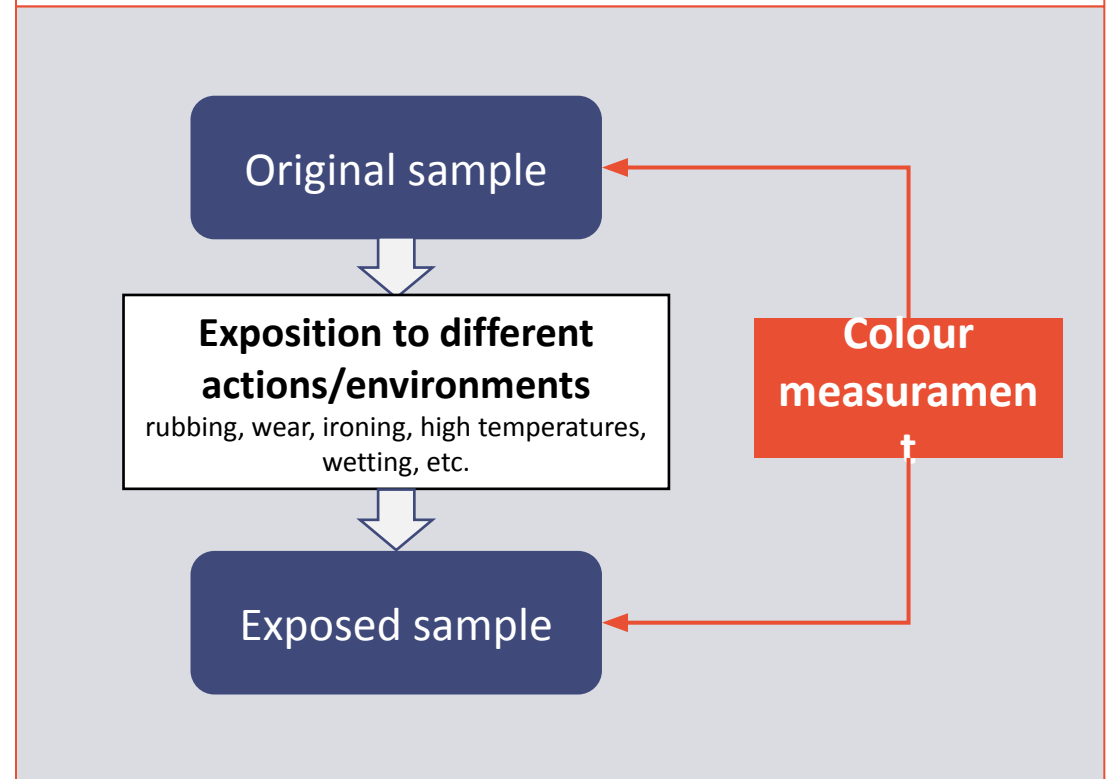


Fastness

Washing fastness



Colour fastness



COMFORT-RELATED PROPERTIES

STIFFNESS & RECOVERY ANGLE



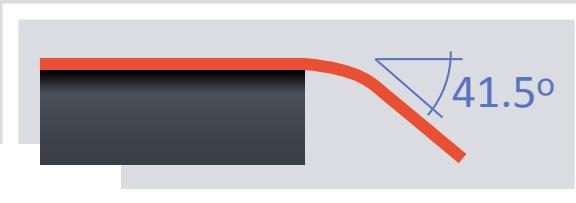
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Stiffness & Recovery angle

Stiffness: Shirley method

- UNE 40392:1979
- ASTM D1388-96R02



Stiffness & Recovery angle

Stiffness: Shirley method

- UNE 40392:1979
- ASTM D1388-96R02



Wrinkle recovery angle

- ISO 2313-1:2021
- ISO 2313-2:2021



WATER VAPOUR RESISTANCE & THERMAL RESISTANCE



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Water vapour resistance & Thermal resistance

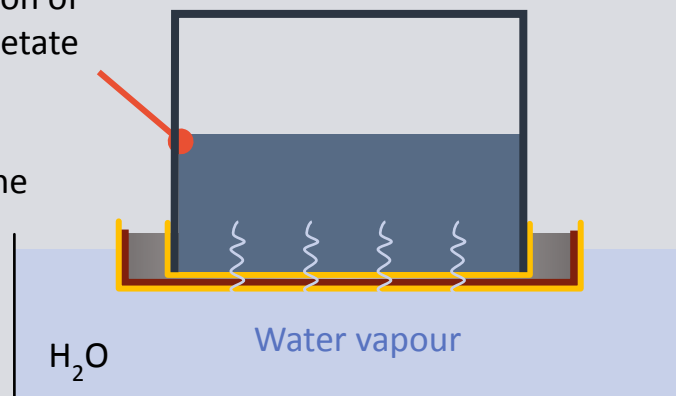
Water vapour resistance

- ISO 15496:2018
- ISO 11092:2014

Saturated solution of potassium acetate

— Fabric

— Membrane



Measurement of weight increase

Water vapour resistance & Thermal resistance

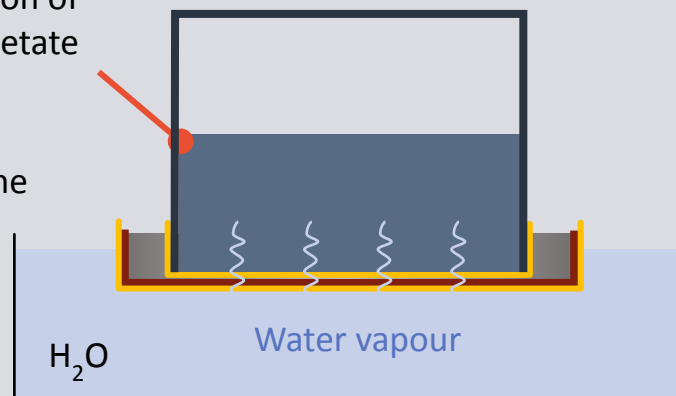
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Measurement of weight increase

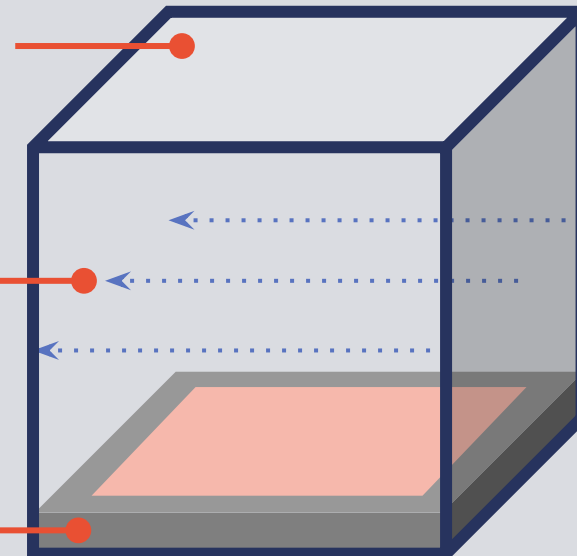
Thermal resistance

- ISO 11092:2014

Controlled atmosphere
at 20 °C, 65% RH

Airflow at 1 m/s

Hot plate at 35 °C



Measurement of heating power

AIR PERMEABILITY & WATER WICKING



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Air permeability & Water wicking

Air permeability

- *Woven Fabrics*
ISO 9237:1995
- *Nonwovens*
ISO 9073-15:2007



Air permeability & Water wicking

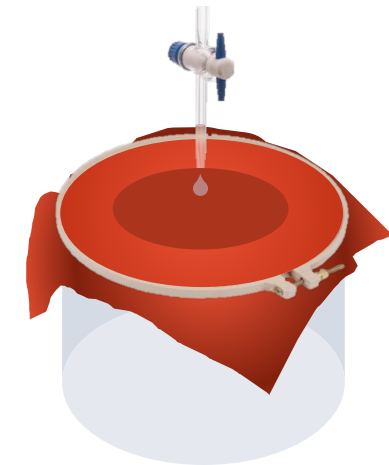
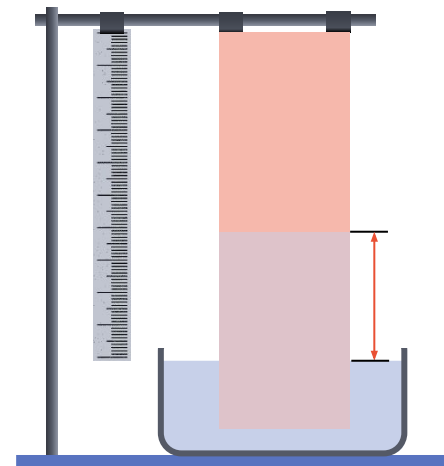
Air permeability

- *Woven Fabrics*
ISO 9237:1995
- *Nonwovens*
ISO 9073-15:2007



Water wicking

- *Vertical wicking test* AATCC 197
- *Horizontal wicking test* AATCC 198



Summary

In this lecture you have revised how to determine the textile properties of smart textiles and the common standards used for testing:

- the **strength-related textile properties** (tensile, tearing, abrasion and pilling tests)
- the **haptic-related properties** (tailorability, drapability and fastness)
- the **comfort-related properties** (stiffness, recovering angle, water vapour resistance, air permeability, thermal resistance and water wicking).

Partners:



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DE CATALUNYA
BARCELONATECH

Project:

Innovative smart textiles & entrepreneurship
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Financial support:



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