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Textiles — Synthetic filament yarns — Electrostatic propensity evaluation by measuring electrical resistance

Textiles — Fils de filaments synthétiques — Évaluation de la propension électrostatique par mesure de la résistance électrique

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 23, *Fibres and yarns.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Textiles — Synthetic filament yarns — Electrostatic propensity evaluation by measuring electrical resistance

1 Scope

This document specifies methods for electrostatic propensity evaluation by measuring electrical resistance of synthetic filament yarns.

It is applicable to synthetic filament yarns. Conductive yarns covered in this document are used for anti-static fabric. They are not used for transmission of electric signals, supply of electric power and electromagnetic shield and heating.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 139, *Textiles — Standard atmospheres for conditioning and testing*

ISO 2060, *Textiles — Yarn from packages — Determination of linear density (mass per unit length) by the skein method*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
electrical resistance per unit length
electrical resistance of a material per unit length

Note 1 to entry: It is expressed in Ω/m.

3.2
volume resistivity
quotient obtained when the potential gradient is divided by the current density

Note 1 to entry: It is expressed in Ω·m.

[SOURCE: ISO 472:2013/Amd.1:2018, 3.17, modified — Note 1 to entry has been deleted]

4 Principle

Resistivity is a physical quantity used to compare the conducting properties of different materials.

Under specific condition, electrical resistance of synthetic filament yarns in certain length is measured. Electrical resistance per unit length and volume resistivity are calculated.

5 Apparatus

5.1 DC high-resistance meter

a) Resistance range: 1×10^{6} Ω to 1×10^{13} Ω.

b) Accuracy: ±5 % for measurements of 1×10^{12} Ω and less, and ±20 % for higher than 1×10^{12} Ω.

c) Open circuit voltage: (100 ± 5) V.

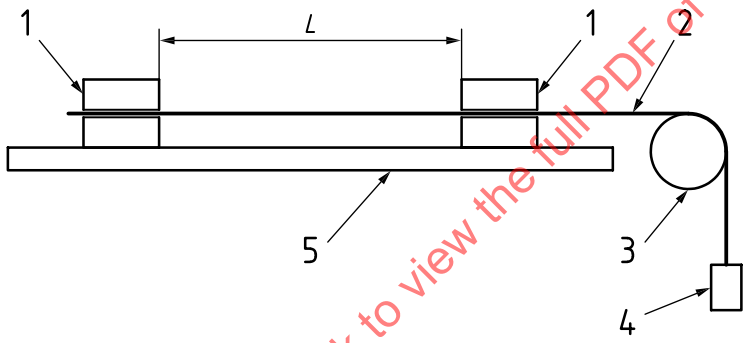
5.2 Insulating specimen holder (see Figure 1)

a) Insulating board, material resistance ≥10^{14} Ω and with a pair of copper clamps in a horizontal spacing of (10 ± 0,1) cm on it.

b) Clamps, with clean and flat jaw faces to hold the test specimen without slippage.

c) A pulley, on the outside of one clamp.

d) Jaw faces of the clamps and upper edge of the pulley are at same horizontal plane.



Key

1 clamps [5.2, b)]
2 specimen
3 pulley [5.2, c)]
4 tensioning weight (5.3)
5 insulating board [5.2, a)]
L spacing between the two clamps [5.2, a)], expressed in cm.

Figure 1 — Schematic diagram of insulating specimen holder

5.3 Tensioning weight

With clamps, to apply tension force to test specimens.

6 Atmosphere for conditioning and testing

The atmosphere shall be a temperature of (20 ± 2) °C and a relative humidity of (40 ± 4) %. If a different temperature or humidity is used, record it in the test report.

NOTE The measurements of temperature and humidity are specified in ISO 139.

7 Preparation of test specimens

7.1 Preparation of specimens

Discard yarn on the outer layer of a package (about 1 g) and cut yarn to a length of 400 mm to 500 mm as the first test specimen.

Discard more yarn, about 3 m to 5 m, before cutting the next test specimen from the same package.

The minimum number of test specimens shall be 3 from each package.

If the resistance non-uniformity test is required, the total amount of test specimens is not less than 30.

7.2 Conditoning

7.2.1 Pre-conditioning

Before conditioning, pre-conditioning is required. Pre-conditioning shall be carried out in accordance with ISO 139.

7.2.2 Conditioning

Condition the specimens in atmosphere (see Clause 6) for at least 2 h until equilibrium is attained.

8 Test procedure

8.1 Tension for the test specimen

8.1.1 Tension per unit linear density is intended to be:

— non-texture yarns: (0,05 ± 0,01) cN/dtex;

— textured yarns: (0,20 ± 0,04) cN/dtex.

8.1.2 Calculate the tension according to Formula (1):

$$F = P \times T \tag{1}$$

where

F is the tension, expressed in cN;

P is the tension per unit linear density (see 8.1.1), expressed in cN/dtex;

T is the linear density of the test specimen (specified in ISO 2060), expressed in dtex.

8.2 Test specimen loading

8.2.1 Place one end of the test specimen in the middle of the clamp nonadjacent to the pulley and close the clamp.

8.2.2 Place the other end in the middle of another clamp and lead the test specimen passing through the pulley.

Add sufficient weight (see 8.1) on the end of the test specimen.

Be sure to keep the test specimen straight and close the clamp.

8.3 Determination of electrical resistance

8.3.1 Attach the measuring electrodes of the DC high-resistance meter to the two copper clamps, regardless of position.

The voltage switch is placed at 100 V.

If under non-specified voltage, it shall be indicated in the report.

8.3.2 Energize the resistance meter and read the value of electric resistance after 1 min.

8.3.3 Break off the voltage switch. Contact two clamps and ground, to enable electrostatic dissipation on the clamps.

8.3.4 Remove the test specimen from the clamps. Repeat measuring other test specimens.

9 Calculation and expression of results

9.1 Resistance per unit length

Calculate electrical resistance per unit length according to Formula (2).

$$R_L = \frac{R}{L} \times 10^2 \tag{2}$$

where

R_L is the resistance per unit length, expressed in Ω/m;

R is the resistance of test specimen between the two clamps, expressed in Ω;

L is the spacing between the two clamps, expressed in cm.

9.2 Volume resistivity

Calculate volume resistivity according to Formula (3).

$$S_V = \frac{R \times T}{L \times \rho} \times 10^{-8} \tag{3}$$

where

S_V is the the volume resistivity, expressed in Ω·m;

R is the resistance of test specimen between the two clamps, expressed in Ω;

T is the linear density of sample (specified in ISO 2060), expressed in dtex;

L is the spacing between the two clamps, expressed in cm;

ρ is the density of fibre (see Annex A), expressed in g/cm^3.

9.3 Expression of results

The result is expressed as arithmetic mean value or geometric mean value of all the test specimens.

The mean value is recorded in scientific notation $a \times 10^n$, in which a value is 1,0 to less than 10 and accurate to the first decimal place.

Usually, the average is calculated by arithmetic mean value.

The arithmetic mean value is calculated according to Formula (4).

$$\overline{X} = \sum_{i=1}^{n} x_i / n \tag{4}$$

where

$\overline{X}$ is the arithmetic mean value of each test items;

x_i is the value of each test items;

n is the number of tests.

When the test value changes in order of magnitude, the geometric mean value is selected.

The geometric mean value is calculated according to Formula (5).

$$\overline{X} = (\prod_{i=1}^{n} x_i)^{1/n} \tag{5}$$

where

$\overline{X}$ is the geometric mean value of each test items;

x_i is the value of each test items;

n is the number of tests.

9.4 Precision

See Annex B.

10 Test report

The test report shall include at least the following information:

a) the International Standard used (including its year of publication);

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

c) test conditions;

d) test results;

e) any deviation, by agreement or otherwise, from the procedure specified;

f) any unusual features observed;

g) the date of the test;

h) any information needs to be indicated.

Annex A
(informative)

Average density of common synthetic fibres

A.1 Description

The density of the fibre is determined by a density gradient column method (ISO 1183-2). The temperature of liquid bath is (25 ± 0,5) °C.

A.2 Average density

The average density of common synthetic fibres are recommend as listed in Table A.1.

Table A.1 — Average density of common synthetic fibres

Type of the fibres	Density value (g/cm^3)	Type of the fibres	Density value (g/cm^3)
polyester PET	1,38	polyethylene	0,96
acrylic	1,18	polypropylene	0,91
modacrylic	1,28	phenolic	1,31
para-aramid	1,46	polysulfonamide	1,37
polyamide	1,14	polyvinyl chloride	1,38
vinylal	1,24	casein modified polyacrylonitrile	1,26
polyvinylidene chloride	1,70	polylactide	1,27
elastane	1,23	—	—

Annex B
(informative)

Precision experiments

B.1 Description

Ten laboratories participated in the experiment, providing test results for six materials and each one repeated twice. Results are analysed according to ISO 5725-2.

B.2 Repeatability

Following the normal and the right operation method specified in this document, one operator, using the same apparatus, tests identical specimens in an appropriate short time and calculates the difference of any two mean values.

Determine 20 cases and only once is above the repeatability listed in Table B.1.

B.3 Reproducibility

Following the normal and the right operation method specified in this document, operators in two laboratories, using different apparatus, tests identical specimens and calculates the difference of any two mean values.

Determine 20 cases and only once is above the reproducibility listed in Table B.1.

Table B.1 — Precision of test results in six materials

Sample	Specifications	Electrical resistance per unit length (Ω/m)		Volume resistivity (Ω·m)	
		repeatability r	reproducibility R	repeatability r	reproducibility R
conductive Polyester filament yarns	22dtex/3f	$1{,}2\times10^{11}$	$4{,}0\times10^{11}$	$1{,}9\times10^{2}$	$6{,}4\times10^{2}$
conductive Polyester filament yarns	55.5dtex/8f	$3{,}4\times10^{8}$	$2{,}7\times10^{9}$	$1{,}4\times10^{0}$	$1{,}1\times10^{1}$
conductive Polyamide 6 filament yarns	22dtex/1f	$2{,}1\times10^{10}$	$7{,}8\times10^{10}$	$4{,}1\times10^{1}$	$1{,}5\times10^{2}$
conductive Polyamide 6 filament yarns	22dtex/3f	$6{,}2\times10^{9}$	$2{,}0\times10^{10}$	$1{,}2\times10^{1}$	$3{,}9\times10^{1}$
Polyester industrial filament yarns	1 100dtex/192f	$4{,}4\times10^{14}$	$3{,}6\times10^{15}$	$3{,}5\times10^{7}$	$2{,}9\times10^{8}$
Polyamide 66 industrial filament yarns	1 400dtex/208f	$9{,}0\times10^{13}$	$6{,}7\times10^{14}$	$1{,}1\times10^{8}$	$8{,}2\times10^{8}$

B.4 Mean value

Test two specimens and calculate arithmetic mean values. When the test value changes in order of magnitude, the geometric mean value is selected.