INTERNATIONAL STANDARD

ISO 21061

First edition
2021-11

Footwear — Chemical tests — General principles on the preparation of samples

Chaussures — Essais chimiques — Principes généraux relatifs à la préparation des échantillons

Reference number
ISO 21061:2021(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 216, *Footwear,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 309, *Footwear,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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.

Introduction

With the development of society and the improvement of people's living standards, the chemical safety of footwear has widely gained attention. As more critical substance in footwear and footwear components are needed, many chemical test methods for critical substances have been developed.

However, there lacks a unified sample preparation method for chemical tests. Due to the complex materials and structures used in footwear and the different ways in which critical substances exist, the sample taken from footwear is often not sufficiently homogeneous to give a representative test specimen. It is thus very difficult to develop a single technique of sampling that can be used in all circumstances. However, if every material in an article of footwear were tested, it would be a large amount of work and yield a large test fee. As an example, see Table 1, a common article of footwear can cut into over 10 kinds of test specimen when carrying out tests for one chemical. So, a sampling method is needed urgently to provide general rules for preparation of samples, which can reduce and even prevent the inconsistency of sampling procedures between different laboratories and which can provide a guarantee for the stability of test results.

Footwear — Chemical tests — General principles on the preparation of samples

1 Scope

This document specifies a range of procedures for the sample preparation of footwear and footwear components to carry out chemical tests. It further specifies how to designate the samples.

The sampling procedures specified are designed to allow concurrent chemical testing for footwear

This document is applicable to all types of footwear and footwear components.

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 4044, *Leather — Chemical tests — Preparation of chemical test samples*

ISO 19952, *Footwear — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 19952 and the following 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
component in contact with the skin
component closely in contact with foot or leg skin during wearing

Note 1 to entry: Foot (leg) skin hose includes sock, stocking, tights, etc.

Note 2 to entry: If a footwear has no lining, the inside of upper should be taken as lining and regarded as component in contact with the skin.

EXAMPLE Linings, tongues, insoles and insocks are components in contact with the skin.

3.2
accessory
indispensable visible component that has a technical function in the footwear construction

EXAMPLE Fasteners, zipper, laces.

3.3
decorative attachment
component with no functional property and usually designed for aesthetic purpose

Note 1 to entry: See Figure 1.

Figure 1 — Example of decorative attachment

3.4
accessible component
component that could be directly reached or touched without dismantling or destroying any permanent joining of the footwear

3.5
inaccessible component
component hidden inside the footwear that cannot be reached or touched without dismantling or destroying any permanent joining of the footwear

EXAMPLE Foam, shank, toe puff, stiffener, etc.

3.6
combined material
composite material
material constituted of a combination of several different raw materials which cannot be separated mechanically

EXAMPLE Coated textile/leather (a textile/leather covered by a polymer film), complex upper (upper and lining are fully stuck by glue or other techniques and it is impossible to separate them), rubber boot upper (the sock is fully dissolved in rubber), soling material (in injected sole footwear the insole can be fully dissolved in the sole), foam with adhesive or foam with residues of adhesive, etc.

3.7
composite test sample
mixture of several different test samples of the footwear from the same material classification

3.8
sample
raw, semi-worked, worked, semi-manufactured, manufactured, semi-made-up or made-up product

4 Designation system

4.1 General

For each sample, the following parameters shall be specified:

— component parts;

— colours;

— material classifications;

— any other useful information.

Table 1 gives examples of sample designation.

4.2 Component part designation

Figure 2 defines the different components of the footwear. Figure 2 shall be used to identify the components present in the tested footwear (see ISO 19952 for definitions to components listed).

If needed, position terms can be used to further specify the designation of the part. Figures 3 and 4 can be used as reference.

There are four main positions viewing from above: front, back, lateral and medial. For parts in between, there are four more sub-positions (see Figure 3). There are two main positions viewing form lateral: top and lower. For parts in between, there are 4 more sub-positions (see Figure 4).

If the decorative attachments cover more than 50 % of the upper area, as shown in Figure 1, consider the decorative attachment as an upper.

4.3 Colour designation

The colour of test samples shall be determined according to the colour designation given in Annex A.

4.4 Material classification designation

Specify the material classification of each test sample. The material classification of each test sample shall be in accordance with Annex C. For example, leather and fur, textile, polymer (including synthetic materials, plastic etc.), rubber, foam, wood, metal and fibrous board, etc.

In certain cases, it is difficult for laboratories to easily identify the material of the component, for example:

— Rubber, PU, plastic, foam should be termed as polymers.

— Natural and synthetic fibres should be termed as textiles.

NOTE The material classification can be completed by additional information:

— Leather can be further classified into bovine, sheep, goat, coated bovine, bovine suede, split bovine, etc.

— Textile can be further classified into cotton, silk, polyamide, polyester, fibre blending, etc.

4.5 Useful information designation

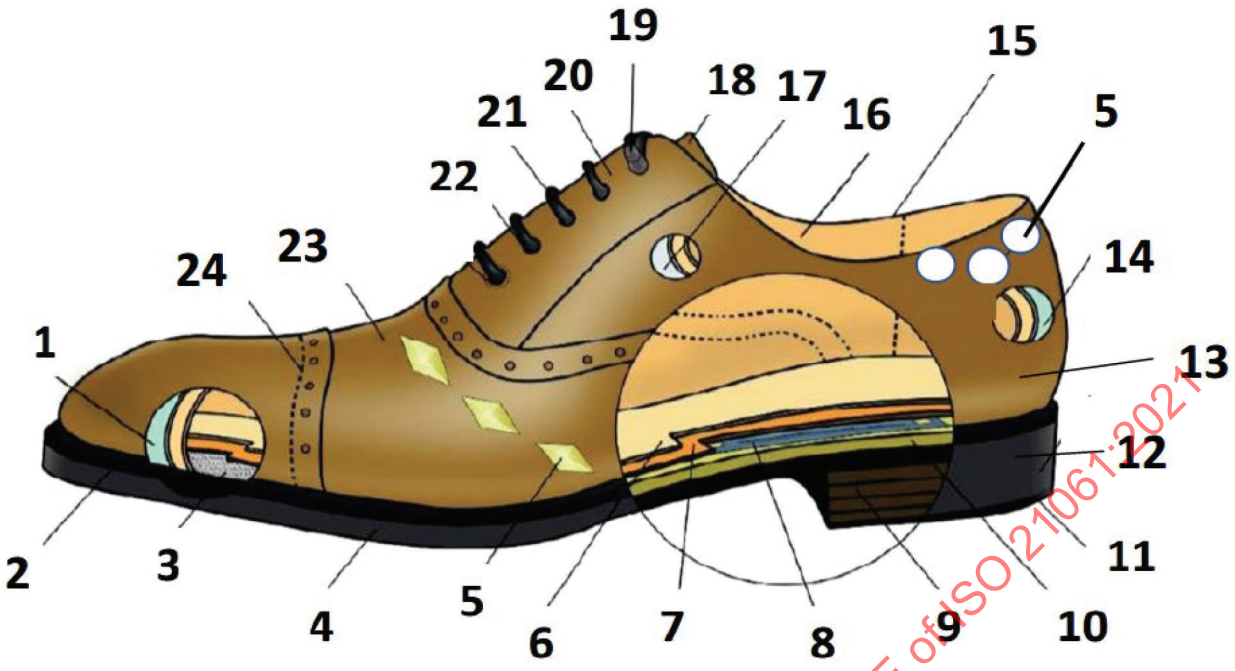
For test samples, the information below shall be specified:

— component in contact with the skin or component not in contact with the skin;

— accessory;

— if the component is covered by glue(s);

— accessible component or inaccessible component.



Key

1	toe puff	9	heel lift	17	interlining
2	welt	10	midsole	18	tongue
3	bottom filling	11	top piece	19	lace hook
4	outsole	12	heel	20	facer
5	decorative attachment	13	quarter	21	lace
6	insock	14	stiffener	22	eyelet
7	insole	15	collar	23	vamp
8	shank	16	lining	24	seam

Figure 2 — Components of footwear

Table 1 — Example of sample designation

Test samples	Component part	Colour	Material classification	Useful information
1	Vamp (upper)	Black	Coated leather	
2	Quarter (upper)	Black	Polyurethane (PU) coated textile	Polyvinyl chloride (PVC) pre-test: negative
3	Counter (upper)	Dark grey	PU coated textile	PVC pre-test: negative
4	Quarter (lining)	Light orange	Natural textile	component in contact with the skin
5	Counter (lining)	Light orange	Natural textile	component in contact with the skin
6	Counter (lining)	Light brown	Synthetic textile [b]	component in contact with the skin
7	Toe puff	Dark yellow	Polymer [a]	
8	Stiffener	Light grey	Polymer [a]	
9	Vamp (lining)	Brown	Leather	component in contact with the skin
10	Insock	Brown	Leather	component in contact with the skin
11	Back lower cushion	Grey	Foam	PVC pre-test: negative
12	Insole	Brown	combined material	
13	Shank	Light grey	Metal	Steel
14	Wedge	Dark grey	Cellulosic material	Paper board
15	Midsole	Grey	PU	PVC pre-test: negative
16	Heel	Light grey	PU	PVC pre-test: negative
17	Top piece	Black	Rubber	
18	Outsole	Black	Rubber	
19	Facer	White	Textile [c]	
20	Decorative attachment, front lateral	Light yellow	Metal	Brass
21	Decorative attachment, back	Light yellow	Metal	through rivet Stainless steel

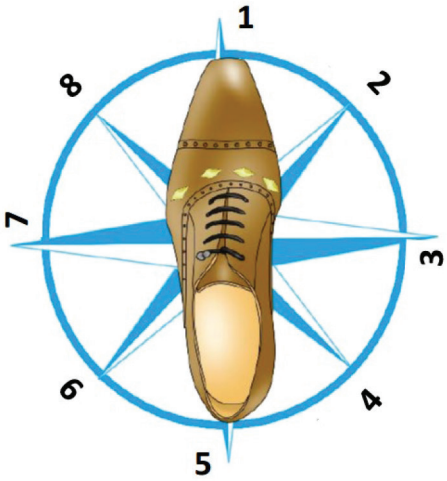
It is possible that a component is constituted of several materials.

In certain cases, it is impossible to specify clearly the material classification. Therefore, a generic term may be used:

[a] Covers all types of polymers excluding synthetic textiles, foams and rubber.

[b] All textiles excluding all natural base fibre.

[c] Covers all types of textile material.



Key

1	front	5	back
2	front medial	6	back lateral
3	medial	7	lateral
4	back medial	8	front lateral

Figure 3 — Positional designation of footwear - Positions from above

Key

1	top	5	bottom
2	back top	6	front bottom
3	back	7	front
4	back bottom	8	front top

Figure 4 — Positional designation of footwear - Positions from lateral

5 Preparation of samples

5.1 General

The preparation of samples shall be in accordance with the generic flowchart for preparing samples in Figure B.1.

5.2 Photo and identification of material classification

Photos should be taken before disassembling the footwear for sample identification purpose.

When necessary, the footwear should be documented with 4 photos: 1 from above, 1 from each side and 1 from underneath.

Using the document of the footwear manufacturer or visually, all different materials of the footwear which are required to be tested, shall be identified and assigned a material classification (see Annex C).

If possible at this stage, for each material classification, list all the different raw materials (for example, Table 1 can be used).

5.3 Disassembling of footwear

Dismantle the footwear and separate all the materials required for chemical testing and register them, for example completing Table 1.

Each test sample shall be separated as cleanly as possible in order to avoid any chemical contamination that could affect the final result.

If the laboratory does not or cannot remove the adhesives from the materials, it shall be specified in the Table 1 (column "useful information").

5.4 Testing schedule

Taking into account the list of test samples, the customer restricted substances list (RSL) (or ISO/TR 16178) and the customer order, the testing schedule is created. An example of the testing schedule is given in Table 2, for all materials identified in Table 1.

Taking into account all the test methods to be performed, the necessary quantity for each test sample is determined.

Composite test samples may be tested if it is not forbidden by the test method.

NOTE The constitution of a composite test sample is a technical decision depending on the performance of the laboratory (limit of quantification, uncertainty of measurement). The results obtained from the composite test samples will permit a decision on the conformity of each single test sample of the composite test sample.

Table 2 — Example of sample for testing schedule

Chemical tests	Test samples	Test methods
Phenol	1, (2+3), (4+5), 6, (7+8), 9, 10, 11, 12, 14, (15+16), (17+18), 19	ISO 20536
Polycyclic aromatic hydrocarbons (PAH)	1, (2+3), (4+5), 6, (7+8), 9, 10, 11, 12, (15+16), (17+18), 19	ISO 16190
Dimethylformamide	1, (2+3), (15+16)	ISO 16189
Dimethyl fumarate (DMFU)	1, (2+3), (4+5), 6, (7+8), 9, 10, 11, 12, 14, (15+16), (17+18), 19	ISO 16186
Phthalates	1, (2+3), (4+5), 6, 9, 10, 19	ISO 16181
Organotin compounds	1, (2+3), (4+5), 6, 9, 10, 19	ISO/TS 16179
Nickel	21	EN 1811

5.5 Sampling

The sampling procedure is applied as is specified in each test standard. For example, for leather material, ISO 4044 shall apply.

All test samples shall be taken from the same footwear.

If the amount of test samples is insufficient to perform all the required tests, then samples from further available footwear of the same model and production batch shall be taken. If the amount of test samples is still insufficient additional samples shall be requested.

If additional samples are not available, a choice shall be made to give a priority to the most critical substances (carcinogenic, mutagenic, toxic for reproduction). The customer and the laboratory shall agree on this list.

If the same material is used in several components of the footwear, the sample for test shall be representative proportionally of all the component.

5.6 Storage and conditioning

The samples shall be stored at room temperature in a clean, dry condition and protected from contamination.

If the test method requires storage under specific conditions they shall be applied and the tests shall be conducted in accordance to the specific requirements of the applicable standard.

Annex A
(normative)

Colour designation

A.1 Colour

The property of a colour by which it can be perceived, such as blue, red, green, etc. determined by the dominant wavelength of the light.

If an inseparable sample has more than one colour, designate it 'multicolour'.

A.2 Brightness

Adding white or black to a colour makes it lighter or darker.

If the samples colour is lighter designate it with 'light', if it is darker with 'dark'.

A.3 Designation model

The colour of a sample is determined by choosing the closest fitting colour from the colour swatches (see Table A.1, which is not exhaustive, other colours are possible, such as gold, silver, bronze, etc.).

Designation Model: (Brightness) + Basic Colour.

If the colour of the sample is closer to the basic colour than to the lighter or darker colour, designate the colour with the basic colour name only.

EXAMPLE Light magenta — magenta — dark magenta.

Table A.1 — Colour swatches

Colour	Swatches	Colour	Swatches	Colour	Swatches
Magenta		Yellow		Blue	
Red		Lime		Purple	
Orange		Green		Grey	
Brown		Cyan		Black and White	

Annex B
(normative)

Procedure for preparation of samples

The procedure for preparing samples shall be in accordance with Figure B.1.

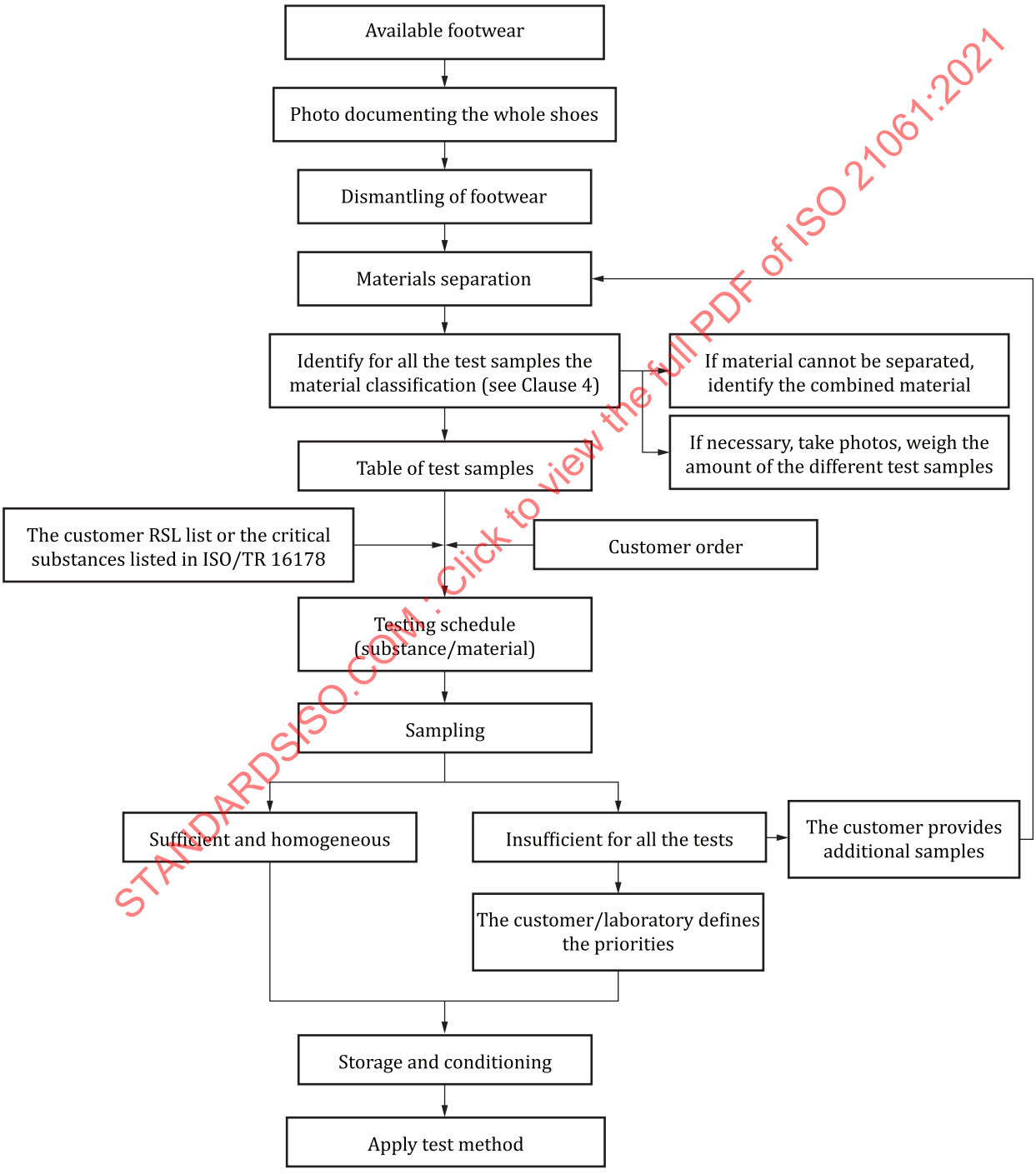


Figure B.1 — Generic flowchart for preparing samples

Annex C
(normative)

Materials used in the footwear industry

C.1 Leather

Leather is a general term for hide or skin with its original fibrous structure more or less intact, tanned to be rotproof. The hair or wool might or might not have been removed. Leather is also made from a hide or skin that has been split into layers, or segmented, either before or after tanning. However, if the tanned hide or skin is disintegrated mechanically and/or chemically into fibrous particles, small pieces or powders and then, with or without the combination of a binding agent, is made into sheets or other forms, such sheets or forms are not leather. If the leather has a surface coating, whatever is applied, or a glued on finish, such surface coating layers should not be thicker than 0,15 mm.

C.2 Coated leather

Leather where the surface coating applied to the leather does not exceed one third of the total thickness of the product, but is in excess of 0,15 mm.

C.3 Leather fibre board

Term for materials where tanned hides or skins are disintegrated, mechanically and/or chemically, into fibrous particles, small pieces or powders and then, are made into sheets or other forms, with or without the combination of a binding agent. A minimum amount of 50 % in weigh of dry leather is necessary to use the term leather fibre board.

C.4 PVC

Polymer constituted of polymerised vinyl chloride. In footwear material, PVC is used with plasticizer in order to create flexibility. It can also be used as polymeric coating in a coated fabric or patent leather.

C.5 EVA foam

Polymer composed of ethylene vinyl acetate; it can be expanded to foam. It is used as a lightweight midsole in some trainers and as an outsole in some summer sandals where resistance to abrasion is not required.

C.6 Rubber, synthetic rubber, rubber foam

Rubbers are polymers based on either synthetic or natural materials that are cross-linked to give required physical performance properties and chemical resistance. Extensively used as outersoles in many styles of footwear (see ISO 1382).

C.7 Thermoplastic polyurethanes (TPU)

Thermoplastic polyurethanes are compounds formed from the condensation of isocyanates and polyols and can be remoulded on the application of heat. They can be in moulded in the compact or cellular forms.

C.8 Thermoplastic elastomers or thermoplastic rubbers (TPE-TPR)

Thermoplastic elastomers or thermoplastic rubbers (not vulcanized) (TPE or TPR) combine the processability of plastics with the flexibility and durability of rubbers, while more light weight and formable. These properties provide favourable conditions for the production of thermoplastic materials, due to a structure consisting of block copolymers that combine elastic chain segments with rubbery properties, and very rigid segments (at room temperature). They play the same role as the sulphur bonds formed during vulcanisation process, i.e. to prevent the chain displacement against stress. However, due to the absence of a cross-linked structure, cohesion is lost when exceeding the glass transition temperature and the hot material can flow and is suitable for injection moulding.

C.9 Latex

Rubber latex is a water-based colloidal solution that includes spherical rubber particles with a diameter smaller than 1 µm, dispersed in an aqueous continuous phase and relatively stable. Due to its hydrophobic nature, it is non-miscible with water, and the suspension is stabilized due to the fact that every rubber particle is coated with a layer of natural or synthetic emulsifiers (see ISO 1382).

In footwear, latex is mainly used as foam or in glues.

C.10 Blown material, foam

Synthetic expanded polymer with a closed-cell or open-cell structure, which can be flexible or rigid, used for a variety of products.

C.11 Composite materials

Composites, also known as composite materials or reinforced plastics, consist of a polymeric matrix or continuous phase and a discrete phase, made up of one or more loads or reinforcements in the form of mineral and/or synthetic fibres. As a result, a structural material is obtained, whose mechanical properties are, at least, higher than the values obtained from the lineal combination of the individual properties of both constituents. For instance, carbon or glass fibres are commonly used as reinforcing materials.

C.12 Polyurethane (PU)

The polyurethane includes those polymers with urethane groups in the molecular backbone, regardless of the chemical composition of the rest of the chain. Urethane groups (see Figure C.1) are produced through a chemical reaction between a diisocyanate and a polyol. Thus, typical polyurethane can contain, in addition to the urethane linkages, aliphatic and aromatic hydrocarbons, esters, ethers, amides, urea and isocyanates groups. A wide range of properties can be obtained depending on chemical composition used: thermoplastic, thermoset, rigid or flexible, cellular or compact polyurethanes, etc. Polyurethanes are used as structural materials, coatings, adhesives and sealants.

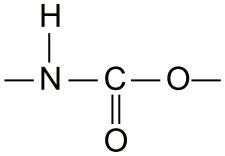


Figure C.1 — Urethane groups

C.13 Textile

Originally used to describe a woven and knitted fabric the term now is applied to fibres, filaments, or yarns, natural or man-made, and products obtained from them.

NOTE For example, threads, cords, ropes, braids, lace, embroidery, nets and fabrics made by weaving, knitting, felting, bonding, and tufting are textiles.

C.14 Polyester fibre

Polymer with ester bonds in its main string (see Figure C.2). The definition of polyester includes the big family of synthetic polymer, with the most used polycarbonate and most of all poly(ethylene terephthalate) (PET).

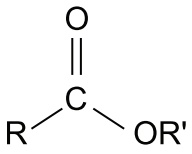


Figure C.2 — Ester bond

Fibres composed of synthetic linear macromolecules having in the chain at least 85 % (by mass) of an ester of a diol and benzene — 1,4 — dicarboxylic acid (terephthalic acid).

C.15 Polyamides

A synthetic linear polymer in which the linkage of the simple chemical compound or compounds used in its production takes place through the formation of amide groups, e.g.

$[— R — CO — NH — R — CO — NH —]_n$, or

$[— R_1 — NH — CO — R_2 — CO — NH —]_n$,

Where R, R_1, and R_2 are generally, but not necessarily, linear divalent hydrocarbon chains $(— CH_2 —)_m$.

Polyamides are distinguished from one another by quoting the number of carbon atoms in the repeating unit, or units for polyamides made from two reactants. In the latter case, the number of carbon atoms in the diamine is given first, this being followed by the number in the dicarboxylic acid, e.g.

— hexanolactam (E – caprolactam)

$[— NH — (CH_2)_5 — CO —]_n$ (Nylon 6)

— 1,6 – diaminohexane + hexanedioic acid (adipic acid)

$[— NH — (CH_2)_6 — NH — CO — (CH_2)_4 — CO —]_n$ (Nylon 6:6)

— 1,6 – diaminohexane + decanedioic acid

$[— NH — (CH_2)_6 — NH — CO — (CH_2)_8 — CO —]_n$ (Nylon 6:10)

Polyamide (synthetic fibre) and Nylon (synthetic fibre) are used to describe fibres composed of synthetic linear macromolecules having in the chain recurring amide groups, at least 85 % of which are attached to aliphatic or cyclo-aliphatic groups.

Nylon is a thermoplastic polymer belonging to the polyamide group (PA). It has good tensile properties, high hardness and toughness. Nylon fibres are commonly used by the textile industry in the shape of threads. This material is comprised of long-chain synthetic polyamides containing amide groups