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Plastics — Film and sheeting — Non-oriented poly(ethylene terephthalate) (PET) sheets

Plastiques — Film et feuille — Films en poly(éthylène téréphtalate) (PET) non-orientés

Reference number
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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.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 13636 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

Introduction

Oriented and non-oriented films and sheets are both made from polyethylene terephthalate (PET). ISO 15988:2003[2] covers only oriented PET films and sheets which have crystalline structure. Non-oriented PET (APET) films and sheets show quite different properties because of their non-crystalline structure and require a separate International Standard.

This International Standard is based on JIS Z 1716:2004,[4] in which, however, only virgin PET resin is allowed to be used as the raw material.

Additional features of this International Standard are:

a) recycled PET resin can also be used under controlled specified conditions;

b) the structure and classification of film and sheet, such as single, double or triple layer, are specified in conjunction with applications;

c) applications for food packaging are described in conjunction with food and sanitary laws or regulations of each country or region.

Plastics — Film and sheeting — Non-oriented poly(ethylene terephthalate) (PET) sheets

1 Scope

This International Standard specifies the requirements and test methods for non-oriented polyethylene terephthalate (PET) or copolymer sheets made from virgin PET resin or recycled PET resin or combinations thereof. It applies only to sheets of thickness less than 2,0 mm. It excludes foamed sheets and shrinkable films.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 472, *Plastics — Vocabulary*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets*

ISO 1628-5, *Plastics — Determination of the viscosity of polymers in dilute solution using capillary viscometers — Part 5: Thermoplastic polyester (TP) homopolymers and copolymers*

ISO 2818, *Plastics — Preparation of test specimens by machining*

ISO 7792-1, *Plastics — Thermoplastic polyester (TP) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

ISO 11501, *Plastics — Film and sheeting — Determination of dimensional change on heating*

ISO 12418-1:2012, *Plastics — Post-consumer poly(ethylene terephthalate) (PET) bottle recyclates — Part 1: Designation system and basis for specifications*

ISO 14782, *Plastics — Determination of haze for transparent materials*

ISO 15105-1, *Plastics — Film and sheeting — Determination of gas-transmission rate — Part 1: Differential-pressure methods*

ISO 15105-2, *Plastics — Film and sheeting — Determination of gas-transmission rate — Part 2: Equal-pressure method*

ISO 15270, *Plastics — Guidelines for the recovery and recycling of plastics waste*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and ISO 15270 apply.

4 Material

Sheets shall be made of virgin polyethylene terephthalate (PET) or copolymer or combination thereof mainly polymerized from ethylene glycol and terephthalic acid as defined in ISO 7792-1. Sheets can also

be made of recycled PET defined in ISO 12418-1. PET materials can be classified in terms of food contact criteria as shown in Table 1.

Table 1 — Classification of PET material in terms of food contact criteria[a]

Code	Description	Condition for use
V	PET virgin material	Acceptable for direct food contact [a]
MRP–FD	PET recyclates for direct food contact (FD) made by the process of general mechanical recycling plus additional treatment (MRP) as described in ISO 12418-1	Acceptable for direct food contact [a]
MRG–FI orMRA–FI	PET recyclates for indirect food contact (FI) made by the process of general mechanical recycling (MRG) or mechanical recycling with alkaline treatment (MRA) as described in ISO 12418-1	Acceptable for indirect food contact as an outside layer or as an encapsulated interior layer (e.g. middle layer of three layers) [a]
MRG–NF orMRA–NF	PET recyclates for non-food (NF) applications made by the process of general mechanical recycling (MRG) or mechanical recycling with alkaline treatment (MRA) as described in ISO 12418-1	Unacceptable for any food contact application

[a] Food packaging shall meet the legal requirements for direct and indirect food contact of the country or region where it is to be used.

NOTE Designation codes of materials are as defined in ISO 12418-1:2012, Tables 1 and 2.

5 Classification of sheet

5.1 General

Sheets shall be classified according to the criteria in Tables 2, 3, and 4. Packaging for food contact applications is restricted in its usage according to classification. Such usage conditions shall meet the legislative or regulative requirements of the country or region where the sheet is to be used.

5.2 Classification by sheet layer

Sheets are classified according to the composition of the layers given in Table 2.

Table 2 — Classification by sheet layers

Composition of layer(s)	Sheet designation
Single layer	A
Two layers composed of two different raw materials	A/B (outside)
Three layers composed of two different raw materials	A/B (interior layer)/A

5.3 Classification by food contact

Sheets are classified in terms of food contact criteria as given in Table 3 in combination with the classification of PET raw materials shown in Table 1.

Table 3 — Classification by food contact

Class	Composition of layer	Condition for use
SF1	A and/or B layer(s) in Table 2 is made from V or MRP–FD as defined in Table 1	Acceptable for direct food contact[a]
SF2	A layer(s) in Table 2 is made from V or MRP–FD as defined in Table 1andB layer in Table 2 is made from MRG–FI or MRA–FI as defined in Table 1	Acceptable for direct food contact[a] only to A layer(s) and indirect food contact[a] to B(outside or interior) layer
SN	A and/or B layers in Table 2 containing MRG–NF or MRA–NF as defined in Table 1	Unacceptable for any food contact application

[a] Food packaging shall meet the legal requirements for direct and indirect food contact of the country or region where it is to be used.

5.4 Classification by intrinsic viscosity of the sheet

Sheets are further classified into four groups given in Table 4, according to the intrinsic viscosity (IV) specified in 8.3. Intrinsic viscosity can be converted from the melt flow volume ratio (MVR) measured by ISO 12418-2.[1]

Table 4 — Classification according to intrinsic viscosity of the sheet

Class	Range of intrinsic viscosity (IV) dl/g	Examples of application
1	<0,60	Packaging not requiring high mechanical strength
2	≥0,60 to <0,70	Packaging made by general thermoforming process
3	≥0,70 to <0,80	Packaging for thick wall and deep drawing
4	≥0,80	Heat-resistant container (CPET)

6 Requirements

6.1 Appearance

Sheet shall be visually free from defects, such as flaws, cracking, slackness, wrinkles, stains, foreign matter, irregular colour, surface irregularities, blocking, and/or any marks that impair its serviceability.

6.2 Properties

The performance of sheets shall conform to the requirements given in Table 5, when determined in accordance with Clause 8.

Table 5 — Basic properties of sheets

Item		Unit	Requirements	Applicable subclause
Tensile stress at yield	Machine direction[a]	MPa	≥45	8.4
	Transverse direction[b]	MPa	≥45	
Heat shrinkage percentage (machine direction[b])		%	≤3	8.5
Oxygen transmission rate		10^{-16} mol•m/ m^2•s•Pa	≤1	8.6
Haze[c]		%	≤10	8.7

[a] Machine direction: direction parallel to extrusion or longitudinal direction.

[b] Transverse direction: perpendicular to extrusion.

[c] This requirement concerns transparent sheets.

7 Dimensions

7.1 Length and tolerance

The length of sheets in flat form shall be agreed upon between the interested parties. Tolerance in length of sheets in flat form shall be limited to $^{+20}_{0}$ mm. A more severe tolerance range can be adopted under the agreement between the interested parties.

The rolling length and tolerance of the sheets in roll form shall be agreed upon between the interested parties, although minus tolerance shall not be allowed.

7.2 Width and tolerance

The width of the sheets shall be agreed upon between the interested parties. Tolerance in width of sheets shall be limited to $^{+20}_{0}$ mm. A more severe tolerance range can be adopted by agreement between the interested parties.

7.3 Thickness and tolerance

The thickness and tolerance of the sheets shall be in accordance with Table 6.

Table 6 — Thickness and tolerance

Dimensions in millimetres

Thickness	Tolerance %
≤0,2	±20
0,2 to 0,5	±15
≥0,5	±10

8 Test method

8.1 General conditions of test

8.1.1 Conditioning of test specimens

Test specimens shall be conditioned prior to test in a standard atmosphere of (23 ± 2) °C, (50 ± 10) % RH in accordance with ISO 291 for at least 48 h.

8.1.2 Standard condition at test site

Tests shall be conducted in a standard atmosphere of (23 ± 2) °C, (50 ± 10) % RH in accordance with ISO 291.

8.1.3 Sampling of test specimen

Representative test specimens shall be cut both longitudinally and transversely, evenly distributed over the length and width of the sheet.

8.1.4 Accuracy and report of test results

The precision and reporting of test results shall be as specified in the relevant test methods.

8.2 Measurement of dimensions

8.2.1 Length and width

Measure the length and width of the sheets to the nearest 1 mm, using a calibrated ruler or tape measure.

For sheets in flat form, measure length and width at two places in the machine direction and transverse direction, respectively, marking both ends in parallel with the periphery.

For sheets in roll form, measure length and width at two places in the transverse direction, in parallel with the periphery.

8.2.2 Thickness

Measure the thickness to the nearest 0,01 mm, using a calibrated thickness gauge.

8.3 Intrinsic viscosity

Intrinsic viscosity shall be determined according to the method specified in ISO 1628-5, using a mixture of phenol and 1,1,2,2-tetrachloroethane (3 + 2 parts by volume) as solvent. Intrinsic viscosity can be converted from MVR measured by ISO 12418-2.[1]

A suitable quantity of material for three measurements shall be sampled from the middle part of the sheet in the transverse direction.

The test results shall be reported in such a way that the average value of three tests is rounded to two decimal places.

8.4 Tensile stress at yield

The tensile stress at yield shall be determined according to ISO 527-1.

The test speed shall be set at (50 ± 5) mm/min as specified in ISO 527-1. Test pieces shall be in accordance with ISO 527-3, type 2 (rectangular strip).

Test pieces shall be prepared from the middle part of the sheet in the transverse direction with equal dimensions for length and width. A minimum of five pieces shall be obtained for each direction in accordance with ISO 2818.

The tensile stress at yield in the machine direction and transverse direction (average value of five tests) shall be reported.

8.5 Heat shrinkage

Heat shrinkage shall be determined in accordance with ISO 11501.

Heating temperature shall be 60 °C and the heating time shall be 30 min. Tests shall be carried out only in the machine direction.

Three test pieces from the middle part of the sheet in the transverse direction shall be prepared in accordance with ISO 11501.

The rate of dimensional change (average value of three rest pieces) in the machine direction shall be reported.

8.6 Oxygen transmission rate

The oxygen transmission rate shall be determined in accordance with ISO 15105-1 or ISO 15105-2.

At least three test pieces from the middle part of the sheet in the transverse direction shall be prepared in accordance with ISO 15105-1 or ISO 15105-2.

The results shall be expressed with the gas transmission rate.

The method, a reference to this International Standard (ISO 13636:2012) and apparatus shall be included in test report. The average value of three test pieces shall be reported to three significant figures.

8.7 Haze

Haze shall be determined in accordance with ISO 14782.

At least three test pieces from the middle part of the sheet in the transverse direction shall be prepared in accordance with ISO 14782.

The test results shall be reported with the average value of the three test pieces.

8.8 Food hygiene tests

Food hygiene tests shall be carried out in accordance with the appropriate test methods on food packaging (of PET) required by the legislation or regulation of the country or region where it is to be used.

9 Package

Packaging and size of unit shall be agreed upon between the interested parties taking into account conditions of transportation and storage.

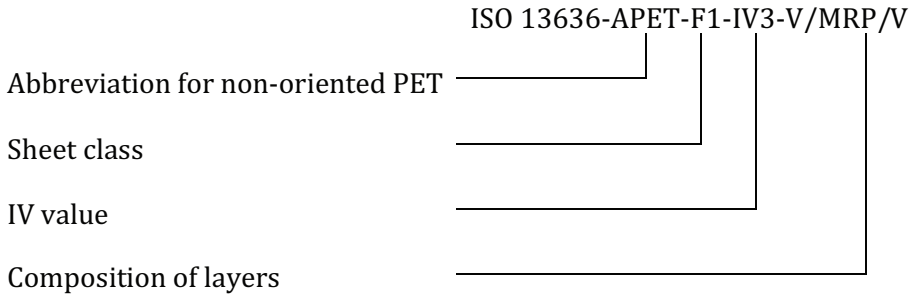
10 Marking

The following information shall be marked in a conspicuous place on the package of each unit:

a) name of the sheet or its abbreviation;

b) designation of sheet;

The designation of the sheet shall be described by this International Standard, APET, classification by food contact, classification by IV and classification by material of sheet layers. Example of designation of the sheet for direct food contact (SF1), with IV: 0,75 (IV3) and three layers virgin/mechanical recycling plus additional treatment/virgin PET resin(V/MRP/V) is:



c) dimensions of the sheets (thickness, width and length);

d) manufacturer's name or its abbreviation;

e) year and month of manufacture or abbreviation.

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