
Plastics — Film and sheeting — Guidance on the testing of thermoplastic films

*Plastiques — Film et feuille — Lignes directrices pour les essais de
films thermoplastiques*

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Published in Switzerland

Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 23559 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

This second edition cancels and replaces the first edition (ISO 23559:2007), of which it constitutes a minor revision to introduce an additional test specimen (for low strains) for the tensile impact test specified in Table 2.

Introduction

This International Standard has been prepared to provide guidance in the testing of plastic films for producers and users.

Although there are existing standards that provide this guidance for a number of film products, these are quite specific in respect to the materials covered and do not address many commercial films that are produced as blends or as multi-layer structures. In some cases, the existing standards are limited to only one process technique for producing the film.

It is also recognized that, because of the multitude of commercial processes used to produce films and the different processing parameters required for different materials, blends and/or structures, the concept of general standardization of film specimen preparation is not realistic at this time. On the other hand, it is possible to standardize specimen preparation for well-defined materials and fabrication processes, but this is not within the scope or intent of this document.

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SAFETY STATEMENT — Persons using this document should be familiar with normal laboratory practice, if applicable. This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any regulatory requirements.

1 Scope

This International Standard identifies specific test procedures to assist producers and users in the selection and characterization of thermoplastic films in single- or multi-layer form. It is intended to serve as a guide for those films for which there are no existing standards or specifications.

NOTE Because of the range of materials used and the wide variety of processes available to produce various film constructions, this document does not address specimen preparation.

If an International Standard exists for a specific film product, the requirements of that standard shall take precedence over this document.

There are many national, regional and industrial standards that address the requirements for specific applications. Since this International Standard is intended to provide general guidance, it is not within the scope to address these.

The significance of the data and fitness for use shall be determined by the user.

2 Normative references

The following referenced documents are indispensable for the application 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 307, *Plastics — Polyamides — Determination of viscosity number*

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

ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method*

ISO 1183-3, *Plastics — Methods for determining the density of non-cellular plastics — Part 3: Gas pycnometer method*

ISO 2813, *Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20°, 60° and 85°*

ISO 4589-1, *Plastics — Determination of burning behaviour by oxygen index — Part 1: Guidance*

ISO 4589-2, *Plastics — Determination of burning behaviour by oxygen index — Part 2: Ambient-temperature test*

ISO 4592, *Plastics — Film and sheeting — Determination of length and width*

- ISO 4593, *Plastics — Film and sheeting — Determination of thickness by mechanical scanning*
- ISO 6383-1, *Plastics — Film and sheeting — Determination of tear resistance — Part 1: Trouser tear method*
- ISO 6383-2, *Plastics — Film and sheeting — Determination of tear resistance — Part 2: Elmendorf method*
- ISO 7765-1, *Plastics film and sheeting — Determination of impact resistance by the free-falling dart method — Part 1: Staircase methods*
- ISO 7765-2, *Plastics film and sheeting — Determination of impact resistance by the free-falling dart method — Part 2: Instrumented puncture test*
- ISO 8256, *Plastics — Determination of tensile-impact strength*
- ISO 8295, *Plastics — Film and sheeting — Determination of the coefficients of friction*
- ISO 8296, *Plastics — Film and sheeting — Determination of wetting tension*
- ISO 9773, *Plastics — Determination of burning behaviour of thin flexible vertical specimens in contact with a small-flame ignition source*
- ISO 11357-2, *Plastics — Differential scanning calorimetry (DSC) — Part 2: Determination of glass transition temperature*
- ISO 11357-3, *Plastics — Differential scanning calorimetry (DSC) — Part 3: Determination of temperature and enthalpy of melting and crystallization*
- ISO 11443, *Plastics — Determination of the fluidity of plastics using capillary and slit-die rheometers*
- ISO 11501, *Plastics — Film and sheeting — Determination of dimensional change on heating*
- ISO 11502, *Plastics — Film and sheeting — Determination of blocking resistance*
- ISO 13468-1, *Plastics — Determination of the total luminous transmittance of transparent materials — Part 1: Single-beam instrument*
- ISO 13468-2, *Plastics — Determination of the total luminous transmittance of transparent materials — Part 2: Double-beam instrument*
- 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 15106-1, *Plastics — Film and sheeting — Determination of water vapour transmission rate — Part 1: Humidity detection sensor method*
- ISO 15106-2, *Plastics — Film and sheeting — Determination of water vapour transmission rate — Part 2: Infrared detection sensor method*
- ISO 15106-3, *Plastics — Film and sheeting — Determination of water vapour transmission rate — Part 3: Electrolytic detection sensor method*
- ISO 15989, *Plastics — Film and sheeting — Measurement of water-contact angle of corona-treated films*
- IEC 60093, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials*
- IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*
- IEC 60243-1, *Electrical strength of insulating materials — Test methods — Part 1: Tests at power frequencies*

IEC 60250, *Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths*

ASTM D882, *Standard Test Method for Tensile Properties of Thin Plastic Sheeting*

ASTM D5458, *Standard Test Method for Peel Cling of Stretch Wrap Film*

ASTM D5459, *Standard Test Method for Machine Direction Elastic Recovery and Permanent Deformation and Stress Retention of Stretch Wrap Film*

ASTM D5748, *Standard Test Method for Protrusion Puncture Resistance of Stretch Wrap Film*

ASTM F88, *Standard Test Method for Seal Strength of Flexible Barrier Materials*

ASTM F1921, *Standard Test Methods for Hot Seal Strength (Hot Tack) of Thermoplastic Polymers and Blends Comprising the Sealing Surfaces of Flexible Webs*

3 Terms and definitions

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

3.1

film

sheeting having a nominal thickness not greater than 0,25 mm

NOTE 1 Although not specifically defined in ISO 472, a limit of 0,25 mm is noted. ASTM D883 specifically defines film as $\leq 0,25$ mm.

NOTE 2 Sheeting with a nominal thickness of greater than 0,25 mm may be too rigid for test methods more suited to thinner structures to be utilized.

4 Specimen preparation and conditioning

4.1 Polymer properties

There are a number of polymer properties that are of interest to producers and users of film products because of their relationship to characterizing product processability and yield. Included among these properties are density (product yield), flow properties (processing) and thermal properties (conversion properties).

For these properties, the preparation and conditioning requirements specified in the material standard shall be followed. In the absence of a material standard, the requirements specified in the test procedure shall be followed.

4.2 Specimen preparation

As noted, it is not the intent of this document to address the standardization of film preparation. Table 1 describes some of the possible methods that are used to produce films of various materials and structures.

Table 1 — Typical processes for the production of plastic films

Chill roll casting
Water quenching
Blowing — Standard
Blowing — High stalk
Blowing — Water quenching
Stenter frame (biaxially oriented film)
Double bubble (biaxially oriented film)
Calendering

Film produced for testing and characterization shall be produced following the requirements in the appropriate product standard. If a product standard does not exist or does not address film fabrication, the same basic process as intended for the commercial application of the film shall be used. The processing conditions employed shall be characteristic and optimized for the specific process, equipment and material being used and shall not employ any devices or techniques that would not be used in the course of accepted manufacturing practices. If special conditions or equipment are used, this shall be noted in the test report.

Key process variables shall be recorded and the records kept for a reasonable period of time to be used for future reference in case of dispute or disagreement.

4.3 Specimen conditioning

For the properties described in Table 2, the preparation and conditioning requirements specified in the material or product standard shall be used. In the absence of a material or product standard, the requirements specified in the test procedure shall be followed.

5 Test requirements

In the absence of a material or product standard, the test methods, test conditions and units specified in Table 2 shall be used when determining data. The number of specimens shall be determined by the requirements of the specific test standard.

It is not necessary that all of the tests in Table 2 be conducted in every case. The specific tests will depend, in part, on the type of film, its intended application and the objective of the testing, i.e. R&D, manufacturing, quality control, etc., or will be by agreement between the interested parties. Likewise, the test frequency will also be dictated by the stated objective or be by agreement.

6 Presentation of results

As appropriate for the type of film tested, its intended application and any agreement between supplier and user, the reported data should typically include the following, in addition to any other information and data deemed appropriate to fulfil the intended purpose of the testing and which is not of a proprietary nature:

- a description of the film, i.e. type, material, composition (if a blend), structure (if co-extruded or laminated);
- the basic process and equipment used to produce the film;
- critical process variables as may apply, such as thickness, melt temperature, linear rates, drawdown ratio, blow-up ratio, orientation ratio, treatment type;
- any non-standard conditions, techniques, equipment, etc., used in producing the film;
- polymer and film property data;
- any deviation of the test conditions from those given in Table 2.

Table 2 — Test conditions and format for presentation of film data

Property	Standard	Test conditions	Units	Test report
Polymer properties				
Melt mass flow rate ^a	ISO 1133-1	—	g/10 min	—
Melt volume flow rate ^a	ISO 1133-1	—		—
Density ^a	ISO 1183-1, ISO 1183-2 or ISO 1183-3	—	g/cm ³	Note procedure used
Melting temperature ^a	ISO 11357-3	—	°C	—
Glass transition temperature ^a	ISO 11357-2	—	°C	—
Fluidity ^a	ISO 11443	—	—	Log shear stress or viscosity versus log shear rate
Viscosity number ^a	ISO 307	—	ml/g	—
Mechanical properties of film				
Length and width	ISO 4592	—	m	—
Thickness	ISO 4593	—	µm	—
Tensile stress at yield	ISO 527-3	Type 2 specimen ^{b, c}	MPa	Note direction of orientation
Tensile strain at yield			%	
Tensile stress at break			MPa	
Tensile strain at break			%	
Nominal tensile strain at break			%	
Nominal tensile strain at tensile strength ^d			%	
Tensile modulus	ASTM D882	≥300 mm (l) × (5 to 25) mm (w) 25 mm/min	MPa	Note direction of orientation
Tear strength (trouser)	ISO 6383-1	—	N/mm	Note direction of orientation
Tear strength (Elmendorf)	ISO 6383-2	—	N	Note direction of orientation
Tensile impact	ISO 8256 ^e	Type 3 specimen, method A, for high strains and Type 4 specimen, method B, for low strains	kJ/m ²	Note direction of orientation
Dart impact (staircase)	ISO 7765-1	—	g	—
Dart impact (instrumented)	ISO 7765-2	—	N	Peak force
		—	J	Energy to peak force
		—	J	Total penetration energy
Surface properties of film				
Static coefficient of friction	ISO 8295	—	—	Note surfaces tested
Dynamic coefficient of friction				
Blocking resistance	ISO 11502	Method B	N	Note surfaces tested
Wetting tension	ISO 8296	—	mN/m	Note surfaces tested
Water-contact angle	ISO 15989	—	—	Note surfaces tested
Wetting tension			mN/m	

Table 2 (continued)

Property	Standard	Test conditions	Units	Test report
Optical properties of film				
Gloss	ISO 2813	—	—	Note gloss angle used
Total luminous transmittance	ISO 13468-1 or ISO 13468-2	—	%	—
Haze	ISO 14782	—	%	—
Barrier properties of film				
Gas transmission rate	ISO 15105-1 or ISO 15105-2	—	mol/(m ² ·s·Pa)	Note procedure and gases used
Water vapour transmission rate	ISO 15106-1, ISO 15106-2 or ISO 15106-3	—	g/(m ² ·24 h)	Note procedure used
Electrical properties				
Surface resistivity	IEC 60093	—	Ω	—
Electric strength	IEC 60243-1	—	V/m	—
Dissipation factor	IEC 60250	—	—	—
Comparative tracking index	IEC 60112	—	—	—
Flammability properties				
Burning behaviour	ISO 9773	—	—	—
Oxygen index	ISO 4589-1 and ISO 4589-2	—	—	—
Other properties				
Hot seal strength (hot tack)	ASTM F1921	—	N	Average heat seal strength
		—	—	Failure mode
Seal strength	ASTM F88	—	N	Peel force
		—	—	Failure mode
		—	N/m	Maximum force
		—	%	Stretch
		—	—	—
Dimensional change on heating	ISO 11501	—	%	Note conditions used and direction tested
Peel cling (stretch wrap film)	ASTM D5458	—	N/mm	Average cling
		—	%	Stretch
Elastic recovery and permanent deformation and stress retention (stretch wrap film)	ASTM D5459	—	%	Permanent deformation
		—	%	Elastic recovery
		—	N	Stress retention
		—	%	

Table 2 (continued)

Property	Standard	Test conditions	Units	Test report
Protrusion puncture (stretch wrap film)	ASTM D5748	—	N	Peak force at break
			N	Maximum force
			J	Energy to break
			mm	Probe penetration
a Refer to the appropriate material standard, if available, for specific conditions. b The type 2 specimen is preferred, but ISO 527-3 allows alternative geometries for special cases. c The optimum test (cross-head) speed is determined by the elongation characteristics of the film and the limitations of the test equipment. Films exhibiting low strain at break, e.g. unplasticized PVC, PC and some PP and PE-HD films, should be tested at 50 mm/min. Thin films or films produced from flexible/elastomeric materials exhibiting high strain at break should be tested at 200 mm/min or 500 mm/min. d Use for films that exhibit a yield point. e The use of tensile impact is generally more applicable to films exhibiting high rigidity.				