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Second edition
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Plastics film and sheeting — Determination of impact resistance by the free-falling dart method —

Part 2: Instrumented puncture test

Film et feuille de plastiques — Détermination de la résistance au choc par la méthode par chute libre de projectile —

Partie 2: Essai avec appareil de perforation

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.

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 61, *Plastics*, Subcommittee SC 11, *Products*.

This second edition cancels and replaces the first edition (ISO 7765-2:1994), which has been technically revised.

The main changes are as follows:

— impact failure definition has been added (3.7);

— the list of clamping devices and techniques has been updated (5.2.4);

— the force measurement (5.3) has been aligned with the ISO 6603-2 method;

— the calculation clause (Clause 8) has been aligned with the ISO 6603-2 method;

— test report requirements (Clause 10) have been improved.

A list of all parts in the ISO 7765 series can be found on the ISO website.

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

The impact-penetration test described in the ISO 7765 series is used for the assessment of plastic films and thin sheets (hereinafter referred to as films) under an impact stress applied at right angles to the plane of the film.

ISO 7765-1 can be used if it is sufficient to characterize the impact behaviour of the film by an impact failure energy. This document is used if a force-deformation or a force-time diagram, recorded at practically constant velocity of the striker, is necessary for characterization of the impact behaviour.

Annex A of is for information only.

Plastics film and sheeting — Determination of impact resistance by the free-falling dart method —

Part 2: Instrumented puncture test

1 Scope

This document specifies a test method for the determination of puncture impact properties of a plastic film using instruments for measuring force and deflection. It is applicable if a force-deflection or force-time diagram, recorded at nominally constant striker velocity, is required for detailed characterization of the impact behaviour. This test method is also required when a small number of test specimens are available, and the staircase method described in the ISO 7765-1 cannot be applied.

The test method is applicable to films of up to 1 mm thickness and makes it possible to compare impact-penetration forces, biaxial deformabilities and energy-absorption capacities of films. Also, the transition region between brittle and tough behaviour of the film under the conditions of testing can be determined by varying the temperature or the penetration velocity or the relative humidity[1].

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

ISO 4593, *Plastics — Film and sheeting — Determination of thickness by mechanical scanning*

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
peak force
F_M
maximum force exerted by the striker in the direction of impact during the test

Note 1 to entry: See Figures 1 to 3.

3.2
deformation at peak force
s_M
deformation in the direction of impact at the centre of the test specimen corresponding to the *peak force* (3.1)

Note 1 to entry: For materials exhibiting a peak-force plateau, the deformation is taken at the centre of the plateau (see Figure 1).

3.3
energy to peak force
W_M
area under the force-deformation curve bounded by the origin, the peak force and the *deformation at peak force* (3.2)

Note 1 to entry: See Figures 1 to 3.

3.4
total penetration energy
W_T
area under the force-deformation curve bounded by the origin, the *peak force* (3.1) and the *deformation at peak force* (3.2)

Note 1 to entry: See Figures 1 to 3.

Note 2 to entry: If the force-deformation diagram as measured during the test is influenced strongly by dynamic resonance effects, a mean curve may be used to obtain the values of the parameters defined in 3.1 to 3.4. This, however, is seldom the case when plastic film is tested

Note 3 to entry: In contrast to the instrumented puncture test applied to test specimens made of brittle plastic (see ISO 6603-2), the force-deformation diagram of this test applied to film and sheeting frequently shows a clear point of first failure (failure point) indicated by a sharp drop in the force. If this is the case, and if the interested parties agree to use this point as a characteristic criterion, the following additional definitions may be used.

3.5
failure force
F_F
force exerted by the striker in the direction of impact, measured at the failure point

Note 1 to entry: See Figures 1 and 2.

3.6
failure deformation
s_F
deformation in the direction of impact at the centre of the test specimen, measured at the failure, point

Note 1 to entry: See Figures 1 and 2.

3.6.1
failure energy
W_F
area under the force deformation curve bounded by the origin, the *failure force* (3.5) and the *failure deformation* (3.6)

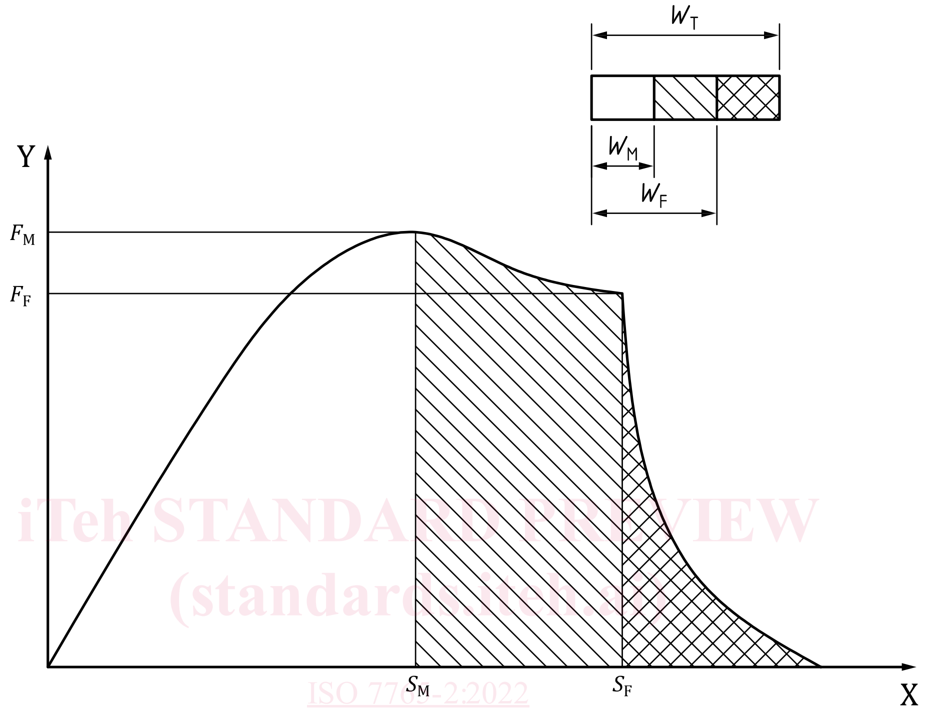
Note 1 to entry: See Figures 1 and 2.

Note 2 to entry: When comparing films of slightly different thicknesses, it is advisable to relate F_M, F_F, W_M and W_F to the thickness d of the specimen. Though the normalized values F_M/d, F_F/d, W_M/d and W_F/d do not allow a physically exact comparison between film specimens of different materials, the thickness dependence of these normalized values is negligible for similar materials (those with the same amount of crystallinity and the same orientation) provided the thicknesses do not differ by more than a factor of 1,5.

3.7
impact failure
mechanical behaviour of the material under test which may be either one of the following types:

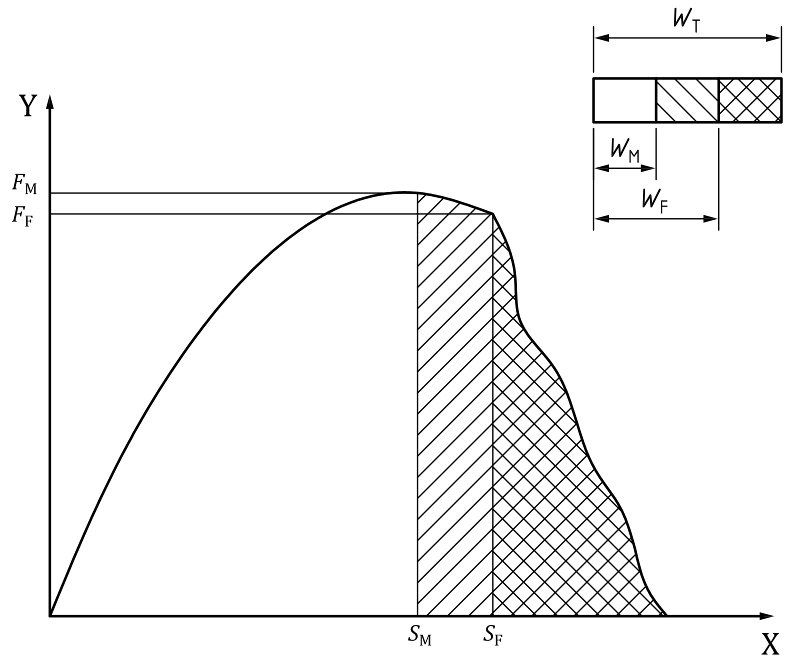
a) ductile. If a clear failure point is available and parts agree, the ductile behaviour can be described in terms of "Very tough" (see Figure 1 as example) and "Tough" (see Figure 2 as example)

b) brittle



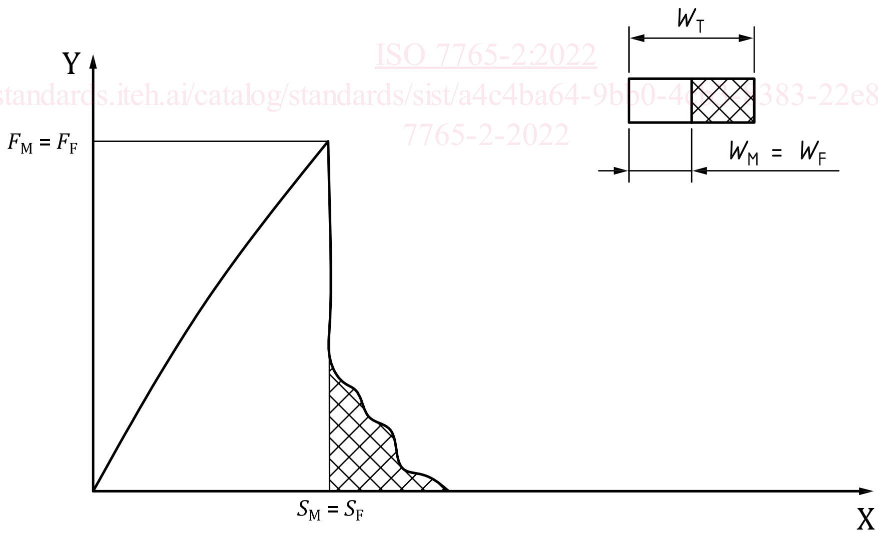
Key
Y force
X deformation

Figure 1 — Force-deformation diagram for very tough materials (schematic)



Key
Y force
X deformation

Figure 2 — Force-deformation diagram for tough materials (schematic)



Key
Y force
X deformation

Figure 3 — Force-deformation diagram for brittle materials (schematic)

4 Principle

The test specimen is penetrated normal to its plane by a striker at a nominally uniform velocity. The resulting force-deformation or force-time diagram is electronically recorded. The test specimen is firmly clamped during the test.

The force-deformation diagram obtained in these tests shows several features of the material's behaviour under impact. For example, the fracture may be “brittle”, “ductile” – “tough” or “very tough” – or characterized by initial damage or by crack initiation and propagation. In addition, dynamic effects may be present, such as load-cell/indenter resonance, specimen resonance and initial contact/inertia peaks (see Figures 1 to 3).

In all cases, care shall be exercised in analysing these features because the operative mechanism and the trains of inference are not yet fully established, and are the subject of continuing research.

The test results are comparable only if the conditions for preparation of specimens, their thickness and surfaces, and the test conditions are identical. Comprehensive evaluation of the reaction to impact stress requires that the determinations are made as functions of deformation rate and temperature for different material variables, such as crystallinity and moisture content.

5 Apparatus

5.1 General

The apparatus consists of a mechanical test device for applying the test force, instruments for measuring the force and the deformation produced, and a thickness gauge.

5.2 Test device

5.2.1 General

The essential components of the test device are the energy carrier (normally a falling mass, but a pneumatically, hydraulically or spring-driven mass or a pendulum impact-testing device may also be used), the striker, and the clamping device consisting of the test specimen support and the clamping ring (see Figures 4 and 5).

The apparatus shall permit the test specimen to be punctured at the centre at a nominally constant velocity, perpendicular to the specimen surface. The force exerted on the test specimen in the direction of impact and the deformation of the specimen in the direction of impact shall be measurable or derivable (see Figure 4). Equipment suitable for this are falling dart machines, pendulums long enough for the penetration path to be regarded as approximately straight, or high-speed tensile-testing machines with suitable attachments.