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Plastics — Acquisition and presentation of comparable single-point data —

Part 1: Moulding materials

Plastiques — Acquisition et présentation de caractéristiques intrinsèques comparables —

Partie 1: Matériaux pour moulage

Reference number
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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
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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.

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 10350-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

This second edition cancels and replaces the first edition (ISO 10350-1:1998), which has been technically revised.

ISO 10350 consists of the following parts, under the general title *Plastics — Acquisition and presentation of comparable single-point data*:

— *Part 1: Moulding materials*

— *Part 2: Long-fibre-reinforced plastics*

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Introduction

ISO 10350 has been prepared because users of plastics find that available data cannot always be readily used to compare the properties of similar materials, especially when the data have been supplied by different sources. Even when the same standard tests have been used, they often allow the adoption of a wide range of alternative test conditions, and the data obtained are not necessarily comparable. The purpose of this International Standard is to identify specific methods and conditions of test to be used for the acquisition and presentation of data in order that valid comparisons between materials can be made.

ISO 10350 is concerned with tests employed to present "single-point" data on the limited range of properties commonly included in data sheets and used for the preliminary selection of materials. Such data represent the most basic approach to the specification of properties of materials, and the standard thus facilitates the first steps towards more efficient selection and use of plastics in the many applications to which they are suited.

Complementary International Standards (ISO 11403-1, ISO 11403-2 and ISO 11403-3)[1)] are concerned with the standardized acquisition and presentation of multipoint data, to demonstrate how properties vary with important factors such as time, temperature and the presence of particular natural and chemical environments. In these standards, some additional properties are included. Their use will provide a more substantial database than one containing only single-point data, and so will enable improved assessment of the fitness of a material for any particular application. In addition, ISO 11403-1, which deals with mechanical properties, assists predictions of the performance of components and ISO 11403-2, covering thermal and processing properties, aids predictions of melt-flow behaviour during manufacturing. ISO 11403-3 is concerned with environmental influences on properties, and other parts may be prepared to cover additional properties.

1) ISO 11403-1, *Plastics — Acquisition and presentation of comparable multipoint data — Part 1: Mechanical properties*

ISO 11403-2, *Plastics — Acquisition and presentation of comparable multipoint data — Part 2: Thermal and processing properties*

ISO 11403-3, *Plastics — Acquisition and presentation of comparable multipoint data — Part 3: Environmental influences on properties*

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Plastics — Acquisition and presentation of comparable single-point data —

Part 1: Moulding materials

1 Scope

ISO 10350 identifies specific test procedures for the acquisition and presentation of comparable data for certain basic properties of plastics. In general, each property is specified by a single experimental value, although in certain cases properties are represented by two values obtained under different test conditions. The properties included are those presented conventionally in manufacturers' data sheets. This part of ISO 10350 applies predominantly to unreinforced and reinforced thermoplastic and thermosetting materials that may be injection- or compression-moulded or prepared as sheets of specified thickness. Part 2 of ISO 10350 deals specifically with long- or continuous-fibre-reinforced plastics. For the purposes of ISO 10350, long-fibre-reinforced plastics are considered to have fibre lengths greater than 7,5 mm prior to moulding.

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 62, *Plastics — Determination of water absorption*

ISO 75-1, *Plastics — Determination of temperature of deflection under load — Part 1: General test method*

ISO 75-2, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

ISO 178, *Plastics — Determination of flexural properties*

ISO 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

ISO 179-2, *Plastics — Determination of Charpy impact properties — Part 2: Instrumented impact test*

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

ISO 293, *Plastics — Compression moulding of test specimens of thermoplastic materials*

ISO 294-1, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar test specimens*

ISO 294-3, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 3: Small plates*

ISO 294-4, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 4: Determination of moulding shrinkage*

ISO 295, *Plastics — Compression moulding of test specimens of thermosetting materials*

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ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

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

ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 899-1, *Plastics — Determination of creep behaviour — Part 1: Tensile creep*

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

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

ISO 2577, *Plastics — Thermosetting moulding materials — Determination of shrinkage*

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

ISO 3167, *Plastics — Multipurpose test specimens*

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

ISO 6603-2, *Plastics — Determination of puncture impact behaviour of rigid plastics — Part 2: Instrumented impact testing*

ISO 8256, *Plastics — Determination of tensile-impact strength*

ISO 10724-1, *Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) — Part 1: General principles and moulding of multipurpose test specimens*

ISO 10724-2, *Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) — Part 2: Small plates*

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 11359-2, *Plastics — Thermomechanical analysis (TMA) — Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

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*

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IEC 60296, *Fluids for electrotechnical applications — Unused mineral insulating oils for transformers and switchgear*

IEC 60695-11-10, *Fire hazard testing — Part 11-10: Test flames — 50 W horizontal and vertical flame test methods*

IEC 60695-11-20, *Fire hazard testing — Part 11-20: Test flames — 500 W flame test methods*

3 Terms and definitions

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

3.1
single-point data
data characterizing a plastics material by means of those property tests in which important aspects of performance can be described with single-value results.

4 Specimen preparation and conditioning

In the preparation of specimens by injection moulding, the procedures described in ISO 294-1 and ISO 294-3 or ISO 10724-1 and ISO 10724-2 shall be used. For compression moulding, the procedures described in ISO 293 or ISO 295 shall be used. The moulding method and the conditions will depend upon the material being moulded. If these conditions are specified in the International Standard appropriate to the material, then they shall be adopted for the preparation of every specimen on which data are obtained using this part of ISO 10350. For those plastics for which moulding conditions have not yet been standardized, the conditions employed shall be within the range recommended by the polymer manufacturer and shall, for each of the processing methods, be the same for every specimen.

Where moulding conditions are not stipulated in any International Standard, the values used for the parameters in Table 1 shall be recorded with the single-point data for that material. Where specimens are prepared by machining from sheet, the machining shall be performed in accordance with ISO 2818 and the dimensions of the specimen shall comply with those for the appropriate specimen in Table 2.

For materials that have properties that are not significantly sensitive to any absorbed water, specimens shall be conditioned in accordance with the International Standard appropriate to the material concerned. If no materials standard is available, condition test specimens at 23 °C $\pm$ 2 °C and (50 $\pm$ 10) % RH for a minimum length of time of 88 h (see ISO 291).

For those materials having properties that are significantly dependent upon the concentration of any absorbed water, data shall be presented both for material that is dry and also for material that is in equilibrium with an atmosphere of 50 % RH at 23 °C but with the following exceptions (see Table 2):

Rheological properties, 1.1 to 1.6	dry only
Creep modulus, 2.8 and 2.9	50 % RH only
Thermal properties, 3.1 to 3.8	dry only
Surface resistivity and comparative tracking index, 4.6 and 4.9	50 % RH only

For these materials, consult the relevant materials standard for procedures for conditioning specimens to achieve material that is dry or in equilibrium under 50 % RH. Following such conditioning, all test specimens shall be stored at 23 °C $\pm$ 2 °C for a minimum of 16 h before testing. The storage atmosphere shall then be either dry or at 50 % RH, depending upon the condition of the specimen.

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Table 1 — Moulding parameters

Moulding-material type	Moulding method and standard (where applicable)	Moulding parameters
Thermoplastic	Injection ISO 294-1 and ISO 294-3	Melt temperature Mould temperature Injection velocity[a] Cavity pressure at hold[b]
	Compression ISO 293	Moulding temperature Moulding time Cooling rate Demoulding temperature
Thermosetting	Injection ISO 10724-1 and ISO 10724-2	Injection temperature Mould temperature Injection velocity Cure time
	Compression ISO 295	Mould temperature Mould pressure Cure time

[a] For the preparation of standard specimens of the 80 mm × 10 mm × 4 mm bar (ISO 294-1, mould type B), values for the injection velocity shall be chosen to give an injection time comparable to that achieved with the multipurpose test specimen (ISO 294-1, mould type A).

[b] Only to be recorded for the 60 mm × 60 mm × 2 mm plate specimen in ISO 294-3 and ISO 294-4 when used for the determination of moulding shrinkage.

5 Test requirements

The test methods, test conditions and units specified in Table 2 shall be used when determining data.

6 Presentation of results

The presentation of data shall be as shown in Table 2, and the data shall be preceded by information that identifies the material together with the information required by Clause 4 where appropriate. Indicate also whether the specimens tested were dry, in equilibrium with an atmosphere of 50 % RH at 23 °C or whether properties are insensitive to the presence of water.

The minimum number of specimens tested shall be the number specified for each property in the associated test method standard (see Note). Record the mean value for each property (or the central value if this is stipulated in the test method standard) in the “value” column.

NOTE In order that the value recorded for each property is as representative as possible of the material being tested, it is recommended that test specimens be prepared from at least three samples of the material taken from the production of the material over an extended timescale.

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Table 2 — Test conditions and format for the presentation of single-point data (see Note 1)

Property		Symbol	Standard	Specimen type (dimensions in mm)	Value	Unit	Test conditions and supplementary instructions	
1	**Rheological properties** (for properties 1.1 to 1.6, see statement regarding water content in Clause 4)							
1.1	Melt mass-flow rate	MFR	ISO 1133	Moulding compound		g/10 min	Use and record test conditions for temperature and load specified in the appropriate materials standard	
1.2	Melt volume-flow rate (see Note 2)	MVR				cm^3/10 min		
1.3	Moulding shrinkage of thermosetting polymers	S_{Mp}	ISO 2577	See ISO 2577		%	Parallel	See Note 3
1.4		S_{Mn}					Normal	
1.5	Moulding shrinkage of thermoplastics	S_{Mp}	ISO 294-4	60 × 60 × 2 ISO 294-3 type D2 (see Note 4)		%	Parallel	See Note 3
1.6		S_{Mn}					Normal	
2	**Mechanical properties** (for properties 2.8 and 2.9, see statement regarding water content in Clause 4)							
2.1	Tensile modulus	E_t	ISO 527-1 and ISO 527-2	ISO 3167 (see Note 5)		MPa	See Note 6 and Figure 1	Test speed 1 mm/min
2.2	Yield stress	σ_y						Failure with yielding: test speed 50 mm/min (see Note 7)
2.3	Yield strain	ε_y				%		
2.4	Nominal strain at break	ε_{tB}						
2.5	Stress at 50 % strain	σ_{50}				MPa		Failure without yielding Test speed: see Note 8
2.6	Stress at break	σ_B						
2.7	Strain at break	ε_B				%		
2.8	Tensile creep modulus	$E_{tc}1$	ISO 899-1			MPa	At 1 h	Strain < 0,5 %
2.9		$E_{tc}10^3$					At 1 000 h	
2.10	Flexural modulus	E_f	ISO 178	80 × 10 × 4 (see Note 5)		MPa	Test speed 2 mm/min Optional extra information for brittle materials (see Note 9)	
2.11	Flexural strength	σ_{fM}						
2.12	Charpy impact strength	a_c	ISO 179-1 or ISO 179-2	80 × 10 × 4 (see Note 5)		kJ/m^2	Edgewise impact Also record type of failure (see Note 10)	
2.13	Charpy notched impact strength	a_{cA}		Machined type A V-notch, r = 0,25				
2.14	Tensile-impact strength	a_{tN}	ISO 8256	80 × 10 × 4 (see Note 5) Machined double V-notch, r = 1				

Table 2 (*continued*)

Property		Symbol	Standard	Specimen type (dimensions in mm)	Value	Unit	Test conditions and supplementary instructions		
2.15	Puncture impact behaviour	F_M	ISO 6603-2	60 × 60 × 2 (see Note 4)		N	Maximum force	Striker velocity 4,4 m/s Striker diameter 20 mm Lubricate the striker (see Note 11) Clamp the specimen sufficiently to prevent any out of plane movement of its outer regions	
2.16		W_P				J	Puncture energy at 50 % decrease in force after the maximum		
3 Thermal properties (for properties 3.1 to 3.8, see statement regarding water content in Clause 4)									
3.1	Melting temperature	T_m	ISO 11357-3	Moulding compound		°C	Record peak melting temperature Use 10 °C/min (see Note 12)		
3.2	Glass transition temperature	T_g	ISO 11357-2				Record midpoint temperature Use 10 °C/min (see Note 12)		
3.3	Temperature of deflection under load	T_f 1,8	ISO 75-1 and ISO 75-2	80 × 10 × 4 (see Note 5)		°C	Maximum surface stress (MPa)	1,8	Use 1,8 MPa and one other value Use flatwise loading
3.4		T_f 0,45						0,45	
3.5		T_f 8,0						8	
3.6	Vicat softening temperature (see Note 13)	T_V 50/50	ISO 306	⩾ 10 × 10 × 4 (see Note 14)		°C	Heating rate 50 °C/h Load 50 N		
3.7	Coefficient of linear thermal expansion	α_p	ISO 11359-2	Prepared from ISO 3167 (see Note 14)		°C^{-1}	Parallel	Record the secant value over the temperature range 23 °C to 55 °C (see Note 3)	
3.8		α_n					Transverse		
3.9	Burning behaviour	B50/3	IEC 60695-11-10	125 × 13 × 3			Record one of the classifications V-0, V-1, V-2, HB40 or HB75		
3.10		B50/h		Greater thickness h					
3.11		B500/3	IEC 60695-11-20	⩾ 150 × ⩾ 150 × 3			Record classification 5VA, 5VB or N (see Note 15)		
3.12		B500/h		Greater thickness h					
3.13	Oxygen index	OI	ISO 4589-2	80 × 10 × 4 (see Note 5)		%	Use procedure A (top surface ignition)		

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Table 2 (*continued*)

Property		Symbol	Standard	Specimen type (dimensions in mm)	Value	Unit	Test conditions and supplementary instructions	
4	**Electrical properties** (for properties 4.6 and 4.9, see statement regarding water content in Clause 4)							
4.1	Relative permittivity	ε_r 100	IEC 60250	$\geqslant 60 \times \geqslant 60 \times 2$ (see Note 4)			100 Hz	Compensate for electrode edge effects
4.2		ε_r 1M					1 MHz	
4.3	Dissipation factor	tan δ 100					100 Hz	
4.4		tan δ 1M					1 MHz	
4.5	Volume resistivity	ρ_e	IEC 60093			Ω·m	Voltage 500 V	Value at 1 minute
4.6	Surface resistivity	σ_e				Ω		Use contacting line electrodes 1 mm to 2 mm wide, 50 mm long and 5 mm apart
4.7	Electric strength	E_B 1	IEC 60243-1	$\geqslant 60 \times \geqslant 60 \times 1$ (see Notes 4 and 16)		kV/mm	Use 20 mm diameter spherical electrodes Immerse in transformer oil in accordance with IEC 60296 Use a voltage application rate of 2 kV/s	
4.8		E_B 2		$\geqslant 60 \times \geqslant 60 \times 2$ (see Notes 4, 15 and 17)				
4.9	Comparative tracking index	CTI	IEC 60112	$\geqslant 20 \times \geqslant 20 \times 4$ (see Note 18)			Use solution A	
5	**Other properties**							
5.1	Water absorption	w_w	ISO 62	Thickness $\geqslant 1$ (see Note 4)		%	Saturation value in water at 23 °C	
5.2		w_H					Equilibrium value at 23 °C, 50 % RH	
5.3	Density	ρ	ISO 1183-1, ISO 1183-2, or ISO 1183-3	For injection-moulded specimens, use part of the centre of the multipurpose test specimen		kg/m^3	See Note 19	

Notes to Table 2

1 Use of the parameters in Table 2 is essentially for the comparison of data, and certain of the instructions listed may not be appropriate for all plastics.

2 The ratio of melt mass-flow rate to melt volume-flow rate gives an estimate of the melt density.

3 Where specimens are prepared by injection moulding, record property values both parallel and normal to the direction of flow into the mould.

4 For test specimens prepared by injection moulding, use mould type D1 for specimens of 1 mm thickness and type D2 for specimens of 2 mm thickness (see ISO 294-3 for thermoplastics and ISO 10724-2 for thermosets). Refer to the appropriate material standard for details of the moulding conditions for this specimen. Where these are not given, use the conditions specified for preparing the ISO 3167 multipurpose specimen, but employing an injection velocity that gives the same injection time as that obtained with the multipurpose specimen.

5 ISO 3167 describes two types of specimen for tensile tests. The type A specimen has a lower value for the radius of the shoulders of 20 mm to 25 mm which thereby enables a central region to be obtained of length at least 80 mm. The standard ISO bar having dimensions 80 mm $\times$ 10 mm $\times$ 4 mm can thus be cut from the central region of this type of test specimen which is therefore recommended for directly moulded specimens. The type B specimen has a larger shoulder radius of $>$ 60 mm and is recommended for machined specimens.

6 The data to be recorded for the properties in 2.1 to 2.7 are intended to give a fair impression of the nature of the stress-strain curve to failure (see Figure 1).

7 If the specimen shows yielding when tested at a speed of 50 mm/min, then the test speed for data acquisition shall be 50 mm/min and the values for yield stress and strain and the nominal strain at break shall be recorded. If rupture occurs above 50 % nominal strain, record either the measured value of the nominal strain at break or simply record "$>$ 50".

The determination of the nominal strain is based upon the initial and final grip separations instead of extensometer measurements.

8 If the specimen has a breaking strain beyond 10 % when tested at a speed of 50 mm/min but does not show a yield point below 50 % strain, record the stress and strain at break. If rupture occurs above 50 % strain, record the stress at 50 % strain and either the measured strain at break or "$>$ 50" for this value. If the specimen shows rupture without yielding and with a strain at break of less than or equal to 10 % when tested at a speed of 50 mm/min, then the test speed for data acquisition shall be 5 mm/min and the values for stress and strain at break shall be recorded.

9 The flexure test generates a non-uniform stress across the cross-section of the specimen. For materials that show significantly non-linear behaviour up to failure, the derived flexural-strength value will thus depend upon the thickness of the specimen. This test is therefore not recommended for these materials. For materials that show predominantly linear behaviour up to failure, the inclusion of data using this test is optional. However, it should be noted that, for injection-moulded or reinforced materials, where the structure often varies through the cross-section of the specimen, values for flexural properties may be different from those obtained in tension.

10 After testing, classify test results according to the three types of failure defined in ISO 179-1 and ISO 179-2:

C complete break or hinge break;

P partial break;

N no break.

Select the test results for the type of failure that occurs most frequently and record the mean value of the impact strength and the corresponding failure type: C, P or N.

11 In order to achieve comparable data with this test, the application of a lubricant to the striking surface is specified to minimize the friction between the striker and the test specimen. See the test method standard for details of suitable lubricants and their application. Results from an unlubricated test may be higher, owing to friction, and the mode of failure may be different from the lubricated test.

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12 A heating rate of 20 °C/min is recommended in the current edition of ISO 11357-3. The lower rate of 10 °C/min is specified here because it can give higher precision in measurements, and the associated higher resolution in enthalpy changes can be better for discriminating between materials.

13 This property is less suitable for thermosets and semicrystalline materials.

14 For injection-moulded test specimens, carry out the test at the central region of the multipurpose test specimen whenever possible.

15 The classification N denotes that the material does not satisfy any of the classifications of the method.

16 The specimen shall be sufficiently wide to prevent discharge along the surface.

17 A measurement at the greater thickness of 2 mm shall be presented for those materials that do not give realistic properties when moulded with a thickness of 1 mm.

Since measurements of electric strength are dependent upon the thickness of the specimen, an additional value may be recorded here, for those materials that can be moulded with a thickness of 1 mm, to demonstrate the dependence on thickness.

18 For injection-moulded specimens, use test specimens from the shoulder of the multipurpose test specimen.

19 The methods specified in ISO 1183-1, ISO 1183-2 and ISO 1183-3 are regarded as equivalent for the purposes of this part of ISO 10350.

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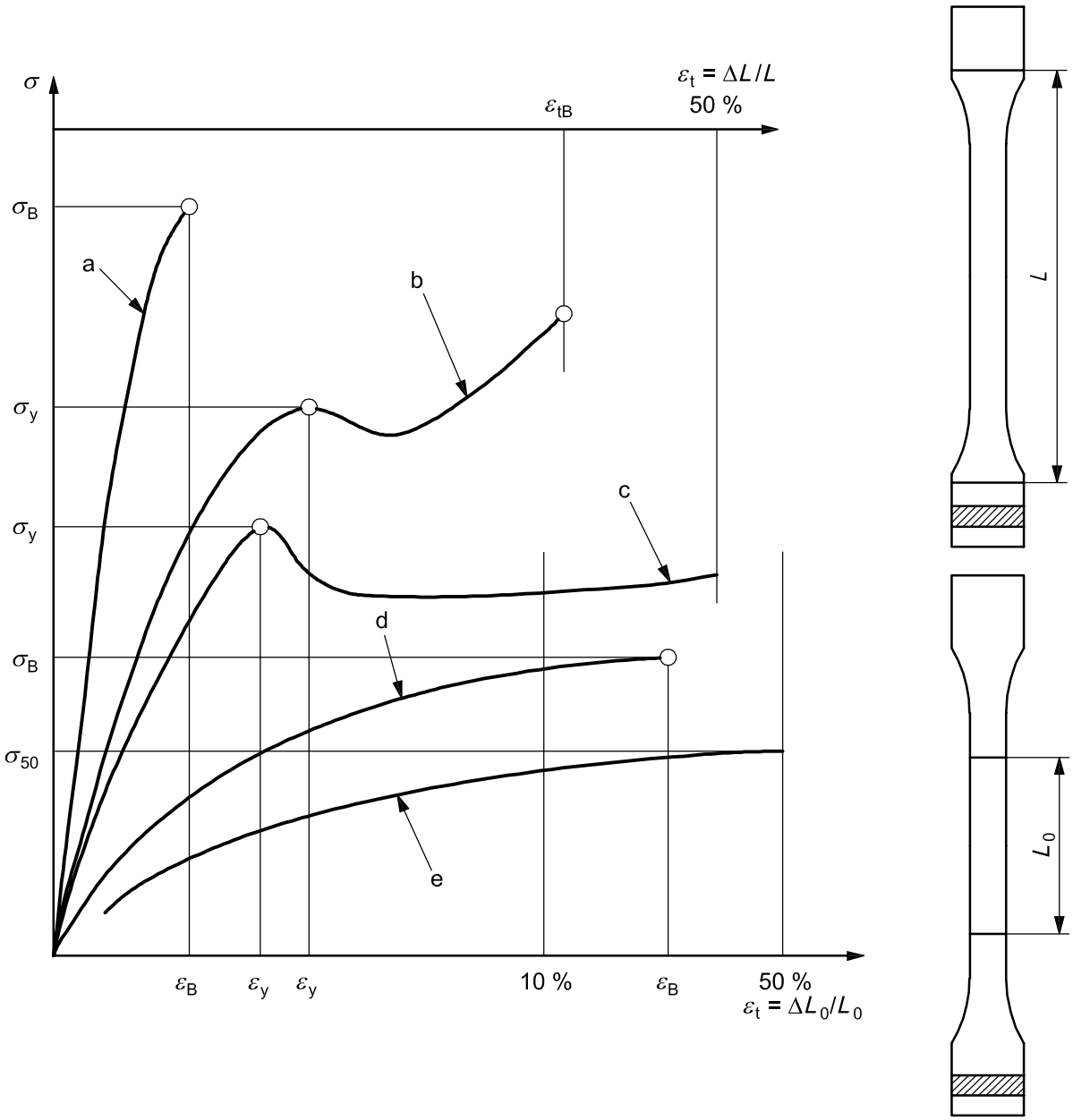

Type of stress-strain curve	Property						Test speed mm/min
	σ_y	ε_y	ε_{tB}	σ_{50}	σ_B	ε_B	
a	—	—	—	—	m	m	5
b	m	m	m	—	—	—	50
c	m	m	m or > 50	—	—	—	50
d	—	—	—	—	m	m	50
e	—	—	—	m	—	m or > 50	50

The table shows which measurements (indicated by the letter m) are to be recorded in Table 2 and which test speeds are to be used for the different types of stress-strain behaviour depicted in the figure. The tensile modulus, obtained at a test speed of 1 mm/min, shall be recorded for all types of behaviour.

Figure 1 — Tensile stress-strain curves showing the determination of the yield stress σ_y and yield strain ε_y, the breaking stress σ_B and breaking strain ε_B, the nominal strain at break ε_{tB} and the stress at 50 % strain σ_{50}

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