International Standard 4894/2

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Plastics — Styrene/acrylonitrile (SAN) copolymer moulding and extrusion materials — Part 2 : Determination of properties

Plastiques — Matières à mouler et à extruder à base de copolymère de styrène et d'acrylonitrile (SAN) — Partie 2 : Détermination des caractéristiques

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4894/2 was developed by Technical Committee ISO/TC 61, *Plastics*, and was circulated to the member bodies in March 1979.

It has been approved by the member bodies of the following countries :

Australia	Germany, F. R.	Poland
Belgium	Hungary	Romania
Brazil	India	South Africa, Rep. of
Bulgaria	Israel	Spain
Canada	Italy	Sweden
China	Japan	Switzerland
Czechoslovakia	Korea, Rep. of	United Kingdom
Egypt, Arab Rep. of	Libyan Arab Jamahiriya	USA
Finland	Netherlands	USSR
France	New Zealand	

No member body expressed disapproval of the document.

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Plastics — Styrene/acrylonitrile (SAN) copolymer moulding and extrusion materials — Part 2 : Determination of properties

1 Scope and field of application

This International Standard specifies procedures for moulding specimens of styrene/acrylonitrile (SAN) compounds in a specified state and methods for measuring their properties. Any property listed in Part 2 and referred to in combination with Part 1 shall be determined by the method referred to in Part 2.

No figures are quoted for these properties. Those required for the designation of SAN compounds are given in ISO 4894/1. Other properties shall be determined by the appropriate methods referred to in this International Standard and values may be obtained from manufacturers' literature. They can be directly compared if the procedures described herein for preparing the test specimens and for determining the properties are followed.

2 References

ISO 62, *Plastics — Determination of water absorption.*

ISO 75, *Plastics and ebonite — Determination of temperature of deflection under load.*

ISO 175, *Plastics — Determination of the effects of liquid chemicals including water.*

ISO 178, *Plastics — Determination of flexural properties of rigid plastics.*

ISO 179, *Rigid plastics — Determination of Charpy impact strength.*[1]

ISO 180, *Rigid plastics — Determination of Izod impact strength.*[2]

ISO 306, *Plastics — Determination of the Vicat softening temperature of thermoplastics.*

ISO/R 489, *Plastics — Determination of the refractive index of transparent plastics.*

ISO 527, *Plastics — Determination of tensile properties.*[3]

ISO 537, *Plastics — Testing with the torsion pendulum.*

ISO 604, *Plastics — Determination of compressive properties.*

ISO 1133, *Plastics — Determination of the melt flow rate of thermoplastics.*[4]

ISO/R 1183, *Plastics — Methods for determining the density and relative density (specific gravity) of plastics, excluding cellular plastics.*

ISO/R 1195, *Plastics — Determination of the water vapour transmission rate of plastic films and thin sheets — Dish method.*

ISO/R 1628, *Plastics — Directives for the standardization of methods for the determination of the dilute solution viscosity of polymers.*

ISO 1656, *Raw natural rubber and natural rubber latex — Determination of nitrogen.*

ISO 2039, *Plastics and ebonite — Determination of hardness by the ball indentation method.*

ISO 2039/2, *Plastics — Determination of Rockwell hardness.*[5]

ISO 2556, *Plastics — Determination of the gas transmission rate of films and thin sheets under atmospheric pressure — Manometric method.*

1) At present at the stage of draft. (Revision of ISO/R 179.)

2) At present at the stage of draft. (Revision of ISO/R 180.)

3) At present at the stage of draft. (Revision of ISO/R 527.)

4) At present at the stage of draft. (Revision of ISO/R 292 and ISO/R 1133.)

5) At present at the stage of draft.

ISO 2557, *Plastics — Amorphous thermoplastic moulding materials — Preparation of test specimens with a defined level of shrinkage.*

ISO 2561, *Plastics — Determination of residual styrene monomer in polystyrene by gas chromatography.*

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

ISO 3167, *Plastics — Preparation and use of multipurpose test specimens.*

ISO 4581, *Plastics — Styrene/acrylonitrile copolymers — Determination of residual acrylonitrile monomer content — Gas chromatographic method.*

ISO 4600, *Plastics — Determination of environmental stress cracking (ESC) — Ball or pin impression method.*

IEC Publication 93, *Recommended methods of test for volume and surface resistivities of electrical insulating materials.*

IEC Publication 112, *Recommended method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions.*

IEC Publication 243, *Recommended methods of test for electric strength of solid insulating materials at power frequencies.*

IEC Publication 250, *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.*

3 Properties

The values determined according to this International Standard will not necessarily be identical to those obtained using specimens of different dimensions and/or prepared by different procedures. They may also be influenced by colorants and other additives. The values obtained for the properties of a moulding depend on the moulding compound, the shape, the test method and the state or anisotropy. The latter depends on the gating and the moulding conditions, for example temperature, pressure or injection rate. Any subsequent treatment must also be considered, for example conditioning or annealing.

The thermal history and the internal stresses of the specimens may strongly influence thermal and mechanical properties and resistance to environmental stress cracking, but exert less effect on the electrical properties, which mainly depend on the chemical composition of the moulding compound.

4 Preparation of test specimens

4.1 General

The specimens shall be prepared and their state assessed by the methods specified in ISO 2557.[1] Before processing, the moulding compound shall be pre-dried as specified in 4.3 or as required by the manufacturer's instructions.

NOTE — Whenever possible, use the multipurpose specimen described in ISO 3167, or parts thereof.

4.2 State of the test specimen

4.2.1 Defined state

Longitudinally oriented specimens shall be injection moulded in a mould with a frontal gate. The diameter of the gate shall be at least equal to the minimum dimension of the specimen. The moulding conditions depend upon the size of the specimens, the moulding machine, and the moulding compound. They should be set so that the maximum shrinkage, S_m (170 °C, 15 min, in air), in the trimmed 30 mm central part of the specimen, is 60 ± 10 %, when determined in air by the method specified in ISO 2557.

4.2.2 Basic state

Specimens in the basic state, i.e., nearly free of internal stresses and orientations, shall be prepared by compression moulding or by thermal relaxation of injection-moulded specimens.

The specimens shall be considered to be in their basic state if, after 15 min at 170 °C in air :

a) the structure of their surface does not change;

b) the values of their properties are known not to change as a result of heat treatment;

c) their maximum shrinkage is 3 % or less (see 4.2.1) :

S_m = 0 to 3 % (170 °C, 15 min, in air).

1) Test specimens with a longitudinal orientation shall be injection moulded separately and not machined from injection-moulded plates.

4.2.2.1 Compression moulding

The conditions for compression moulding shall be adapted to the presses, moulds and moulding compounds. The following starting conditions are recommended :

Temperature : 180 °C

Pre-heating time : 5 min

Moulding pressure : 4 MPa (per square millimetre area of test specimen)

Moulding time : 5 min

Cooling rate : 10 ± 5 K/min (under pressure)

Demoulding at ⩽ 60 °C

4.2.2.2 Thermal relaxation

The conditions for thermal relaxation shall be adapted to the presses, moulds, and moulding materials. The following starting conditions are recommended :

Temperature : 180 °C

Pressure : 1,5 MPa

Relaxation time : 15 min

Cooling rate : 10 ± 5 K/min (under pressure)

Demoulding at ⩽ 60 °C

4.3 Conditioning

After moulding, specimens shall be allowed to cool to 23 ± 2 °C in a desiccator. In case of dispute, the specimens or particles shall be placed for 4 h in an oven at 80 °C, then cooled in a desiccator to 23 ± 2 °C, and stored there until required for testing.

5 Test methods

5.1 General

The properties quoted shall be determined using the specimens and methods referred to in the table. All measurements shall be made at 23 ± 2 °C and 50 ± 5 % relative humidity unless otherwise stated in the relevant International Standard.

If the values for the properties have been determined on specimens with defined longitudinal shrinkage, this shall be stated.

For example,

a) for Charpy impact strength unnotched determined on specimens with a longitudinal shrinkage of 60 % :

Charpy impact strength (unnotched, S_m = 60 %)

= 25 kJ/m^2;

b) for Charpy impact strength unnotched determined on specimens in the basic state, i.e., with a longitudinal shrinkage of 0 to 3 % :

Charpy impact strength (unnotched, S_m = 0 to 3 %)

= 10 kJ/m^2.

5.2 Determination of bound acrylonitrile content

5.2.1 Preparation

Dry granules or particles of similar size to constant mass (for approximately 3 h) in a vacuum oven at 80 °C and a pressure less than or equal to 15 mbar.[1] After cooling in a desiccator, extract the particles for 80 h in a Soxhlet apparatus with *n*-hexane. During this time, additives such as antioxidants, lubricants and oligomers will be removed. Dry the residue under vacuum (60 °C, ⩽ 15 mbar) to constant mass.

5.2.2 Analysis

Determine the acrylonitrile content of the resin by the Kjeldahl semi-micro method of analysis of nitrogen specified in ISO 1656.

5.2.3 Calculation

The acrylonitrile content, expressed as a percentage by mass, is given by the formula

$$3{,}79 \times c$$

where

c is the nitrogen content of the resin, expressed as a percentage by mass;

3,79 is the ratio of the relative molecular masses of acrylonitrile (C_2H_3CN) and nitrogen.

1) 1 mbar = 100 Pa

Table — Methods of test for styrene/acrylonitrile compounds

Property	Unit	Method	Specimen dimensions, mm	State[1]	Particulars
Tests on moulding material					
Melt flow rate[2]	g/10 min	ISO 1133	– [3]	–	Load 10 kg, *t* 220 °C
Viscosity number	cm^3/g	ISO/R 1628	– [3]	–	0,005 g/ml in dimethylformamide
Density	g/cm^3	ISO/R 1183	– [3]	–	
Tests on standard specimens					
Mechanical properties					
Shear modulus	MPa	ISO 537	60 × 10 × 1 [4]	A	Frequency 0,1 to 10 Hz
Mechanical loss factor	–	ISO 537	60 × 10 × 1 [4]	A	Frequency 0,1 to 10 Hz
Tensile modulus of elasticity	MPa	ISO 527	150 × 20/10 × 4	B	Testing speed 1 mm/min
Tensile stress at break or at yield	MPa	ISO 527	150 × 20/10 × 4	B	Testing speed 5 mm/min
Tensile elongation at break or at yield	%	ISO 527	150 × 20/10 × 4	B	Testing speed 5 mm/min
Flexural modulus of elasticity	MPa	ISO 178	80 × 10 × 4	B	Testing speed 1 mm/min
Flexural stress at rupture	MPa	ISO 178	80 × 10 × 4	B	Testing speed 2 mm/min
Flexural deflection at rupture	mm	ISO 178	80 × 10 × 4	B	Testing speed 2 mm/min
Impact strength Charpy	kJ/m^2	ISO 179	50 × 6 × 4 [4] [5]	B	
Impact strength Izod	J/m	ISO 180	63,5 × 12,7 × 3,2 or 80 × 10 × 4	B	
Compressive strength	MPa	ISO 604	11,6 × 6 × 4	B	Testing speed 1 mm/min
Rockwell-α hardness number	–	ISO 2039/2	50 × 50 × 6	B	
Ball indentation hardness	daN/mm^2	ISO 2039	10 × 10 × 4 [6]	A	Load 35,8 daN, time 30 s
Thermal properties					
Vicat softening temperature[2]	°C	ISO 306, method B	10 × 10 × 3/6,4 [6]	A	Heating rate 50° C/h
Temperature of deflection under load	°C	ISO 75, method A	110 × 10 × 4	B	Heating rate 2 °C/min
Electrical properties					
Surface resistivity	Ω	IEC 93	120 × 120 × 1 [4]	A	1 000 V measuring voltage
Volume resistivity	Ω·cm	IEC 93	120 × 120 × 1 [4]	A	1 000 V measuring voltage
Electric strength	kV/mm	IEC 243	120 × 120 × 0,5 [4]	A	A C voltage; electrode : sphere *diameter 20 mm, against plate* under dibutylphthalate, rapidly applied
Relative permittivity ε_r		IEC 250	120 × 120 × 1 [4]	A	A C voltage, 1 MHz
Dissipation factor, tan δ		IEC 250	120 × 120 × 1 [4]	A	A C voltage, 1 MHz
Comparative tracking index		IEC 112	50 × 50 × 3 [4]	A	A C voltage, 50 Hz
Miscellaneous properties					
Refractive index	–	ISO/R 489			
Water vapour transmission rate	$g/(m^2 \cdot 24\ h)$	ISO/R 1195	Disc φ 80 × 0,1	B	Testing atmosphere : 25 °C, 90 % relative humidity
Gas transmission rate	$cm^3/(m^2 \cdot 24\ h \cdot 1\ atm)$ [7]	ISO 2556	Sheet 0,1	B	
Water absorption		ISO 62, method 1	Disc φ 50 × 3	B	
Effect of liquid chemicals		ISO 175		B	Immersion time 7 days
Environmental-stress-cracking		ISO 4600	80 × 10 × 4	B	*n*-heptane : propan-2-ol [1 : 10 (*V*/*V*)]
Residual styrene monomer	%	ISO 2561			
Residual acrylonitrile monomer	%	ISO 4581			

1) A indicates that specimens can be tested either in the basic state **or** in the oriented state, because orientation does not affect the values of these properties.

B indicates that it is advisable to test specimens both in the basic state **and** in the oriented state, because orientation affects the value of these properties.

2) Properties used for material designation in ISO 4894/1.

3) Moulding material or fragments of moulded articles.

4) Specimens of other dimensions may be used when they give the same results.

5) To be replaced eventually by a cross section of 10 mm × 4 mm.

6) Specimens may be machined (see ISO 2818).

7) 1 $cm^3/(m^2 \cdot 24\ h \cdot 1\ atm)$ = 0,114 3 fm/(Pa.s).

Annex

Other International Standards for styrene-containing moulding and extrusion materials

(This annex does not form part of the standard.)

ISO 1622, *Plastics — Polystyrene moulding and extrusion materials — Designation.*

ISO 1622/2, *Plastics — Polystyrene moulding and extrusion materials — Part 2 : Determination of properties.*

ISO 2580/1, *Plastics — Acrylonitrile-butadiene-styrene (ABS) moulding and extrusion materials — Part 1 : Designation.*

ISO 2580/2, *Plastics — Acrylonitrile-butadiene-styrene (ABS) moulding and extrusion materials — Part 2 : Determination of properties.*[1)]

ISO 2897, *Plastics — Designation of impact-resistant polystyrenes.*

ISO 2897/2, *Plastics — Impact-resistant polystyrenes — Part 2 : Determination of properties.*

ISO 4894/1, *Plastics — Styrene/acrylonitrile (SAN) copolymer moulding and extrusion materials — Part 1 : Designation.*

ISO 6402/1, *Plastics — Impact-resistant acrylonitrile/styrene moulding and extrusion materials (ASA, AES, ACS) excluding butadiene-modified materials — Part 1 : Designation.*[1)]

1) At present at the stage of draft.