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# Plastics — Extruded sheets of impact-modified acrylonitrile-styrene copolymers (ABS, AEPDS and ASA) — Requirements and test methods

*Plastiques — Plaques extrudées en copolymères d'acrylonitrile-styrène modifiés choc (ABS, AEPDS ou ASA) — Exigences et méthodes d'essai*

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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 15015 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

This second edition cancels and replaces the first edition (ISO 15015:2007), of which it constitutes a minor revision in which the temperature in Tables 2, 3 and A.2 at which the Charpy impact strength of notched specimens is measured has been changed from −20 °C to +23 °C.

# Plastics — Extruded sheets of impact-modified acrylonitrile-styrene copolymers (ABS, AEPDS and ASA) — Requirements and test methods

## 1 Scope

This International Standard specifies the requirements and test methods for solid flat extruded sheets of impact-modified acrylonitrile-styrene copolymer materials: acrylonitrile-butadiene-styrene (ABS), acrylonitrile-(ethylene-propylene-diene)-styrene (AEPDS) (commonly known as AES) and acrylonitrile-styrene-acrylate (ASA), without fillers or reinforcing materials. This International Standard also applies to ABS, AEPDS and ASA sheet in rolled form. It applies only to thicknesses from 0,25 mm to 20,0 mm.

## 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 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 306:2004, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

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

ISO 1183 (all parts), *Plastics — Methods for determining the density of non-cellular plastics*

ISO 2039-1, *Plastics — Determination of hardness — Part 1: Ball indentation method*

ISO 2580-1, *Plastics — Acrylonitrile-butadiene-styrene (ABS) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

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

ISO 6402-1, *Plastics — Acrylonitrile-styrene-acrylate (ASA), acrylonitrile-(ethylene-propylene-diene)-styrene (AEPDS) and acrylonitrile-(chlorinated polyethylene)-styrene (ACS) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

ISO 6603-1:2000, *Plastics — Determination of puncture impact behaviour of rigid plastics — Part 1: Non-instrumented impact testing*

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

# 3 Material

Sheets shall be made of either ABS extrusion materials as defined in ISO 2580-1 or AEPDS (AES) or ASA extrusion materials as defined in ISO 6402-1, without fillers or reinforcing materials. The extrusion materials can contain additives such as processing aids, stabilizers, flame-protective agents and colorants. Compounds and additives of unknown identity shall not be used.

NOTE Legal conditions might necessitate a specific choice of extrusion material (see 4.3.3).

# 4 Requirements

## 4.1 Appearance

Sheets shall be substantially free from bubbles, voids, cracks, visible impurities and other defects which would make them unfit for the intended use. Surfaces shall be substantially smooth, if not embossed, and free from grooves, sink marks or damage. Colorants shall be homogeneously distributed throughout the material. Slight colour variations due to variations in the extrusion compound or processing conditions are admissible. The exact extent of variations in any of the above, as well as gloss level specifications, if required, shall be agreed between the interested parties. Sheets shall be examined in accordance with 5.3.

## 4.2 Dimensional tolerances

### 4.2.1 Thickness

Within any delivery of sheets, the maximum thickness variation from the nominal value, $\Delta h_1$, in millimetres, shall satisfy the requirement

$$|\Delta h_1| \leqslant (0{,}03\ \text{mm} + 0{,}04 \times h_\text{n}) \tag{1}$$

where $h_\text{n}$ is the nominal sheet thickness, in millimetres.

Within any individual sheet, the maximum thickness variation, $\Delta h_2$, in millimetres, shall satisfy the requirement

$$|\Delta h_2| \leqslant (0{,}03\ \text{mm} + 0{,}02 \times h_\text{n}) \tag{2}$$

Testing shall be in accordance with 5.4.1.

### 4.2.2 Length and width

The nominal length, $l_\text{n}$, and nominal width, $b_\text{n}$, of sheets shall be as agreed between the interested parties. Unless agreed differently, the length shall be in the direction of extrusion.

For any individual sheet selected at random from any delivery, the tolerances on length and width shall be in accordance with Table 1. Testing shall be in accordance with 5.4.2.

**Table 1 — Tolerances on length and width of sheets**

Values in millimetres

| Nominal dimension $D_\text{n}$ | Tolerances | |
|---|---|---|
| | Length | Width |
| $D_\text{n} \leqslant 1\,000$ | $^{+3}_{-1}$ | $^{+2}_{-1}$ |
| $D_\text{n} > 1\,000$ | $^{+3\times10^{-3}\times l_\text{n}}_{-1}$ | $^{+2\times10^{-3}\times b_\text{n}}_{-1}$ |

For rolled sheets, the minimum length shall be the nominal length.

### 4.2.3 Rectangularity

For any individual sheet selected at random from any delivery, the rectangularity tolerance, expressed as the difference in length of the diagonals, $|d_1 - d_2|$ (see Figure 1), shall satisfy the requirement

$$|d_1 - d_2| \leqslant 2 \times 10^{-3} \times \sqrt{(l_n^2 + b_n^2)} \quad (3)$$

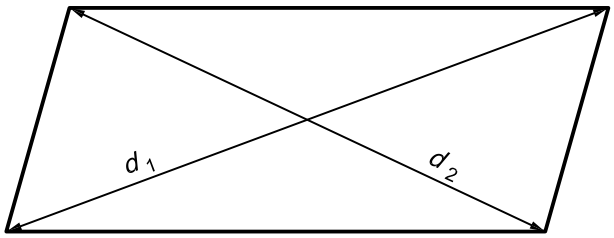



**Figure 1 — Difference in length of diagonals, $|d_1 - d_2|$**

Testing shall be in accordance with 5.4.3.

### 4.2.4 Bow of sheets in rolled form

For sheets in rolled form, a maximum bow of 20 mm in a 10 m length is permissible. Testing shall be in accordance with 5.4.4.

## 4.3 Properties

### 4.3.1 Mechanical and thermal properties

The basic mechanical and thermal properties shall be as specified in Tables 2 and 3. Guide values of other properties of extruded ABS, AEPDS (AES) and ASA sheets are given in Tables A.1 and A.2 in Annex A.

**Table 2 — Mechanical and thermal properties — ABS**

| Property | | Unit | Requirements (average values) for | | Test method subclause |
|---|---|---|---|---|---|
| | | | ABS-NI[a] | ABS-HI[a] | |
| Mechanical properties | Tensile stress at yield, $\sigma_y$ | MPa | $\geqslant$ 35 | $\geqslant$ 30 | 5.6.1 |
| | Tensile modulus, $E_t$ | MPa | $\geqslant$ 2 100 | $\geqslant$ 1 800 | 5.6.2 |
| | Charpy impact strength of unnotched specimens, $a_{cu}$, at −20 °C[b] | kJ/m$^2$ | $\geqslant$ 40 | $\geqslant$ 60 | 5.6.3 |
| | Charpy impact strength of notched specimens, $a_{cn}$, at +23 °C[b] | kJ/m$^2$ | $\geqslant$ 10 | $\geqslant$ 15 | 5.6.4 |
| | 50 % impact-failure energy, $E_{50}$, at $h_n = 4$ mm | J | $\geqslant$ 30 | $\geqslant$ 55 | 5.6.5 |
| | Ball indentation hardness, HB (test load 358 N) | N/mm$^2$ | $\geqslant$ 80 | $\geqslant$ 60 | 5.6.6 |
| Thermal properties | Vicat softening temperature, VST (force 50 N, heating rate 50 °C/h) | °C | 90 to 105 | 85 to 105 | 5.7.1 |

[a] NI: normal impact, HI: high impact.

[b] Only valid for nominal sheet thicknesses $h_n \geqslant 4$ mm (see also 5.1.1).

**Table 3 — Mechanical and thermal properties — AEPDS (AES) and ASA**

| Property | | Unit | Requirements (average values) for | | Test method subclause |
|---|---|---|---|---|---|
| | | | AEPDS | ASA | |
| Mechanical properties | Tensile stress at yield, $\sigma_y$ | MPa | $\geqslant$ 30 | $\geqslant$ 30 | 5.6.1 |
| | Tensile modulus, $E_t$ | MPa | $\geqslant$ 1 700 | $\geqslant$ 1 500 | 5.6.2 |
| | Charpy impact strength of unnotched specimens, $a_{cu}$, at –20 °C[a] | kJ/m$^2$ | $\geqslant$ 60 | $\geqslant$ 80 | 5.6.3 |
| | Charpy impact strength of notched specimens, $a_{cn}$, at +23 °C[a] | kJ/m$^2$ | $\geqslant$ 25 | $\geqslant$ 30 | 5.6.4 |
| | 50 % impact-failure energy, $E_{50}$, at $h_n$ = 4 mm | J | $\geqslant$ 60 | $\geqslant$ 60 | 5.6.5 |
| | Ball indentation hardness, HB (test load 358 N) | N/mm$^2$ | $\geqslant$ 70 | $\geqslant$ 60 | 5.6.6 |
| Thermal properties | Vicat softening temperature, VST (force 50 N, heating rate 50 °C/h) | °C | 85 to 105 | 85 to 105 | 5.7.1 |

[a] Only valid for nominal sheet thicknesses $h_n \geqslant$ 4 mm (see also 5.1.1).

### 4.3.2 Behaviour on heating

The maximum shrinkage in the direction of extrusion shall not exceed the values given in Table 4 when measured using the method specified in 5.7.2 under the conditions given in Table 6. The test specimens shall be substantially free from bubbles and cracks after heating.

**Table 4 — Maximum shrinkage for thermoforming applications**

| Nominal thickness, $h_n$ | 0,25 mm | 0,5 mm | 1 mm | 2 mm | 4 mm | 8 mm | > 8 mm |
|---|---|---|---|---|---|---|---|
| Max. shrinkage in the direction of extrusion | 35 % | 22 % | 16 % | 12 % | 8 % | 6 % | Not relevant |

Intermediate values for other sheet thicknesses can be calculated by interpolation.

### 4.3.3 Physiological behaviour

Relevant legislation concerning physiological behaviour shall be taken into consideration.

## 5 Test methods

### 5.1 Test specimens

#### 5.1.1 Preparation of test specimens

Representative test specimens shall be cut both longitudinally and transversely from locations evenly distributed over the length and width of the sheet. With sheets in rolled form, a 2 m sample shall be cut from the end of the roll to prepare test specimens. The surfaces of the test specimens shall be free from damage and faults in order to avoid notch effects. Should any burrs be formed on the test specimens during preparation, these shall be eliminated without damaging the surfaces of the specimens. If required, the cut edges shall be finished with abrasive paper (grain size 220 or finer), the direction of abrasion being along the length of the test specimens. If it is necessary to machine the sheet to reduce it to the thickness required, one original surface shall be left intact. In particular, test specimens over 4,2 mm thick intended to be used in the tests described in 5.6.1 to 5.6.6 shall be machined down on one side to a thickness of 4,0 mm $\pm$ 0,2 mm in accordance with ISO 2818.

#### 5.1.2 Conditioning

Any production quality control test specimens shall be conditioned for at least 16 h in accordance with ISO 291 or as specified in the appropriate material standard. Shorter conditioning times may be used by agreement between the interested parties when it can be shown that there is no significant difference in the results obtained.

#### 5.1.3 Test conditions

Testing shall be carried out under conditions which are in accordance with ISO 291, unless otherwise agreed between the interested parties or specified in the individual test standards.

### 5.2 Delivery condition

Surfaces and cut edges shall be visually examined for bubbles, voids, cracks, notches and swarf.

### 5.3 Appearance

Where possible, sheets shall be examined for visual defects by transmitted light using a suitable light source. Otherwise, sufficiently bright reflected light shall be used. Any defects thus identified shall be compared with the agreed specification (which may be either a written specification or in the form of reference samples) and the sheets classified accordingly.

### 5.4 Dimensions

#### 5.4.1 Thickness, $h$

The thickness, $h$, shall be measured using suitable calibrated equipment meeting the requirements given in Table 5.

**Table 5 — Error limits of equipment**

Values in millimetres

| Nominal thickness, $h_n$ | Error limit |
|---|---|
| $0{,}25 \leqslant h_n < 1{,}0$ | $\leqslant +0{,}01$ |
| $1{,}0 \leqslant h_n < 10{,}0$ | $\leqslant +0{,}05$ |
| $10{,}0 \leqslant h_n \leqslant 20{,}0$ | $\leqslant +0{,}1$ |

#### 5.4.2 Length, $l$, and width, $b$

The length, $l$, and width, $b$, shall be measured to the nearest 1 mm using suitable equipment. Measurements shall be made directly across the surface of the sheet and along the cut edge.

#### 5.4.3 Rectangularity

For flat sheets, the rectangularity, expressed as the difference between the lengths of the diagonals, $|d_1 - d_2|$, as shown in Figure 1, shall be measured to the nearest 1 mm using a graduated ruler or tape measure.

#### 5.4.4 Bow of sheets in rolled form

For sheets in rolled form, the bow shall be determined after the sheets have been pulled free from the rolls and measured against a straight edge. The bow shall be measured to the nearest 1 mm using suitable calibrated equipment.

## 5.5 Density

The density shall be determined in accordance with the appropriate part of ISO 1183.

## 5.6 Mechanical properties

### 5.6.1 Tensile stress at yield, $\sigma_y$

The tensile stress at yield, $\sigma_y$, shall be determined using at least five type 1B test specimens in each direction in accordance with ISO 527-2, using a test speed of 50 mm/min $\pm$ 5 mm/min.

### 5.6.2 Modulus of elasticity in tension, $E_t$

The modulus of elasticity in tension, $E_t$, shall be determined using at least type 1B test specimens in each direction in accordance with ISO 527-2, using a test speed of 1 mm/min $\pm$ 0,2 mm/min.

### 5.6.3 Charpy impact strength of unnotched specimens, $a_{cu}$

To determine the influence of surface effects caused by the processing conditions, the Charpy impact strength of unnotched specimens, $a_{cu}$, for nominal sheet thicknesses $h_n \geqslant 4$ mm shall be determined flatwise in accordance with ISO 179-1/1fU or ISO 179-2/1fU, using at least 10 test specimens cut in each direction. If the test specimens are machined down to the required thickness, the impact shall be applied to the machined surface.

### 5.6.4 Charpy impact strength of notched specimens, $a_{cn}$

To determine the influence of surface effects caused by the processing conditions, the Charpy impact strength of notched specimens, $a_{cn}$, shall be determined for nominal sheet thicknesses $h_n \geqslant 4$ mm, flatwise in accordance with ISO 179-1/1fA or ISO 179-2/1fA, using at least 10 double-notched test specimens cut in each direction. If the test specimens are machined down to the required thickness, the impact shall be applied to the machined surface.

### 5.6.5 Puncture impact behaviour

The puncture impact behaviour shall be determined as the 50 % impact-failure energy, $E_{50}$, in accordance with ISO 6603-1:2000, staircase method A.

### 5.6.6 Ball indentation hardness

The ball indentation hardness shall be determined in accordance with ISO 2039-1, using a test load of 358 N.

## 5.7 Thermal properties

### 5.7.1 Vicat softening temperature

The Vicat softening temperature shall be determined in accordance with method B50 of ISO 306:2004. The thickness of the test specimens shall be equal to the thickness of the sheet, except as follows:

a) If the thickness exceeds 6,5 mm, the test specimens shall be reduced in thickness to between 3 mm and 6,5 mm by machining one surface (see ISO 2818), the other surface being left intact. The test surface shall be the intact one.

b) If the thickness of the sheet is less than 3 mm, not more than three pieces shall be stacked together in direct contact to give a total thickness between 3 mm and 6,5 mm and the thickness of the upper (measured) piece shall be at least 1,5 mm. Stacking of pieces of lesser thickness does not always give the same test result.

### 5.7.2 Determination of shrinkage on heating

The shrinkage on heating shall be determined in accordance with the principles of ISO 11501. The principle of the test procedure is as follows:

a) a tray containing a kaolin or talc bed is placed in a circulating-air oven and the temperature controlled such that the bed is within the specified temperature limits;

b) the initial length between the reference marks on each test specimen is measured in the longitudinal direction;

c) the test specimens are heated for a specified period of time at a specified temperature on the kaolin or talc bed in the circulating-air oven;

d) the distance between the longitudinal reference marks is measured again after cooling, and the change in the length of each specimen calculated.

Cut at least three test specimens with dimensions of 100 mm × 100 mm from the centre and both sides of the sheet. The side test specimens shall be taken at least 50 mm from the edge of the sheet. Make one or more pairs of reference marks on the specimens in the extrusion direction. Measure the initial length, $L_0$, between the pairs of marks with an accuracy of 0,1 mm at room temperature. Cover the test specimens with kaolin or talc and place them flat on the kaolin or talc bed in the circulating-air oven. The temperature and duration of the test shall be as given in Table 6.

**Table 6 — Shrinkage test conditions for ABS, AEPDS (AES) or ASA sheet**

| **Nominal sheet thickness,** $h_n$<br>mm | **Test temperature**<br>°C | **Duration of test**[a]<br>min |
|---|---|---|
| $0{,}25 \leqslant h_n < 1{,}0$ | $170 \pm 2$ | $10 \pm 1$ |
| $1{,}0 \leqslant h_n < 4{,}0$ | $170 \pm 2$ | $20 \pm 1$ |
| $4{,}0 \leqslant h_n < 8{,}0$ | $170 \pm 2$ | $30 \pm 1$ |
| $8{,}0 \leqslant h_n$ | $170 \pm 2$ | $60 \pm 1$ |
| [a] The heating period until the test temperature is reached is not included. | | |

Remove the tray with the test specimens from the circulating-air oven. Allow to cool down to room temperature. Measure the length, $L$, of each specimen between the pairs of reference marks. Calculate the shrinkage, $\Delta L$, for each pair of reference marks using Equation (4):

$$\Delta L = \frac{L_0 - L}{L_0} \times 100 \tag{4}$$

where

$\Delta L$ is the shrinkage on heating, in percent;

$L_0$ is the initial length in the direction of extrusion before heating, in millimetres;

$L$ is the length in the direction of extrusion after heating, in millimetres.

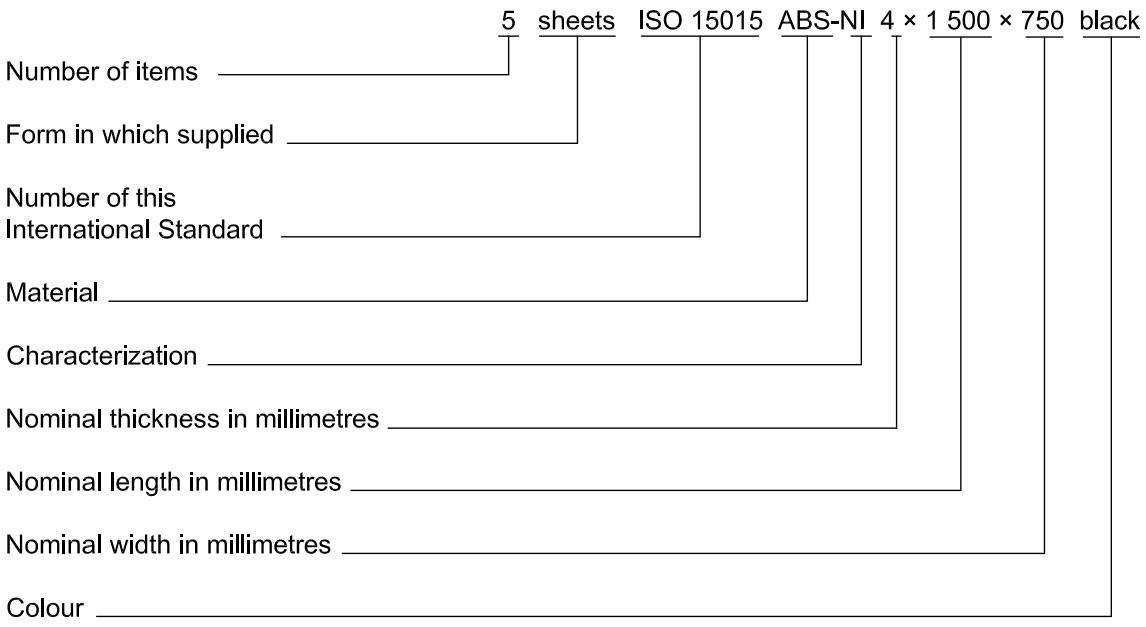
Calculate the arithmetic mean of all the $\Delta L$ values for all the specimens.

If the test specimens show a tendency to curl or become wavy, this deformation can be limited by placing a 3 mm to 4 mm thick glass sheet over the test specimens at a distance of about 3 mm. The glass plate shall rest on spacers (e.g. made from cork) of equal height. Use weights, if necessary, to hold the glass plate in place. The weights and glass plate shall be heated to the appropriate temperature given in Table 6 before use.

If agreed between the interested parties, each specimen shall be examined after the test to ensure that no excessive cracks or bubbles have developed.

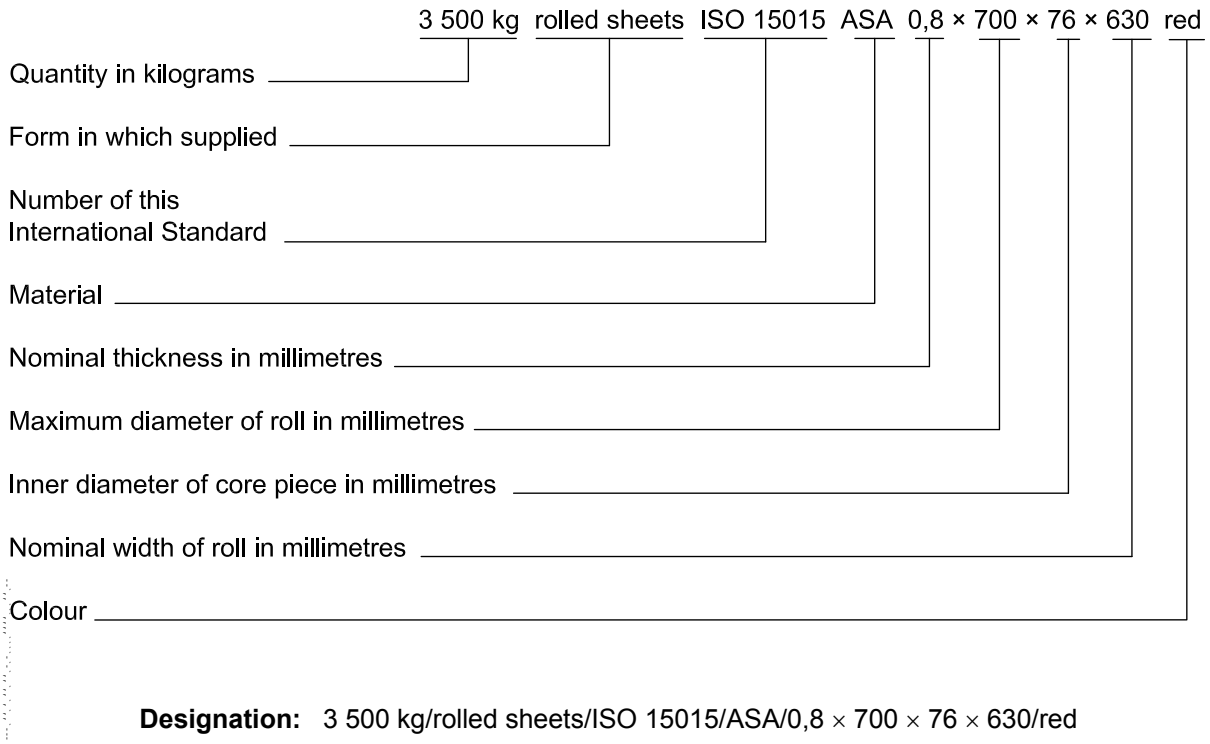
# 6 Designation

## 6.1 Example for ABS sheets




**Designation:** 5/sheets/ISO 15015/ABS-NI/4 × 1 500 × 750/black

## 6.2 Example for ASA sheets in rolled form




**Designation:** 3 500 kg/rolled sheets/ISO 15015/ASA/0,8 × 700 × 76 × 630/red

## 7 Marking

Sheets and rolls that conform to this International Standard may be marked with the following information:

a) the manufacturer's name, trade mark or identification mark;

b) the reference number of this International Standard, ISO 15015;

c) the designation of the material;

d) the date of manufacture/batch number.

# Annex A
(informative)

# Additional guide values

**Table A.1 — Guide values for further physical properties of ABS, AEPDS (AES) and ASA extrusion materials**

| Physical properties | Unit | Typical value | Test method |
|---|---|---|---|
| Density, $\rho$ | g/cm$^3$ | 1,00 to 1,15 | ISO 1183 |
| Coefficient of thermal expansion, $\alpha$ (test range 23 °C to 80 °C) | K$^{-1}$ | approx. $1 \times 10^{-4}$ | ISO 7991 |
| Thermal conductivity, $\lambda$ | W/m·K | approx. 0,17 | ISO 8302:1991, method A |
| Surface resistivity, $\rho_S$ | Ω | approx. $10^{13}$ | IEC 60093 |
| Volume resistivity, $\rho_D$ | Ω·m | approx. $10^{13}$ | IEC 60093 |
| Water absorption, $W_A$, up to saturation at 23 °C | % by mass | approx. 1,7 | ISO 62 |

**Table A.2 — Guide values for further mechanical properties of ABS, AEPDS (AES) and ASA extrusion materials**

| Mechanical properties | Unit | ABS-NI[a] | ABS-HI[a] | AEPDS/ASA | Test method |
|---|---|---|---|---|---|
| Charpy impact strength of unnotched specimens, $a_{cu}$, at −20 °C[b] | kJ/m$^2$ | ⩾ 60 | ⩾ 75 | ⩾ 75 | ISO 179-1/1eU or ISO 179-2/1eU |
| Charpy impact strength of notched specimens, $a_{cn}$, at +23 °C[b] | kJ/m$^2$ | ⩾ 10 | ⩾ 15 | ⩾ 20 | ISO 179-1/1eA or ISO 179-2/1eA |
| Total penetration energy, $E_{tot}$, at $h_n$ = 4 mm | J | ⩾ 35 | ⩾ 60 | ⩾ 45 | ISO 6603-2 |

[a] NI: normal impact, HI: high impact.

[b] Only valid for nominal sheet thicknesses $h_n \geqslant 4$ mm (see also 5.1.1). Determined edgewise.

# Bibliography

[1] ISO 62, *Plastics — Determination of water absorption*

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

[3] ISO 7991, *Glass — Determination of coefficient of mean linear thermal expansion*

[4] ISO 8302:1991, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*

[5] IEC 60093, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials*

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