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Glass reinforced plastics — Determination of indentation hardness by means of a Barcol hardness tester

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Glass reinforced plastics - Determination of indentation hardness by means of a Barcol hardness tester

Matières plastiques renforcées de verre - Détermination de la dureté par pénétration au moyen d'un appareil d'essai de dureté Barcol

Glasfaserverstärkte Kunststoffe - Bestimmung der Eindruckhärte mit einem Barcol-Härteprüfgerät

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Contents

Page

European foreword ... **3**

1 Scope ... **4**

2 Normative references ... **4**

3 Principle ... **4**

4 Apparatus ... **4**

5 Test specimens ... **6**
5.1 Test surface ... **6**
5.2 Test specimen dimensions ... **7**

6 Calibration ... **7**
6.1 Direct calibration ... **7**
6.1.1 Indenter and presser foot ... **7**
6.1.2 Test force ... **7**
6.1.3 Penetration depth ... **7**
6.2 Verification ... **8**

7 Conditioning and testing atmospheres ... **8**

8 Procedure ... **8**

9 Number of measurements ... **9**

10 Test report ... **9**

Bibliography ... **10**

European foreword

This document (EN 59:2016) has been prepared by Technical Committee CEN/TC 249 “Plastics”, the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2016, and conflicting national standards shall be withdrawn at the latest by August 2016.

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1 Scope

This European Standard specifies a method for determining the indentation hardness of glass reinforced plastics materials by means of a Barcol hardness tester.

The Barcol hardness tester is a portable device which can be used with a stand. This method is suitable for testing the indentation hardness of individual test specimens or finished products for production control purposes.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 291, *Plastics - Standard atmospheres for conditioning and testing (ISO 291)*

3 Principle

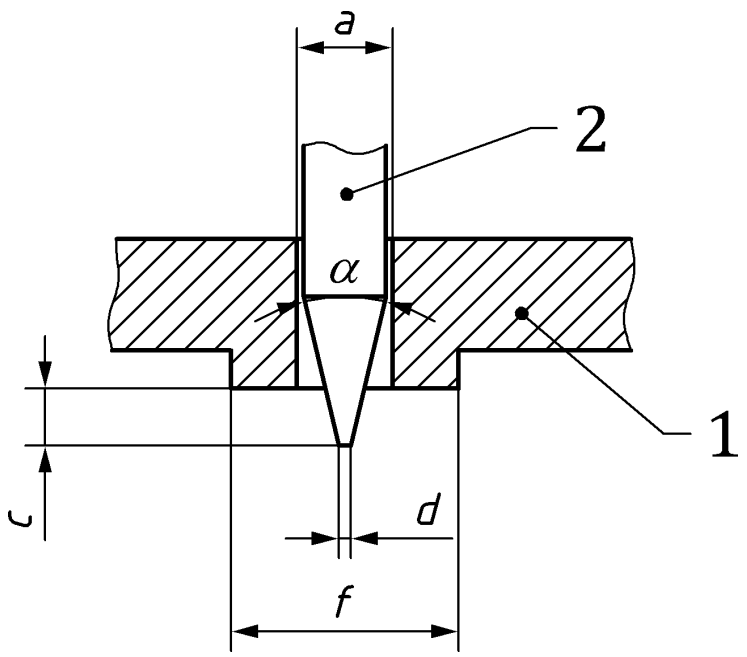
A specified indenter is forced into the test material under specified conditions and the depth of penetration measured.

4 Apparatus

4.1 Barcol hardness tester

4.1.1 Indenter, formed from a hardened steel truncated cone to the shape shown in Figure 1. The dimensions and their tolerances of the indenter are given in Table 1. It shall fit into a hollow spindle and be held down by a spring.

4.1.2 Presser foot, intended to be placed on the test specimen, to the shape shown in Figure 1. The dimensions and their tolerances of the presser foot are given in Table 1.



Key

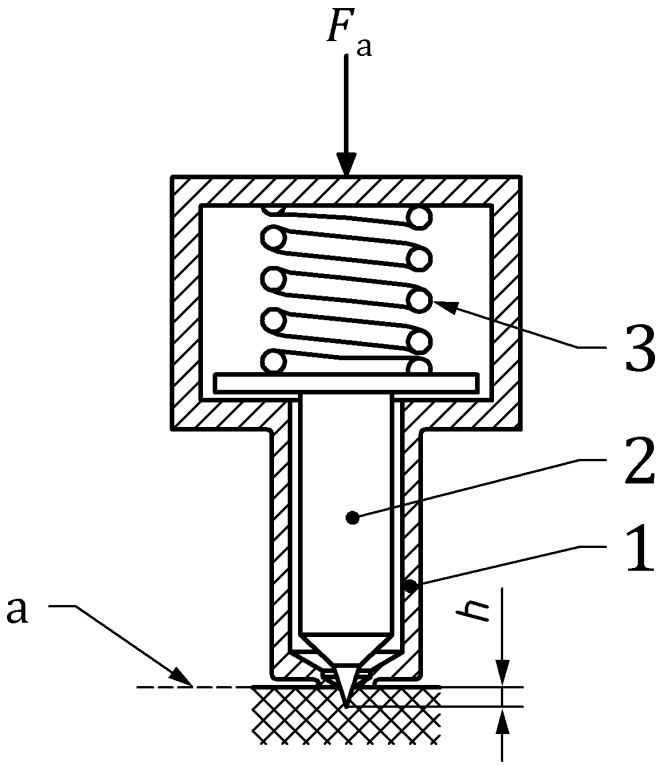
1 presser foot
2 indenter
a hole diameter of the presser foot
c full protrusion of the indenter
d diameter of the indenter flat tip
f diameter of the presser foot back face
α angle of the truncated cone of the indenter

Figure 1 — View of the indenter and presser foot

Table 1 — Dimensions of the indenter and presser foot

Dimension	Nominal size	Uncertainty of measurement
Angle of the truncated cone of the indenter, *α*	(26 ± 0,25)°	0,07°
Hole diameter of the presser foot, *a*	(1,0 ± 0,1) mm	0,01 mm
Full protrusion of the indenter, *c*	(0,760 ± 0,02) mm	3,0 µm
Diameter of the indenter flat tip, *d*	(0,157 ± 0,02) mm	3,0 µm
Diameter of the presser foot back face, *f*	(2,0 ± 1,0) mm	0,05 mm

4.1.3 Force application system, capable to apply a force from 61,10 N to 71,30 N continuously. This force is applied by a sufficient manual force ≥ 80 N from the top cover of the device, even when working with a stand.



Key

1 presser foot
2 indenter
3 spring (for spring load, see Table 2)
a reference plane
F_a applied force, ≥ 80 N
h penetration depth (0,000 mm to 0,007 6 mm)

Figure 2 — Schematic view of a Barcol hardness tester in measurement position

4.1.4 Depth measuring system, connected to the stem of the indenter which allows a penetration in the range of 0,000 mm to 0,760 mm. It is also connected to a display device which indicates the indentation hardness of the test specimen in Barcol hardness units. A penetration depth of 0,760 mm is equivalent to 0 Barcol hardness units while a penetration depth of 0,000 mm is equivalent to 100 Barcol hardness units. The scale value of the indicator is 1 Barcol unit per 0,007 6 mm penetration depth.

4.1.5 Feet, capable to support the Barcol hardness tester.

4.1.6 Fixing system, capable to adapt the Barcol hardness tester to a stand (optional).

4.2 Calibrated references plates, made from aluminium.

4.3 Smooth glass plate or hardened steel plate

5 Test specimens

5.1 Test surface

The testing area shall be smooth and free from mechanical damage (such as scratches or holes).

5.2 Test specimen dimensions

The thickness of the test specimens shall be at least 1,5 mm. The test area shall be sufficient to have a minimum distance of 3 mm from the test point to the edges of the test specimen or the previous test point in all directions.

6 Calibration

6.1 Direct calibration

6.1.1 Indenter and presser foot

All parameters of the indenter and the presser foot are calibrated according to the tolerances and uncertainties given in Table 1 with appropriate calibration devices for the measurement of the lengths and the angle. The Barcol hardness tester meets the requirements of this European Standard when the actual values match the target values within the measurement uncertainty.

6.1.2 Test force

Perform the calibration of the test force by means of a force measuring device as a comparison measurement. In this case, the actual values of the nominal values listed in Table 2 are the Barcol hardness unit of the Barcol hardness tester while the force measuring device is used as a reference standard.

The Barcol hardness tester meets the requirements of this European Standard when the actual values match the target values within the measurement uncertainty.

Table 2 — Calibration of the test load

Barcol hardness unit	Nominal value of the load N	Uncertainty of measurement N
0	61,10 ± 0,29	0,08
20	63,14 ± 0,29	0,08
40	65,18 ± 0,29	0,08
60	67,22 ± 0,29	0,08
80	69,26 ± 0,29	0,08
100	71,30 ± 0,29	0,08

6.1.3 Penetration depth

Perform the calibration of the depth by means of a length measuring device as a comparison measurement. The actual values of the nominal values given in Table 3 are the Barcol hardness units of the Barcol hardness tester while the length measuring device is used as a reference standard. The Barcol hardness tester meets the requirements of this European Standard when the actual values match the target values within the measurement uncertainty.

Table 3 — Calibration of penetration depth

Barcol hardness unit	Nominal value of penetration depth mm	Uncertainty of measurement µm
0	0,760 ± 0,020	3,0
20	0,608 ± 0,020	3,0
40	0,456 ± 0,020	3,0
60	0,304 ± 0,020	3,0
80	0,152 ± 0,020	3,0
100	0,000 ± 0,020	3,0

6.2 Verification

Check the device by a measurement on a glass plate or a hardened steel plate so as to obtain a reading of 100 on the display.

In addition the calibrated reference plates made of aluminium are used for verification. These reference plates shall be calibrated in a calibration laboratory.

The deviation of a measurement on a reference plate is limited to a maximum of ± 2 Barcol units.

The deviation of a measurement with the Barcol tester shall be maximum ± 1 Barcol unit.

The deviation due to the reference plate and the deviation due to measurement with the Barcol tester are cumulative (so the overall deviation is maximum ± 3 Barcol units).

7 Conditioning and testing atmospheres

7.1 Condition the test specimens before testing in the atmosphere specified in the relevant material specification. If no material specification exists, condition the test specimens in one of those specified in EN ISO 291.

For testing in the standard atmosphere of (23 ± 2) °C/(50 ± 2) % RH, a conditioning time of 16 h may be selected.

7.2 Carry out the test in one of the standard atmospheres specified in EN ISO 291, unless otherwise specified in the relevant material specification.

When conditioning and testing in the specified standard conditions is not possible, this shall be stated in the test report.

8 Procedure

8.1 Place the test specimen on a stable and hard surface that it cannot be bent or deformed under the pressure of the Barcol hardness tester.

Curved surfaces can cause difficulties for placing the Barcol hardness tester properly. While the pressure is applied, the deflection or jerking stress of the test specimen should be avoided.

8.2 Position the Barcol hardness tester with the feet or by using a test stand so that the presser foot is positioned straight above the specimen.

The penetration of the indenter shall occur only when the indenter is perpendicular to the surface of the test specimen.

In case of a small test specimen, it may be necessary to fit the Barcol hardness tester with one or two support feet so that the indenter can be positioned straight above the test specimen.

Impressions should not be made within 3 mm of the edge of the specimen or of other impressions.

8.3 Apply by hand a large and quick force, preferably ≥ 80 N, on the top cover of the Barcol hardness tester while the highest number on the display unit is recorded, preferably within 1 s after applying the force. The time period of 1 s starts as soon as the indenter's movement exceeds 5 Barcol units.

A slow fall in the reading on the indicating dial is sometimes noted for materials which are susceptible to creep. It is particularly important for such materials to record the highest instantaneous reading on the indicating dial.

A sliding of the indenter on the test surface during the test shall be avoided.

NOTE For materials which are subject to deformation and cannot be fully restored, fluctuations can occur on the display during the measurement In such cases, it is important to detect the maximum value on the display.

An automatic registration of time and indentation depth at a sufficient data collection frequency with an analysis algorithm may be used to calculate the initial hardness value. Registration of time dependence indentation depth offers the possibility to analyse and quantify the creep effects.

9 Number of measurements

Reinforced plastics materials are inherently heterogeneous and a large scatter of readings is observed. This is mainly caused by the differences in hardness between the resin and the reinforcement material in contact with the small diameter indenter. The number of measurements shall be such that the average result has a standard deviation of ± 4 % (at a 95 % probability level).

10 Test report

The test report shall include the following information:

a) a reference to this European Standard (i.e. EN 59);

b) all details necessary for identification of the material tested;

c) a detailed description of the test specimen (5.2);

d) conditioning and testing conditions (Clause 7);

e) the number of measurements;

f) the mean value of the indentation hardness rounded to the nearest whole integer;

g) the date of testing.

Bibliography

ASTM D2583-13A, *Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor*

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