BS ISO 17221:2014

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Plastics — Determination of image clarity (degree of sharpness of reflected or transmitted image)

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PRI/21, Testing of plastics.

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

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INTERNATIONAL STANDARD

ISO 17221

First edition
2014-05-01

Plastics — Determination of image clarity (degree of sharpness of reflected or transmitted image)

Plastiques — Détermination de la clarté de l'image (degré de netteté de l'image réfléchie ou transmise)

Reference number
ISO 17221:2014(E)

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
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Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 5, *Physical chemical properties*.

Introduction

Visual assessment of the image clarity of plastics is carried out by evaluating the sharpness of an image reflected from a surface, using a specified incident angle, for reflection. For transmission, image sharpness is evaluated by viewing a suitable target through the plastic. The degree of image clarity is influenced by the clearness, surface irregularities and haziness of surfaces. Gloss meters and haze meters do not correctly access this phenomenon. Image clarity is not the same as and should not be confused with gloss or haze. Therefore, standardized methods for determining the optical parameter of image clarity are needed.

INTERNATIONAL STANDARD ISO 17221:2014(E)

Plastics — Determination of image clarity (degree of sharpness of reflected or transmitted image)

1 Scope

This International Standard specifies an instrumental method for determining the image clarity on plastics specimens by measuring reflection from the specimen surface or transmission through the specimen.

The method can be applied only to a flat surface.

NOTE For same materials, different values of image clarity can be obtained depending on specimen preparation.

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.

ISO 472, *Plastics — Vocabulary*

ISO 2813, *Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20°, 60° and 85°*

ISO 11664-1, *Colorimetry — Part 1: CIE standard colorimetric observers*

ISO 11664-2, *Colorimetry — Part 2: CIE standard illuminants*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and the following apply.

3.1
image clarity
degree of sharpness of an image reflected by a specimen or transmitted through a specimen

Note 1 to entry: Image clarity is expressed in percentage (%).

4 Principle

For the measurement of image clarity, a lamp illuminates the narrow source aperture-slit. The collimating lens projects a parallel beam upon the specimen. The image is either reflected from or transmitted through the specimen, as appropriate. The image is received by the de-collimating lens and focused upon the optical mask. The light passing through the optical mask is received by the light receptor. This resultant signal is processed yielding image clarity values.

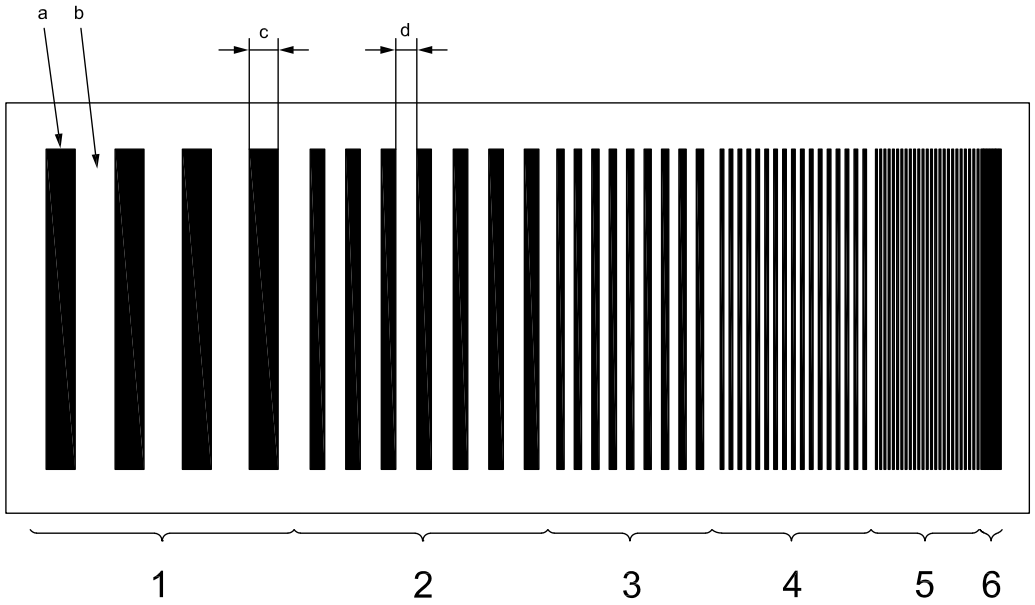
5 Instrument

5.1 Light source and spectral response. The light source and the photometer shall be used in conjunction with a filter to provide an output corresponding to the photopic standard luminous efficiency $V(\lambda)$, which is identical to the colour-matching function $y(\lambda)$ specified in ISO 11664-1, under CIE standard illuminant A as specified in ISO 11664-2. The output of the photodetector shall be proportional to the

incident flux, to within 1 % of the incident flux, over the range used. The spectral and photometric characteristics of the light source and photometer shall be kept constant during measurements.

5.2 **Slit**, 0,03 mm ± 0,01 mm in width and not less than 20 mm in length.

5.3 **Optical mask**, consisting of opaque and transparent lines having the same width and spacing. Six different groups of lines having different widths are utilized. An optical mask is illustrated in Figure 1. Table 1 gives the dimension for the lines of the optical mask.



Key

a	opaque area	Group 1	transparent and opaque lines each 2,0 mm in width
b	transparent area	Group 2	transparent and opaque lines each 1,0 mm in width
c	width of opaque area	Group 3	transparent and opaque lines each 0,5 mm in width
d	width of transparent area	Group 4	transparent and opaque lines each 0,25 mm in width
		Group 5	transparent and opaque lines each 0,125 mm in width
		Group 6	opaque line 1,0 mm in width

Figure 1 — Optical mask of image clarity

Table 1 — Optical mask (dimensions)

Group No.	**Optical mask line width** mm	**Quantity**	**Tolerance** mm	**Group width** mm
1	2,000	4	±0,200	16
2	1,000	6	±0,100	12
3	0,500	9	±0,050	9
4	0,250	16	±0,025	8
5	0,125	21	±0,013	5,25
6	1,000 (only opaque)	1	±0,100	1
NOTE Other dimensions of the optical mask may be used depending on the surface structure of the specimen if agreed upon between the interested parties.				

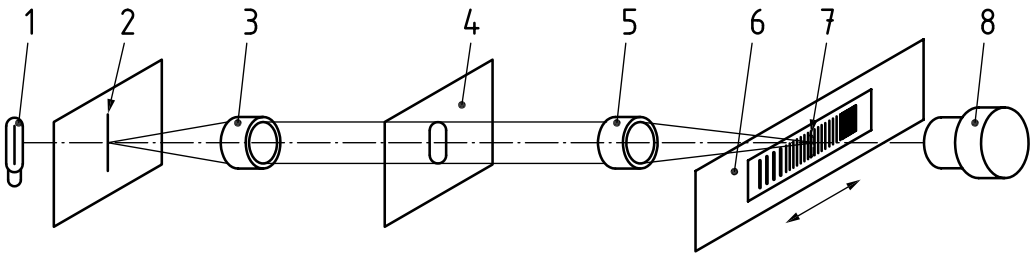
5.4 Geometry (for reflection measurement). The normal geometry is 45°:45°. The 60°:60° may be used if agreed upon between the interested parties.

NOTE The 60°:60° geometry may be used depending on the surface structure of the specimen for conforming the visual assessments.

5.5 Black glass standard, giving a constant light intensity when any of the five line widths of optical mask is used for passing light. The bottom level of the waves is defined as the standard zero level.

The black glass standard surface used should conform to specifications such as given in ISO 2813.

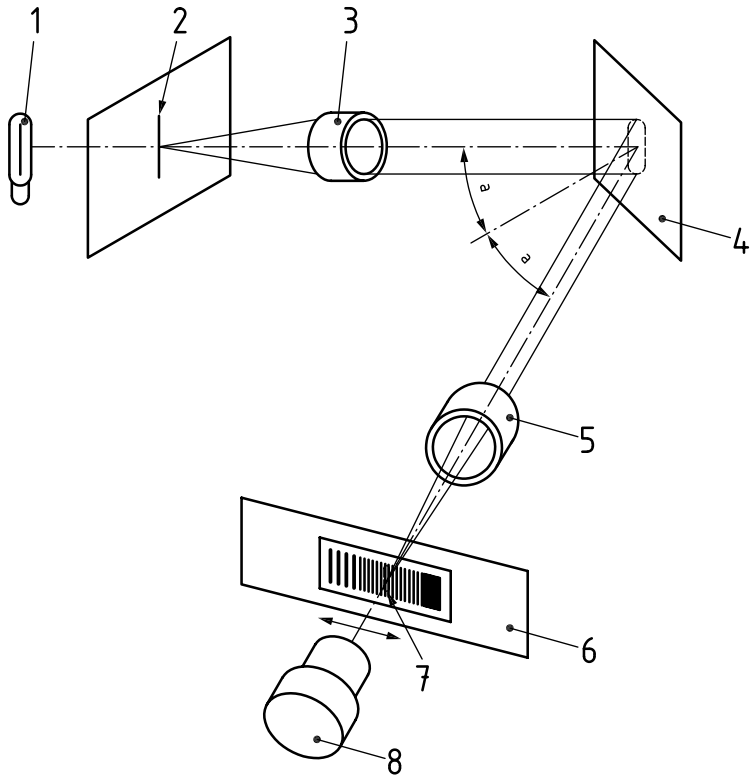
5.6 Structure. A diagrammatic representation of the apparatus used for evaluation of image clarity in transmission is shown in Figure 2. Figure 3 shows a diagrammatic representation for reflection measurement of image clarity.



Key

1 light source
2 source aperture-slit
3 collimating lens with a focal length 130 mm
4 specimen
5 de-collimating lens with a focal length 130 mm
6 optical mask
7 image of source aperture-slit on the optical mask
8 light receptor

Figure 2 — Typical diagrammatic representation for transmission measurement of image clarity



Key

1	light source	5	de-collimating lens with a focal length 130 mm
2	source aperture-slit	6	optical mask
3	collimating lens with a focal length 130 mm	7	image of source aperture-slit on the optical mask
4	specimen	8	light receptor
a	45° or 60°		

Figure 3 — Typical diagrammatic representation for reflection measurement of image clarity

6 Test specimen

For transmission and reflection, the size of the test specimen should be:

a) not less than 30 mm × 30 mm,

b) not larger than 150 mm × 150 mm, and

c) less than 10 mm in thickness.

7 Procedure

7.1 Zero adjustment

Make a zero adjustment using the dark portion of the optical mask without specimen for transmission and with the black glass standard for reflection.

7.2 Sensitivity adjustment

Scan the optical mask over its full range and adjust the full scale standardization sensitivity so that the maximum signal is not saturating the electronics. That is increasing the sensitivity and causes a corresponding change in signal at maximum signal condition.

7.3 Measurement on the test specimen

Some specimens exhibit directionality. For those specimens, it is necessary to measure in one orientation, rotate 90° and measure again. If necessary, carry out measurements for other additional orientations. Record the image clarity values and the orientation of the specimen relative to the slit.

If specimens exhibit directionality and image clarity values do not conform to visual assessment, it is necessary to measure another direction.

8 Calculation

Calculate the image clarity value from the wave heights using Formula (1) (see Figure 4);

$$C(n)=\frac{M_n-m_n}{M_n+m_n}\times 100\,(\%) \tag{1}$$

where

$C(n)$ is the image clarity value, expressed as a percentage, at n (mm) of the optical mask line width;

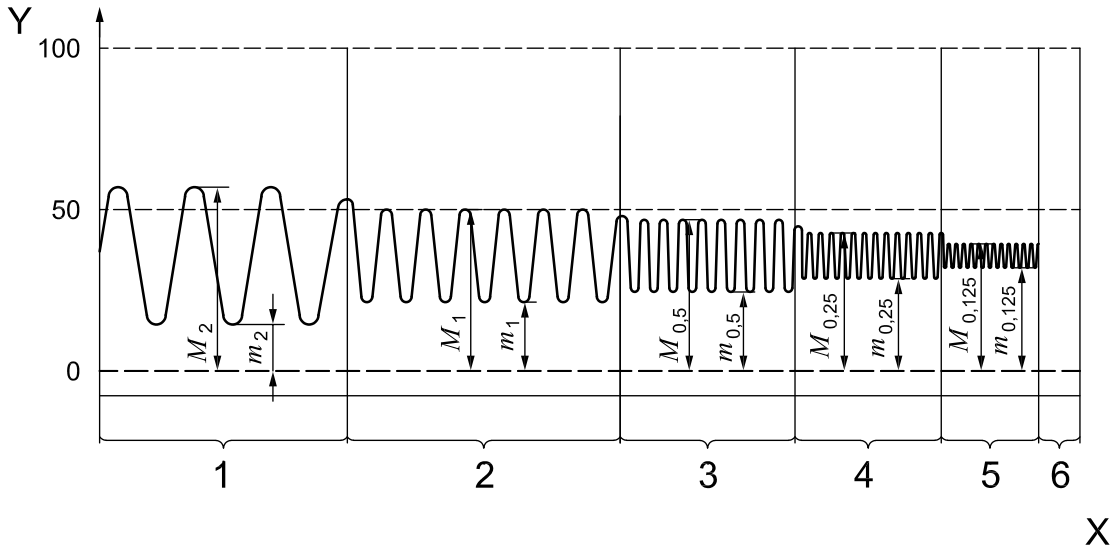
M_n is the maximum relative light intensity at n (mm) of the optical mask line width;

m_n is the minimum relative light intensity at n (mm) of the optical mask line width.

NOTE 1 When the image clarity value is high, the image can be seen clearly. On the contrary, when the image clarity value is low, the image is distorted.

NOTE 2 Examples of determination of image clarity are shown in Annex A.

NOTE 3 Precision of the image clarity is shown in Annex B.



Key

X group

Y relative light intensity

M_n maximum relative light intensity at n (mm) of optical mask line width

m_n minimum relative light intensity at n (mm) of optical mask line width

Figure 4 — Example of the received relative light intensity of a specimen

9 Test report

The test report shall contain at least the following information:

a) a reference to this International Standard, i.e. ISO 17221;

b) a description of the specimen measured, including material and shape;

c) the method of measurement (transmission/reflection);

d) in case of measurement by reflection, the measurement angle;

e) if each side has different surface condition, the side used for the measurement;

f) if the specimen has the orientation of the specimen relative to the slit, the direction of measurement;

g) the image clarity value(s) and optical mask line width(s);

h) the date of the measurement.

Annex A
(informative)

Example of determination

A.1 Selection of optical mask width

It is desirable to select optical mask line width depending on conformity to the visual assessment. There are five optical masks which differ in the line widths of the opaque and transparent areas.

For high image clarity specimens, use 0,125 mm and 0,25 mm in line width.

For medium image clarity specimens, use 0,50 mm in line width.

For low image clarity (matt) specimens, use 1,0 mm and 2,0 mm in line width.

These five widths are sufficient to assess image clarity. Image clarity values of five optical mask line widths are measured at the same time. The optical mask line width is selected to conform to visual assessments referred to in Tables A.1 to A.4.

A.2 Example of image clarity measurement (transmission)

Table A.1 shows haze values and image clarity values for four kinds of plastic films.

Table A.1 — Measurement of plastic films (transmission)

Specimen no.	Specimen characteristics (thickness, mm)	Haze value (%)	$C(n)$ Image clarity value (%)					Visual assessment
			C (0,125)	C (0,25)	C (0,5)	C (1,0)	C (2,0)	
1–1	Film (0,06 mm)	1,57	91,5	92,0	93,0	92,9	97,1	Clear
1–2	Film (0,2 mm)	14,11	74,8	75,4	80,0	82,0	90,4	Slightly hazy
1–3	Film (0,1 mm)	33,18	67,8	68,6	75,3	77,2	88,5	Hazy
1–4	Anti-glare film (0,08 mm)	14,67	6,3	5,7	5,9	11,6	38,4	Considerably hazy

Specimens 1-1 to 1-3 are plastic films with different haze values. Specimen 1-4 is an anti-glare film. When this film is placed just above a paper, the characters can be seen. On the contrary, when the film is moved away from the paper, the characters cannot be seen.

Haze values of specimens 1-1 to 1-3 conform to visual assessment as image clarity values do.

Comparing specimen 1-4 with 1-2, although 1-4 appears to have more haze, the measured haze values are almost the same. In this case, only image clarity values conform to visual assessment.

NOTE The haze values are determined in accordance with ISO 14782[2].

A.3 Example of image clarity measurement (reflection)

Table A.2 shows gloss values and image clarity values for three kinds of painted plastic sheet.

Table A.2 — Measurement of painted plastic sheets (reflection)

Specimen no.	Specimen surface characteristics	Gloss value (%) 60° gloss units	*C*(*n*) Image clarity value(%)					Visual assessment
			C (0,125)	*C* (0,25)	*C* (0,5)	*C* (1,0)	*C* (2,0)	
2–1	High gloss	90,4	71,1	86,5	91,6	94,6	95,8	Highly glossy
2–2	Gloss	83,3	43,9	59,8	63,2	67,2	74,6	Glossy
2–3	Orange peel	87,7	1,4	2,7	22,3	49,5	92,5	Distorted

Specimens 2-1 and 2-2 are painted plastic sheets with various gloss values. Specimen 2-3 has orange peel surface.

Gloss and image clarity values of specimen 2-1 and 2-2 agree with visual assessment.

Comparing specimen 2-2 with 2-3, although 2-2 looks glossier and 2-3 looks distorted visually, gloss value of specimen 2-3 is higher than that of 2-2. In this case, only image clarity values conform to visual assessment with optical mask line widths not larger than 1,0 mm.

NOTE The gloss values are determined in accordance with ISO 2813.

A.4 Example of plastic sheet with a matt coated surface

Table A.3 shows haze values and image clarity values for three kinds of plastic sheets with 1,5 mm thickness.

Table A.4 shows gloss values and image clarity values for the three sheets.

Table A.3 — Measurement of plastic sheet with a matt surface (transmission)

Specimen no.	Specimen characteristics	Haze value (%)	*C*(*n*) Image clarity value(%)					Visual assessment
			C (0,125)	*C* (0,25)	*C* (0,5)	*C* (1,0)	*C* (2,0)	
3–1	Not matt coated	0,17	96,9	98,0	98,8	97,2	99,4	Clear
3–2	Matt coated	2,94	48,9	49,7	53,3	56,4	72,7	Slightly hazy
3–3	Coarse matt coated	7,91	12,2	11,6	12,5	17,7	40,5	Hazy

Table A.4 — Measurement of plastic sheet with a matt surface (reflection)

Specimen no.	Specimen characteristics	Gloss value (%) 60° gloss units	Image clarity (%)					Visual assessment
			C (0,125)	*C* (0,25)	*C* (0,5)	*C* (1,0)	*C* (2,0)	
3–1 no matt coated	Not matt coated	150,2	94,3	95,3	97,7	98,7	99,4	Highly glossy
3–2 glossy side	Matt coated	101,2	94,7	95,2	96,8	98,0	98,2	Glossy
3–2 matt side		91,5	12,7	14,4	15,4	18,3	26,5	Low gloss (rough surface)
3–3 glossy side	Coarse matt coated	94,8	81,8	94,4	94,6	97,2	97,7	Glossy
3–3 coarse matt side		55,7	2,6	1,4	2,1	4,1	8,9	Low gloss (rough surface)
NOTE A gloss meter conforming to ISO 2813 with extended range was used to obtain these values.								

Specimen 3-1 is not matt coated. Specimen 3-2 has glossy side and matt coated side. Specimen 3-3 has glossy side and coarse matt coated side.

Haze values of specimen 3-1 to 3-3 conform to visual assessment as image clarity values do. Gloss values of specimen 3-1, 3-2 glossy side and 3-3 glossy side conform to visual assessment as image clarity values do.

Comparing specimen 3-2 matt coated side with 3-3 glossy side, although 3-2 matt coated side looks rougher and 3-3 glossy side looks glossier visually, their gloss values are almost the same. In this case, only image clarity values conform to visual assessment.

Annex B
(informative)

Precision

B.1 Data

The precision data of reflection (see Table B.1) shows repeatability and reproducibility from an interlaboratory study. The study consisted of measurements gathered from six different laboratories, six materials, six different operators, made on different days on a single make and model instrument.

The precision data of transmission (see Table B.2) shows repeatability and reproducibility from an interlaboratory study. The study consisted of measurements gathered from six different laboratories, four materials, six different operators, made on different days on a single make and model instrument.

The results were analysed using ISO 5725-1[1].

B.2 Instrumentation

The instruments used were ICM-1T manufactured by Suga Test Instruments Co.,Ltd., Japan[1)].

B.3 Repeatability

Closeness of agreement between successive results obtained with the same method on identical test material, under the same conditions (same operator, same instrument, same laboratory, short intervals of time) and using the same make and model instrument.

B.4 Reproducibility

Closeness of agreement between individual results obtained with the same method on identical test material but different conditions (different operators, different instruments, different laboratories and/or different times) and using the same make and model instruments.

1) Example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Table B.1 — Precision data obtained for a single make and model of instrument (reflection)

***C*(0,5) Image clarity value (%), measurement method: reflection**						
Material No.	$\bar{x}$	s_x	s_r	s_R	r	R
A 1	32,3	0,53	0,10	0,54	0,3	1,5
A 2	82,5	0,46	0,11	0,47	0,3	1,3
A 3	92,3	0,25	0,09	0,26	0,3	0,7
A 4	69,9	0,66	0,09	0,66	0,3	1,9
A 5	86,3	0,42	0,08	0,42	0,2	1,2
A 6	60,7	0,46	0,12	0,47	0,3	1,3
***C*(2,0) Image clarity value (%), measurement method: reflection**						
Material No.	$\bar{x}$	s_x	s_r	s_R	r	R
A 1	61,2	0,66	0,23	0,69	0,6	1,9
A 2	91,1	0,51	0,23	0,55	0,7	1,5
A 3	97,3	0,30	0,26	0,37	0,7	1,0
A 4	82,8	0,82	0,20	0,84	0,6	2,3
A 5	95,2	0,45	0,24	0,50	0,7	1,4
A 6	79,1	0,61	0,20	0,63	0,6	1,8
Explanation of the symbols used: $\bar{x}$ is the mean value of six laboratories data s_x is the standard deviation of six laboratories data s_r is the repeatability standard deviation s_R is the reproducibility standard deviation r is the the 95 % repeatability limit R is the the 95 % reproducibility limit						

Table B.2 — Precision data obtained for a single make and model of instrument (transmission)

***C*(0,5) Image clarity value (%), measurement method: transmission**						
Material No.	$\bar{x}$	s_x	s_r	s_R	r	R
B 1	98,1	0,12	0,04	0,13	0,1	0,4
B 2	90,7	0,14	0,12	0,17	0,3	0,5
B 3	72,2	0,39	0,19	0,42	0,5	1,2
B 4	8,5	0,38	0,08	0,39	0,2	1,1
***C*(2,0) Image clarity value (%), measurement method: transmission**						
Material No.	$\bar{x}$	s_x	s_r	s_R	r	R
B 1	98,8	0,04	0,05	0,06	0,1	0,2
B 2	96,2	0,19	0,27	0,29	0,8	0,8
B 3	82,7	0,46	0,31	0,52	0,9	1,5
B 4	42,6	0,62	0,27	0,66	0,8	1,8
For explanation of the symbols used, see Table B.1.						

Bibliography

[1] ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

[2] ISO 14782, *Plastics — Determination of haze for transparent materials*

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