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Paper and board — Measurement of specular gloss —

Part 1:
75° gloss with a converging beam, TAPPI method

Papiers et cartons — Mesurage du brillant spéculaire —
Partie 1: Brillant à 75° avec un faisceau convergent, méthode TAPPI

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

International Standard ISO 8254-1 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, working group WG 3, *Optical properties*.

ISO 8254 consists of the following parts, under the general title *Paper and board — Measurement of specular gloss*:

— *Part 1: 75° gloss with a converging beam, TAPPI method*

— *Part 2: 75° gloss with a parallel beam, DIN method*

— *Part 3: 20° gloss*

Annex A forms a normative part of this part of ISO 8254.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

Printed in Switzerland

Introduction

This part of ISO 8254 deals with the assessment of the specular gloss of paper and board at 75° using a converging beam geometry commonly known as the TAPPI method and described in TAPPI 480 om-92 ([1] in the bibliography). Subsequent parts of this International Standard will deal with measurements made at 75° using a collimated beam geometry known as the DIN method (DIN 54502, [6] in the bibliography), and with measurements made at other angles e.g. 20°.

The word "assessment" is used rather than "measurement" because the definition of gloss (3.1) relates to a scale of visual perception whereas the method described uses a physical measurement of mixed, regular and diffuse reflection. The exact correlation between the visual perception and the scale established by the physical measurement is not known. However, this physical gloss scale has proved to be useful for a number of technical applications and consequently its standardization is justified.

Paper and board — Measurement of specular gloss —

Part 1:
75° gloss with a converging beam, TAPPI method

1 Scope

This part of ISO 8254 specifies a method for measuring the specular gloss of paper at an angle of 75° to the normal to the paper surface. Although its chief application is to coated papers, it may also be used for glossy uncoated papers such as supercalendered papers.

NOTE 1 This method does not provide an assessment of image-reflecting quality and should not be used for cast-coated, lacquered, highly varnished or waxed papers or for high-gloss ink films. For these purposes, measurements at other angles, for example 20°, are preferred, although the present method has been shown to be suitable for gloss measurements of most other ink films on paper or paperboard. Differences in the colour and the diffuse reflectances of these ink films have a negligible effect on gloss measured according to this International Standard. For example, measurements on white and black surfaces which are otherwise identical give a value for the white surface that is less than one gloss unit higher than the value for the black surface.

NOTE 2 The methods specified in ISO 2813:1978, *Paints and varnishes — Measurement of specular gloss of non-metallic paint film at 20°, 60° and 85°,* may be applicable to certain grades of paper.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 8254. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 8254 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 186, *Paper and board — Sampling to determine average quality.*

ISO 187:1990, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples.*

3 Terms and definitions

For the purposes of this part of ISO 8254, the following terms and definitions apply.

3.1
gloss
mode of appearance by which reflected highlights of objects are perceived as superimposed on the surface due to the directionally selective properties of that surface
[CIE Publication No. 17.4:1987, definition 845.04.73[5]]

3.2
regular reflection; specular reflection
reflection in accordance with the laws of geometrical optics, without diffusion
[CIE Publication No. 17.4:1987, definition 845.04.45[5]]

3.3
diffuse reflection
diffusion by reflection in which, on the macroscopic scale, there is no regular reflection
[CIE Publication No. 17.4:1987, definition 845.04.47[5]]

3.4
specular gloss
ratio, expressed as a percentage, of the luminous flux reflected by the test surface into a specified aperture at the angle of specular reflection to that from a standard specularly reflecting surface under the same conditions

4 Principle

Light incident on the test piece surface at an angle of 75° to the normal and reflected from the surface at an angle of 75° from the normal into a defined aperture is detected by a photodetector, the output of which is displayed on a meter.

5 Apparatus

5.1 Gloss meter, having the general arrangement and relative dimensions of the principal parts described in annex A. It consists of

a) a source of light,

b) a lens giving a converging beam of light incident to the test piece,

c) a suitable device such as a suction plate to hold the test piece flat if required, and

d) a photodetector to receive and measure certain of the rays reflected by the test piece.

These components are combined in a light-tight housing that is matt black inside and is structurally and optically stable at the operating temperature.

5.2 Gloss standards, consisting of the following:

5.2.1 Primary gloss standard. The theoretical primary specular gloss standard is an ideal, completely reflecting plane mirror having an assigned gloss value of 384,4 gloss units. A black glass which is flat and clean and has a polished surface, having a refractive index of 1,540 at 589,26 nm, may be shown by the Fresnel equation ([3] in the bibliography) to measure 100 gloss units on this scale.

5.2.2 High-gloss reference standard, consisting of a clean plaque of polished black glass for which the 75° specular reflectance has been computed from its refractive index as measured at a wavelength of 589,26 nm.

NOTE If the refractive index is known, the gloss value may be calculated by adding to or subtracting from 100,0 a value of 0,065 for each 0,001 departure of the refractive index from the standard value of 1,540. For example, for a black glass of refractive index 1,523, the assigned value would be 98,9.

5.2.3 Intermediate-gloss standards, having a reflected flux distribution comparable with that of the paper to be tested. Such standards may consist of ceramic tiles which are sufficiently flat not to rock when placed in the measurement position and are uniform in gloss over their central area. Each of these tiles shall be calibrated against the high-gloss working standard by a reputable laboratory in an instrument conforming to 5.1.

5.2.4 Working standards, having reflected flux distributions corresponding to different gloss levels, calibrated in the instrument concerned against a range of intermediate-gloss standards.

Store standards in a closed container when they are not in use. Keep them away from any dirt which may scratch or mar their surfaces. Never place a standard face down on a surface which may be dirty or abrasive. Always hold a standard at the side edges to avoid transferring oil from one's skin to the standard surface. Clean standards in warm water and mild detergent solution, brushing gently with a soft nylon brush. (Do not use soap solutions to clean standards.) Rinse in hot running water (temperature near 65 °C) to remove detergent solution, followed by a final rinse in distilled water. Do not wipe intermediate-gloss standards (5.2.3). Place rinsed standards in a warm oven to dry.

NOTE 1 The high-gloss standard (5.2.2) may be dabbed gently with a lint-free paper towel or other lint-free absorbent material.

NOTE 2 The refractive index of the surface, and consequently the gloss value of the high-gloss standard (5.2.2) may slowly change over a period of a few years. This may be accompanied by a loss of uniformity. It is recommended that these standards be sent to a reputable laboratory at least once every 2 years for a check on their calibration and for possible repolishing to restore their uniformity.

5.3 Zero-gloss standard, consisting of a black velvet-lined cavity or any other suitable type of black cavity.

NOTE A variety of suitable cavities are available, including those coated with a matt black paint or having an interior black pyramidal construction.

6 Sampling

Sampling is not included in this International Standard. If the mean quality of a lot is to be determined, sampling shall be carried out according to ISO 186. Otherwise, the method of sampling should be reported and care should be taken to ensure that the test pieces are representative of the sample available.

7 Preparation of test pieces

Avoiding watermarks, dirt and obvious defects, cut at least ten test pieces of sufficient size to completely cover the test piece opening of the instrument. Keep the test piece clean and do not handle the area to be tested. Condition the test pieces in an atmosphere at 23 °C and 50 % relative humidity according to ISO 187.

The measurement area (see annex A) is equal to (0,10 $d \times$ 0,05 d/cos 75°). If the dimension d (see Figure A.1) is equal to 100 mm, the size of the measurement area is therefore 195 mm^2 ± 40 mm^2. Ten measurements thus provide a mean value for an area of about 2 000 mm^2. If the distance d is less than 100 mm, the measurement area is reduced in proportion to d^2 and it is recommended that a larger number of measurements be made in order to obtain a mean for a similar area of paper.

NOTE The exposure of paper to high humidities frequently decreases the gloss. If papers are tested at a relative humidity higher than 65 %, this fact should be stated in the test report.

8 Calibration of the instrument

8.1 Turn on the instrument and, after a suitable warm-up period, check the zero of the instrument either with the test piece opening uncovered and exposed to a dark room, or with the test piece opening covered with the zero-gloss standard (5.3). Check that the zero reading agrees with the mechanical zero setting. (Disagreement in the zero readings suggests that unwanted light rays are entering the receptor window.)

8.2 Insert the high-gloss reference standard (5.2.2) or a high-gloss working standard (5.2.4) and adjust the instrument to give the correct value of gloss for the standard.

8.3 Insert an intermediate-gloss standard (5.2.3) or intermediate-gloss working standard (5.2.4) having a gloss comparable to the gloss of the paper to be tested and see that the instrument reads the value correctly. (Correct readings on the high-gloss and intermediate-gloss standards suggest that an instrument is in approximate, but not necessarily in exact, conformance with the apparatus specifications.) If the reading differs by more than 1 gloss unit from the assigned value, the instrument should be checked for conformance to the geometric, spectral and photometric requirements, and the standards should be checked with respect to their calibration.

9 Procedure

Insert each test piece one at a time and read the gloss from the meter. Record the gloss readings for all four directions, i.e. in the machine direction and counter-machine direction and in both cross directions, and calculate the mean value. Record data for the two sides of the paper separately.

Insert a working standard at frequent intervals to ensure that the instrument remains in adjustment throughout the period during which the gloss measurements are being made, and again at the end of the test.

Record data for at least five test pieces.

Calculate the means and the standard deviations, to the nearest unit, for each side of the paper.

10 Precision

Precision data has been derived from the CTS-TAPPI Interlaboratory program reports 166-170 (1997).

Table 1 presents data for five samples measured in the machine direction by at least 25 laboratories, each result being based on 10 determinations with two replicate measurements in opposite directions per determination.

Table 1 — Gloss units

Sample No.	Mean	Repeatability limit, *r*	Reproducibility limit, *R*
1	84,2	1,4	2,1
2	72,9	4,6	4,9
3	48,6	2,0	3,1
4	42,7	2,2	3,0
5	28,6	2,1	2,7

11 Test report

The test report shall contain the following information:

a) the date and place of testing;

b) a reference to this part of ISO 8254;

c) precise identification of the sample, including the sampling procedure;

d) the number of independent gloss readings, the average gloss value and the standard deviation of each required side separately;

e) any particular points observed in the course of the test;

f) any departure from the method or any circumstances or influences that may have affected the results.

Annex A
(normative)

Specification of the optical system of the gloss meter

A.1 Introduction

A schematic diagram of the optical system of the gloss meter is shown in Figure A.1.

The dashed line beginning at the lamp indicates the path of the ray of light passing through the condensing lenses and the geometric centre of a rectangular aperture (rectangular source-field stop) which becomes the effective source of light; through the source objective lens, through the geometric centre of the rectangular aperture stop and to the test piece. This axial ray of light intersects the plane of the test piece at a point defined as the centre of the test area. (This is not necessarily the geometric centre of the illuminated area of the test piece.) With a plane front-surface mirror as the test piece, the axial ray is specularly reflected and passes through the centre of the receptor window. The source objective lens makes an image of the source aperture at the receptor window. The distance, d, from the centre of the test area to the receptor window is used as the base from which to specify all other dimensions. The most critical dimensions are the angle of incidence, the position of the receptor window and the diameter of the receptor window.

NOTE No minimum value of the distance d is specified. No such limit is required provided that the mean result obtained refers to at least 2 000 mm^2 of the sample.

A.2 Light mixer

To achieve uniform weighting of the rays taking different paths through the receptor window, a light mixer shall be interposed between the receptor window and the photodetector. The positive lens shall be located adjacent to the receptor window and shall be arranged to collect all rays of light passing through the window, and to form an image of the illuminated surface of the test piece on the sensitive surface of the photodetector or on a diffusing screen immediately in front of this surface. No rays other than those reflected from the test piece surface shall be permitted to enter the receptor window.

A.3 Angle of incidence

The axial ray shall intersect the test piece plane at an angle of $\varepsilon_1 = (75{,}0 \pm 0{,}1)°$ to the normal.

A.4 Angle of reflected ray

The specularly reflected axial ray shall intersect the test piece plane at an angle of $\varepsilon_2 = \varepsilon_1 \pm 0{,}1°$ to the normal, i.e. $|\varepsilon_1 - \varepsilon_2| \leqslant 0{,}1°$.

A.5 Receptor window

The diameter of the receptor window is expressed in terms of the distance, d, from the centre of the test area to the entrance plane of the receptor window and shall be $0{,}2\,d \pm 0{,}005\,d$; the thickness of its edge shall not exceed $0{,}005\,d$. The axial ray, when reflected from a plane front-surface mirror in the test piece position, shall pass through the centre of the receptor window within $0{,}004\,d$ and shall be perpendicular to the plane of the receptor window.