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Paper and board — Measurement of specular gloss —

Part 3: 20° gloss with a converging beam, TAPPI method

Papier et carton — Mesurage du brillant spéculaire — Partie 3: Brillant à 20° avec un faisceau convergent, méthode TAPPI

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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 6, *Paper, board and pulps*.

This second edition cancels and replaces the first edition (ISO 8254-3:2004), which has been editorially revised to provide a precision statement, to update the bibliographic references and to provide additional clarification on Scope and application of the method described in this International Standard.

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 with a converging beam, TAPPI method*

Introduction

This part of ISO 8254 deals with the assessment of the specular gloss of paper and board at an angle of 20°, using a converging beam geometry commonly known as the TAPPI method and described in TAPPI T653[2]. ISO 8254-1 and ISO 8254-2 deal with the measurement of specular gloss at 75°.

Although the word “measurement” is used, it is to be noted that this is strictly speaking only an “assessment” because the definition of gloss (see 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 3:
20° gloss with a converging beam, TAPPI method

1 Scope

This part of ISO 8254 specifies a method for measuring the specular gloss of paper and board at an angle of 20° to the normal to the paper surface. It is applicable chiefly to highly glossy surfaces, such as cast-coated, lacquered, highly varnished or waxed papers and high-gloss ink films.

NOTE This part of ISO 8254 has been developed from TAPPI T653[2], ISO 2813[1] and from ISO 8254-1.

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

ISO 187, *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 document, the following terms and definitions apply.

3.1
gloss (of a surface)
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

[SOURCE: CIE S 017/E:2011, 17-500[3]]

3.2
regular reflection
specular reflection
reflection in accordance with the laws of geometrical optics, without diffusion

[SOURCE: CIE S 017/E:2001, 17-1077[3]]

3.3
diffuse reflection
diffusion by reflection in which, on the macroscopic scale, there is no regular reflection

[SOURCE: CIE S 017/E:2011, 17-305[3]]

3.4
specular gloss
measured variable equal to 100 times the ratio of the luminous flux reflected by the test-piece surface into a specified aperture at the specified angle of specular reflection to that reflected by a gloss standard specularly reflecting surface under the same conditions

4 Principle

Light incident on the test-piece surface at an angle of 20° to the normal and reflected from the surface at an angle of 20° to the normal into a defined aperture is detected by a photodetector, the output of which is displayed on a meter. The gloss scale is established by reference to the reflection from a standard black glass of known refractive index. Annex B provides precision data.

5 Apparatus

5.1 Gloss meter

It has 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 on the test piece;

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

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 matte black inside and is structurally and optically stable at the operating temperature.

5.2 Gloss standards

5.2.1 Primary gloss standard, a flat, clean and polished surface, having a refractive index of 1,540 at 587,6 nm (the helium D-line). This may be shown by the Fresnel formulae to measure 100 gloss units on a scale related to the theoretical primary gloss standard. The theoretical primary specular gloss standard is an ideal, completely reflecting plane mirror having an assigned gloss value of 2 199.[4]

5.2.2 High gloss reference standard, a clean plaque of polished black glass for which the 20° specular reflectance has been computed from its refractive index measured at a wavelength of 587,6 nm.

If the refractive index differs from 1,540, the gloss value shall be calculated as follows:

$$G = 100 \times K \tag{1}$$

where

$$K\left(n,\varepsilon\right) = \frac{\left[\dfrac{n^2\cos\varepsilon - \left(n^2 - \sin^2\varepsilon\right)^{0,5}}{n^2\cos\varepsilon + \left(n^2 - \sin^2\varepsilon\right)^{0,5}}\right]^2 + \left[\dfrac{\left(n^2 - \sin^2\varepsilon\right)^{0,5} - \cos\varepsilon}{\left(n^2 - \sin^2\varepsilon\right)^{0,5} + \cos\varepsilon}\right]^2}{\left[\dfrac{1,540^2\cos\varepsilon - \left(1,540^2 - \sin^2\varepsilon\right)^{0,5}}{1,540^2\cos\varepsilon + \left(1,540^2 - \sin^2\varepsilon\right)^{0,5}}\right]^2 + \left[\dfrac{\left(1,540^2 - \sin^2\varepsilon\right)^{0,5} - \cos\varepsilon}{\left(1,540^2 - \sin^2\varepsilon\right)^{0,5} + \cos\varepsilon}\right]^2} \tag{2}$$

where

n is the refractive index of the glass;

ε is the angle of incidence.

When $\varepsilon = 20°$, the formula reduces to

$$K\left(n, 20°\right) = 10,994\left(\left[\frac{0,939\,7n^2 - \left(n^2 - 0,117\right)^{0,5}}{0,939\,7n^2 + \left(n^2 - 0,117\right)^{0,5}}\right]^2 + \left[\frac{\left(n^2 - 0,117\right)^{0,5} - 0,939\,7}{\left(n^2 - 0,117\right)^{0,5} + 0,939\,7}\right]^2\right) \quad (3)$$

NOTE 1 If the refractive index is known, the gloss value can be calculated by adding or subtracting from 100,0 a value of 0,29 for each 0,001 departure of the refractive index from the standard value of 1,540. For example, for a glass of refractive index $n = 1,523$, the assigned gloss value G would be

$$\begin{aligned} G &= 100 - \frac{0,29\left(1,540 - n\right)}{0,001} \\ &= 290n - 346,60 \\ &= 95,1 \end{aligned} \quad (4)$$

This method is, however, valid only for refractive index values between 1,50 and 1,54. It is not applicable to quartz standards for which n is about 1,46.

NOTE 2 Commercial gloss meters with 20° gloss scales based on International Standards with refractive index of 1,567 for general materials (paint, plastics, ceramics) will report different gloss readings for paper samples which are based on a refractive index of 1,540 and are not compatible with this part of ISO 8254.

5.2.3 Intermediate gloss standards, having a reflected flux distribution comparable with that of the paper to be tested. Such standards can consist of ceramic tiles which are sufficiently flat to remain stationary without rocking when placed in the measurement position and are uniform in gloss over a central region larger in area than the illuminated area defined by Formulae (A.3) and (A.4). Each of these tiles shall be calibrated against the high gloss reference standard by a technically competent 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 not in use. Keep them away from any dirt which may scratch or mar their surfaces. Never place standards face down on a surface which may be dirty or abrasive. Always hold standards by their side edges to avoid transferring oil from the 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). The high gloss reference standard (5.2.2) may be dabbed gently with a lint-free paper towel or other lint-free absorbent material. Place rinsed standards in a warm oven to dry.

The refractive index of the surface, and consequently the gloss value of the high gloss reference standard (5.2.2), might change slowly over a period of a few years. This could be accompanied by a loss of uniformity. It is recommended that this standard be sent to a technically competent laboratory at least once every two years for a check on its calibration and for possible repolishing to restore its uniformity.[5]

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 matte black paint or having an interior black pyramidal construction.