

New ISO test method for high-gloss papers

J. ANTHONY BRISTOW

There are important differences in gloss scale and application of existing methods for measuring gloss. A brief examination of these differences illustrates the need for several standards. The author, J. Anthony Bristow, was formerly convenor of ISO/TC6/WG3 (Optical properties of paper and board). This paper has been read and approved for publication by the members of ISO/TC6/WG3, Paper and Board—Optical test methods.

Application: A brief presentation of this new method will be valuable for those within the paper industry who are trying to understand why there is more than one standard procedure for measuring gloss.

In November 2004, a new ISO standard was published for the determination of paper gloss at a specular angle of 20°. This method, which is essentially the same as the corresponding TAPPI method, is particularly suitable for high-gloss papers and boards. It is a complement to the two ISO Standards previously published, which are more suitable for matte and low-gloss papers and boards.

The three methods have the same basic ISO number, but they are published as separate parts with the following designations:

- ISO 8254-1: 1999
Paper and board—Measurement of specular gloss—Part 1: 75° gloss with a converging beam, TAPPI method
- ISO 8254-2: 2003
Paper and board—Measurement of specular gloss—Part 2: 75° gloss with a parallel beam, DIN method
- ISO 8254-3: 2004
Paper and board—Measurement of specular gloss—Part 3: 20° gloss with a converging beam, TAPPI method

As the titles indicate, Parts 1 and 3 are based on—and are essentially the same as—the corresponding TAPPI methods. The major difference in application of these two parts is illustrated in **Figure 1**, which shows the gloss measured at 20° in accordance with Part 3 plotted against the gloss measured at 75° in accordance with Part 1 for a collection of papers covering a wide gloss range.

In this figure, it is evident that the measurement at 20° is very insensitive to differences between matte and low-gloss papers. The value at 20° only varies between 0 and 10 gloss units while the value obtained at 75° varies between 0 and 80 gloss units. For high-gloss papers, however, it is the 20° gloss measurement

that is the more sensitive. In this case, the value varies between 10 and 100 gloss units, while the 75° gloss value varies only between 80 and 100 gloss units. Although each of the methods can be used on all papers, it is clearly advisable to use the 75° method for low-gloss materials and the 20° method for high-gloss materials.

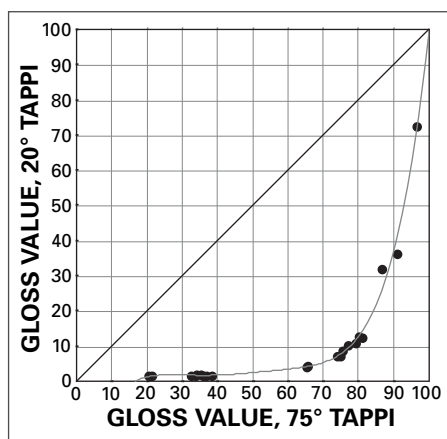
The fact that there are two standards for measurement at 75° is a reflection of political and cultural differences rather than optical differences. In Europe, in particular, the German DIN-standards are widely used, and it was felt within the ISO/TC6 committee concerned with test methods for paper, board and pulps for global use that there was justification for standardizing both the TAPPI and DIN methods.

These two methods differ only slightly in their application for low-gloss papers, but they give significantly different results, as shown in **Figure 2**. This is due not only to the difference in the geometry of the incident light, but also to a difference in the angle of acceptance, i.e. the area of the paper from which the detector accepts and measures the reflected light. A detector having a larger angle of acceptance around the specular angle collects a larger amount of the light diffusely reflected from the surface of the paper, and this means that it yields a higher gloss value. It is therefore important to state which of the two methods has been used.

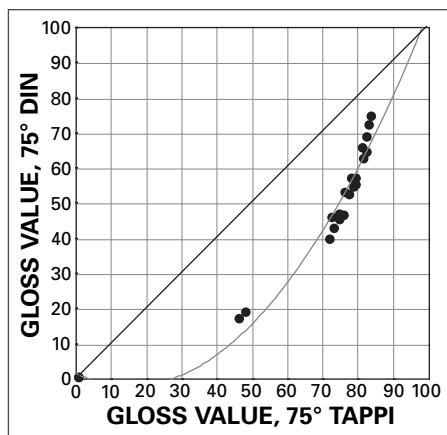
It is also important to note that there are slight differences in the definitions of the different gloss scales, due also to the traditional differences between the DIN and the TAPPI approaches. Each gloss scale is defined in relation to a polished black glass that is assigned a value of 100 gloss units. The definition is, however, related to black glass of a specified refractive index, n , at a specified wavelength, λ , and, as indicated in **Table I**, there are slight differences in the specified values.

It is planned to propose a change when Part 1 is next revised in order to eliminate the sodium-D line, which is no longer used as a standard in other optical contexts, and to relate all three parts of the ISO Standard to the helium-D line.

At the 75° geometry, this change in reference wavelength from 589.3 nm to 587.6 nm has an insignificant effect on



1. Gloss at 20° plotted against gloss at 75°, showing that the measurement at 20° is much more sensitive for high-gloss papers than the measurement at 75°.



2. Gloss at 75° according to DIN plotted against gloss at 75° according to TAPPI.

the gloss scale. For typical glass samples, the refractive index changes by less than 0.0001 between 589.3 nm and 587.6 nm. Changing the definition from $n = 1.540$ at 589.26 nm to $n = 1.540$ at 587.6 nm results in a change of less than 0.02 gloss units in the gloss scale for measurements at 75°.

The difference in refractive index has a much greater effect, however, particularly at 20°, and, since the TAPPI method at 20° specifying $n = 1.540$ is well established, it has not been possible to change this specification and to relate all the methods to a glass of the same refractive index.

In fact, it is difficult to obtain black glass with exactly the desired refractive index, which means that the instrument maker should assign a calibration value to the glass standard supplied with the instrument, taking into consideration the refractive index. These values are calculated on the basis of the Fresnel equations.

Because of the differences in the specifications and the differences in the

Standard	Measurement angle	BLACK GLASS=100	
		n	λ nm
ISO 8254-1	75° (TAPPI)	1.540	589.3 Na-D
ISO 8254-2	75° (DIN)	1.567	587.6 He-D
ISO 8254-3	20° (TAPPI)	1.540	587.6 He-D

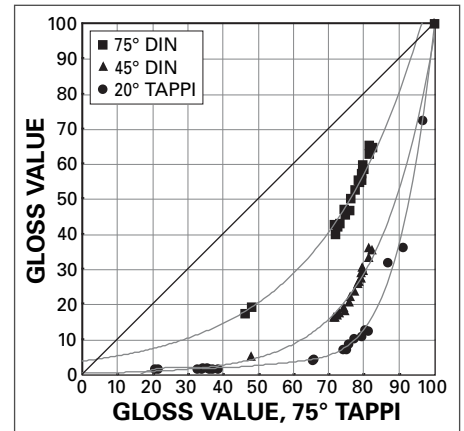
I. Characteristics of the black glass standard.

Refractive index of polished black glass standard	ISO 8254		
	Part 1 75°, TAPPI	Part 2 75°, DIN	Part 3 20°, TAPPI
1.567	101.7	100.0	107.9
1.550	100.6	99.0	102.9
1.540	100.0	98.3	100.0
1.530	99.3	97.7	97.1
1.520	98.7	97.0	94.2
1.510	98.0	96.4	91.4

II. Gloss values assigned to black glass reference standards of different refractive indices for use with the different parts of ISO 8254.

dependence on the refractive index at different angles, a black glass reference tile cannot have the same value for all the different parts of ISO 8254. **Table II** shows for a range of black glass plates with different refractive indices the gloss values that would be assigned to them for use in the different parts of the Standard.

There is an additional gloss Standard in use in Europe where measurements are made at 45° with a converging beam according to the DIN method, but this has not been considered for publication as an ISO Standard because there is insufficient evidence showing the merits of making a measurement at this angle. The



3. Gloss at 75° according to DIN, at 45° according to DIN and at 20° according to TAPPI plotted against gloss at 75° according to TAPPI.

data available indicate, as shown in **Figure 3**, that it gives values similar to ISO 8254-3, but that it is not as sensitive as the 20° measurement for high-gloss papers and boards. **TJ**

ACKNOWLEDGEMENT

Thanks are extended to Kristina Wågberg, M-Real for help with the data presented in Figure 1. The data for the 75° DIN and 45° DIN methods have been obtained from a brochure published by Lehmann Messtechnik AG.

Contact Bristow at Bristow Consulting AB, Bernströmsvägen 28, SE-146 38 Tullinge, Sweden, or by email at bristow@beta.telenordia.se.