
Graphic technology — Visual opacity of printed white ink

*Technologie graphique — Opacité visuelle de l'encre blanche
imprimée*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

This second edition cancels and replaces the first edition (ISO 23498:2020), which has been technically revised.

The main change is as follows:

— [Formula A.1](#) has been corrected.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Methods for measuring the transparency or opacity of printing inks and paints have been described in a number of publications^{[1]–[4]}. Standard methods^[1] for paints are based on the reflectance of the colorant when printed over a black background relative to the reflectance of the black background without coloration. The contrast ratio method described in Reference ^[1] is widely used in the industry for evaluating opacity, but results can vary significantly depending on how it is used especially where white ink printed upon on transparent substrates are measured, or where a standard test substrate is not used.

Methods of measuring opacity and transparency are based on the reflectance of printed and unprinted areas of a substrate. Reflectance is defined as the luminous reflectance factor and expressed as the CIE Y tristimulus value, which is not as perceptually uniform as other derived CIE colour spaces such as 1976 CIELAB. Transparency is related to opacity but is not equal or equivalent to opacity. ISO 2846-1 includes a measure of transparency.

In the transparent imaging model introduced from PDF 1.4, objects can be less than fully opaque, and all of the objects in a stack can potentially contribute to the final appearance of the page. PDF uses the term "solidity" rather than opacity, but these terms are essentially the same. An opacity or "solidity" value of 1,0 describes an ink that completely hides the inks beneath, while a value of 0,0 describes a transparent ink that completely reveals the inks beneath^[5], for example a clear varnish. Document creators specify the opacity of one or more inks, and anticipate that this specified opacity is consistent with the visual appearance of both preview and final print. This document is intended to be used to measure the opacity of inks printed using a known configuration of a printing system and so the measured value is not the opacity of the ink per se but of the ink as printed. This aspect is especially important when assessing inks printed using inkjet printers. For the opacity value so measured to be useful, it is important to communicate details of the configuration of the printing system used so that the printing can be repeated.

There is thus a need for a metric for opacity which has better agreement with visual perception. For consistency with the PDF model, it is expected that the metric produces values in the range 0 to 100 for fully transparent and fully opaque prints respectively. These requirements exclude the use of the contrast ratio metric.

The method described in this document was tested using the data reported in Reference ^[6] and it was shown to correlate well with the visual perception of opacity.

This document is limited to the opacity of "opaque" white inks, as the published work cited in this document was limited to the evaluation of such inks. A method is described in [Annex A](#) showing how this document could be extended to test coloured inks. We anticipate that in the future this standard could be extended if there is a need and adequate experimental data. For this reason, the visual opacity metric defined in this document is not the simplest formula that fits the experimental data, but is one that gives good results and can readily be extended to colour inks and substrates if required. The metric is based on functions used in the Spot Colour Tone Value (SCTV) defined in ISO 20654.

Opaque white inks are formulated to be relatively opaque to light in order to hide any underlying matter, in contrast to "transparent" white inks which are formulated to permit transmission of light and are commonly used to extend coloured inks. For the purpose of this document, white ink is an ink formulated with an opaque white colorant that has a neutral colour and a reflectance factor greater than 80 %, and which is intended to have high opacity.

This document is also limited in the range of substrates to which it is intended to apply. Substrates should be either transparent, or have a CIELAB L^* lightness of 80 or above and a CIELAB C^*_{ab} chroma of 20 or less.

Various factors can affect the appearance of opacity on a given substrate, including the presence of optical brightening agents in the ink or substrate, and to minimize such effects, it is assumed that the material is viewed and measured under standard conditions, where the viewing condition is defined by ISO 3664^[8] P1 or P2 condition and the measurement by ISO 13655 M1 condition.

Graphic technology — Visual opacity of printed white ink

1 Scope

This document specifies a method of measuring the visual opacity of printed specimens of white ink. It is applicable to printing opaque white ink on transparent and white or coloured opaque substrates.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13655, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

3 Terms and definition

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

contrast ratio

ratio of the reflectance of an ink film on a black substrate to that of an identical ink film on a white substrate

3.2

opacity

ability of a film or sheet of material, such as ink, paint or paper, to hide a surface behind and in contact with it

3.3

opaque white

colorant formulated to have a neutral colour and a reflectance factor greater than 80 %, and which is intended to have high *opacity* (3.2)

4 Requirements

4.1 General

Depending on the needs of the final product, white ink may be printed directly on to the substrate, to form a base for other inks to be printed on top, or it may be printed on top of other inks, especially where the substrate is transparent and intended to be viewed from the reverse side. The substrate may be a transparent film or an opaque material such as paper or board.