
**Anodizing of aluminium and its
alloys — Measurement of specular
reflectance and specular gloss of
anodic oxidation coatings at angles of
20°, 45°, 60° or 85°**

*Anodisation de l'aluminium et de ses alliages — Mesurage des
caractéristiques de réflectivité et de brillant spéculaires des couches
anodiques à angle fixe de 20°, 45°, 60° ou 85°*

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Contents

Page

| | |
|-----------------------------------------------------------------------------------------|-----------|
| Foreword | iv |
| Introduction | v |
| 1 Scope | 1 |
| 2 Normative references | 1 |
| 3 Terms and definitions | 1 |
| 4 Principle | 2 |
| 5 Apparatus and geometric conditions | 2 |
| 6 Optical standards | 6 |
| 6.1 Reference standards..... | 6 |
| 6.1.1 Black glass..... | 6 |
| 6.1.2 Glass prism (for Method E only)..... | 6 |
| 6.2 Working standards..... | 7 |
| 6.2.1 Description..... | 7 |
| 6.2.2 Zero point check..... | 7 |
| 7 Preparation and calibration of apparatus | 7 |
| 8 Measurement of specular reflectance and specular gloss | 8 |
| 8.1 General..... | 8 |
| 8.2 Measurement of specular reflectance..... | 8 |
| 8.3 Measurement of specular gloss..... | 8 |
| 9 Expression of results | 11 |
| 9.1 General..... | 11 |
| 9.2 Specular reflectance..... | 11 |
| 9.3 Specular gloss..... | 12 |
| 10 Test report | 12 |
| Annex A (normative) Specular reflectance and specular gloss of black glass | 13 |

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).

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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 2, *Organic and anodic oxidation coatings on aluminium*.

This third edition cancels and replaces the second edition (ISO 7668:2010), which has been technically revised. The main technical changes are as follows:

- the normative references have been added;
- the definition of specular gloss has been revised;
- the references to CIE spectral luminous efficiency and CIE standard illuminants C and D65 have been added.

Introduction

Specular reflectance and specular gloss are not unique physical properties of a surface. They vary with the angle of measurement, and with the aperture dimensions that define the incident and the reflected beams, such that measurements of these properties are not independent of the apparatus being used.

The specular reflectance of most surfaces increases with the angle of measurement and accounts for the use of reflectometers with various angles as, for example, for painted surfaces. The specular reflectance characteristics of anodized aluminium, however, do not always behave in the normal manner and, because of its property of double reflection, reflected light comes partly from the film surface and partly from the underlying metal. It is advisable to measure the specular reflectance characteristics at 20°, 45°, 60° and 85° to obtain a complete understanding of the specular reflectance properties of the anodized surface, and careful thought should be given to which method or methods are most relevant in any particular situation. The specular reflectance of bright-anodized aluminium with a mirror finish is best measured using 45° or 20° geometry.

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Anodizing of aluminium and its alloys — Measurement of specular reflectance and specular gloss of anodic oxidation coatings at angles of 20°, 45°, 60° or 85°

1 Scope

This document specifies methods for the measurement of specular reflectance and specular gloss of flat samples of anodized aluminium using geometries of 20° (Method A), 45° (Method B), 60° (Method C) and 85° (Method D); and of specular reflectance by an additional 45° method (Method E) employing a narrow acceptance angle.

The methods described are intended mainly for use with clear anodized surfaces. They can be used with colour-anodized aluminium, but only with similar colours.

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 7583, *Anodizing of aluminium and its alloys — Terms and definitions*

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

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

CIE Publication No. 15, *Colorimetry*

ISO 7668:2018

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7583 and the following 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 <http://www.electropedia.org/>

3.1

specular reflectance

ratio of the luminous flux, reflected in the specular direction for a specified source and receptor angle, to the luminous flux of the incident light

Note 1 to entry: Normally expressed as a percentage.

3.2

specular gloss

ratio of the luminous flux, reflected from an object in the specular direction for a specified source and receptor angle, to the luminous flux reflected from glass with a refractive index of 1,567 at a wavelength of 546,1 nm (which is the central wavelength of the spectral luminous efficiency function) in the specular direction

Note 1 to entry: To set the specular gloss scale, polished black glass with a refractive index of 1,567 is assigned the value of 100 for geometries of 20°, 45°, 60° and 85° (see Table 5). The phenomenon of light reflectance by anodized aluminium is very different to that of black glass and the choice of a black-glass standard is arbitrary and made to allow comparison of different qualities of anodized aluminium.

4 Principle

The specular reflectance and specular gloss of anodized aluminium surfaces are measured under defined conditions using, as required, geometries of 20°, 45°, 60° and 85°.

5 Apparatus and geometric conditions

Usual laboratory apparatus and in particular the following.

5.1 General. Approximate comparisons between surfaces of the same colour can be made, but an accurate measurement requires the combination of light source, photoelectric cell and associated colour filters to give a spectral sensitivity, approximating to the CIE spectral luminous efficiency, $V(\lambda)$, weighted for CIE standard illuminants C or D65. $V(\lambda)$ shall conform to the requirements of ISO 11664-1. CIE standard illuminants C and D65 shall conform to the requirements of CIE 15 and ISO 11664-2.

NOTE Since specular reflection is in general spectrally non-selective, the spectral characteristics of the light source (5.2) and the receptor (5.4) do not affect the measurement of normal uncoloured anodized surfaces.

5.2 Polychromatic light source and housing, with a lens that directs a parallel, or very slightly converging, beam of light onto the surface under test.

5.3 Means for locating the specimen surface, in the correct position for measurement.

5.4 Receptor housing containing a lens, a receptor aperture and a photoelectric cell, to receive the cone of reflected light.

5.5 Sensitivity control, for setting the photocell current to any desired value on the instrument scale or digital indicator.

5.6 Receptor meter, capable of giving an indication proportional to the light flux passing the receptor aperture within 1 % of the full-scale reading. Spectral corrections are not usually required (see Note to 5.1).

5.7 Geometric conditions

The incident angle, ε_1 , which is the angle between the axis of the incident beam and the perpendicular to the surface under test, shall have the following values and tolerances:

- for Method A: 20° ± 0,1°;
- for Method B: 45° ± 0,1°;
- for Method C: 60° ± 0,1°;
- for Method D: 85° ± 0,1°;
- for Method E: 45° ± 0,1°.

There shall be no vignetting of rays that lie within the angles specified above.

The axis of the receptor shall, as far as possible, coincide with the mirror image of the axis of the incident beam; the receptor angle, ε_2 , which is the angle between the axis of the receptor and the perpendicular to the surface under test, shall be for all methods such that

$$|\varepsilon_1 - \varepsilon_2| \leq 0,1^\circ$$

With a flat piece of polished glass or other front-surface mirror in the test specimen position, an image of the source shall be formed at the centre of the receptor aperture. The width of the illustrated area of the test specimen shall be not less than 10 mm.

The angular dimensions of the receptor apertures shall be measured from the receptor lenses. The dimensions and tolerances of the sources and receptors shall be as indicated in [Tables 1](#) and [2](#). [Figures 1](#), [2](#) and [3](#) give generalized illustrations of these dimensions. [Table 1](#) gives both angles and corresponding dimensions calculated for lenses of a focal length of 50 mm for Methods A, B, C and D. [Table 2](#) gives the angles and aperture dimensions for Method E. The angles are mandatory and the aperture sizes have been calculated from the corresponding angle, δ , as $2f(\tan \delta/2)$, where f is the focal length of the receptor lens.

Table 1 — Angles and dimensions of source image and receptor apertures for Methods A, B, C and D

| Method(s) | Instrument characteristics | In plane of measurement | | Perpendicular to plane of measurement | |
|---------------|------------------------------------|------------------------------------------|------------------------------|----------------------------------------|---------------------------------|
| | | Angle δ_1 degrees (°) | Dimension ^a mm | Angle δ_2 degrees (°) | Dimension ^a mm |
| A, B, C and D | Source image size Tolerance | 0,75($\delta_{1\alpha}$) $\pm 0,25$ | 0,65 $\pm 0,22$ | 2,5($\delta_{2\alpha}$) $\pm 0,5$ | 2,18 ^b $\pm 0,44$ |
| A | 20° Receptor aperture Tolerance | 1,80($\delta_{1\beta}$) $\pm 0,05$ | 1,57 $\pm 0,04$ | 3,6($\delta_{2\beta}$) $\pm 0,1$ | 3,14 $\pm 0,09$ |
| B | 45° Receptor aperture Tolerance | 4,4($\delta_{1\beta}$) $\pm 0,1$ | 3,84 $\pm 0,09$ | 11,7($\delta_{2\beta}$) $\pm 0,2$ | 10,25 $\pm 0,17$ |
| C | 60° Receptor aperture Tolerance | 4,4($\delta_{1\beta}$) $\pm 0,1$ | 3,84 $\pm 0,09$ | 11,7($\delta_{2\beta}$) $\pm 0,2$ | 10,25 $\pm 0,17$ |
| D | 85° Receptor aperture Tolerance | 4,0($\delta_{1\beta}$) $\pm 0,3$ | 3,49 $\pm 0,26$ | 6,0($\delta_{2\beta}$) $\pm 0,3$ | 5,24 $\pm 0,26$ |

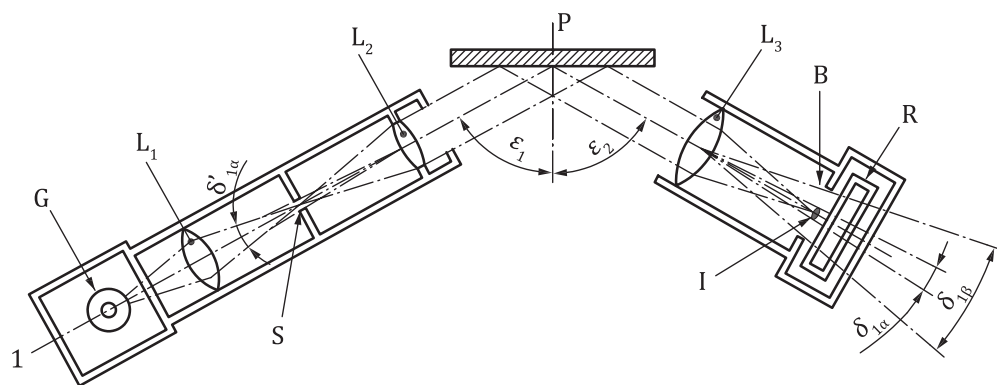
^a Calculated for a focal length of 50 mm. For any other focal length, f , these dimensions shall be multiplied by $f/50$.

^b $0,75^\circ \pm 0,25^\circ$, corresponding to dimensions of 0,65 mm \pm 0,22 mm, i.e. the same as those in the plane of measurement, is also recommended.

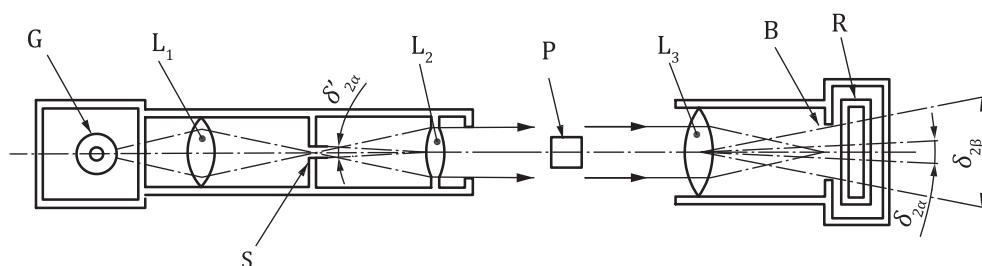
Table 2 — Angles and dimensions of circular source image and circular receptor aperture for 45° reflectometer of Method E

| Instrument characteristics | Angle δ degrees (°) | Dimension ^a mm |
|------------------------------------|-------------------------------|------------------------------|
| Source image size Tolerance | 3,44 $\pm 0,23$ | 1,5 $\pm 0,1$ |
| 45° Receptor aperture Tolerance | 3,44 $\pm 0,23$ | 1,5 $\pm 0,1$ |

^a Calculated for focal length of 25,4 mm. For any other focal length, f , the aperture diameter is equal to $2f(\tan \delta/2)$.



a) In plane of measurement



b) Perpendicular to plane of measurement

Key

| | | | |
|-------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| 1 | axis | $\delta_{1\alpha}$ | source image angles (in plane of measurement) |
| G | filament lamp | $\delta_{1\beta}$ | receptor aperture angles (in plane of measurement) |
| L_1 | condenser lens | $\delta_{2\alpha}$ | source image angles (perpendicular to plane of measurement) |
| L_2 | collimator lens | $\delta_{2\beta}$ | receptor aperture angles (perpendicular to plane of measurement) |
| L_3 | receptor lens | $\delta'_{1\alpha} = \delta_{1\alpha}$ and $\delta'_{2\alpha} = \delta_{2\alpha}$ if the focal lengths of L_2 and L_3 are the same | |
| S | effective light source (pin note) | ϵ_1 | incident angle |
| P | test surface | ϵ_2 | receptor angle |
| B | receptor field aperture | | |
| I | source image | | |
| R | photoelectric cell | | |

NOTE Angles and dimensions are given in [Table 1](#).

Figure 1 — Schematic arrangement of apparatus showing apertures and source image formation for a collimated-beam-type instrument for Method A (20°), Method B (45°), Method C (60°) and Method D (85°)