
**Optics and photonics — Optical
coatings —**

Part 6:
**Minimum requirements for reflecting
coatings**

Optique et photonique — Traitements optiques —

Partie 6: Exigences minimales pour revêtements réfléchissants

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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).

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 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 ISO/TC 172, *Optics and photonics*, Subcommittee SC 3, *Optical materials and components*.

A list of all parts in the ISO 9211 series can be found on the ISO website.

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.

Optics and photonics — Optical coatings —

Part 6:

Minimum requirements for reflecting coatings

1 Scope

This document specifies minimum requirements on the optical effects and the mechanical, chemical and environmental properties of reflecting metal coatings. This document applies to reflecting metal coatings based on aluminium or silver for optical applications. Thereby the user is able to rely on defined numerical data while the manufacturer of thin films has the choice for the materials and production method.

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 9211-1, *Optics and photonics — Optical coatings — Part 1: Vocabulary*

ISO 9211-4, *Optics and photonics — Optical coatings — Part 4: Specific test methods*

ISO 10110-7, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 7: Surface imperfections*

ISO 10110-8, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 8: Surface texture; roughness and waviness*

ISO 10110-9, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 9: Surface treatment and coating*

ISO 13696, *Optics and optical instruments — Test methods for radiation scattered by optical components*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9211-1 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

reflecting coating

mirror coating

coating which shows high reflectance in a defined spectral region

3.2

front surface mirror coating

coating which reflects the optical radiation away from the substrate

3.3

rear surface mirror coating

R

coating which reflects the optical radiation towards the substrate

3.4

Al

metallic coating made of aluminium

3.5

Ag

metallic coating made of silver

3.6

GS

protective coating between incident medium and the *reflecting coating* (3.1)

3.7

RI

dielectric coating that increases the reflecting function

4 Designation

Designation of a front surface mirror of aluminium (Al) with a protecting layer (GS) and the wavelength limits $\lambda_1 = 400 \text{ nm}$ and $\lambda_2 = 680 \text{ nm}$:

RE coating ISO 9211-6 - Al - GS - 400 - 680

The following abbreviations shall be applied:

Al Aluminium, front surface mirror coating, unprotected

Al - GS Aluminium, front surface mirror coating, protected

Al - RI Aluminium, front surface mirror coating, with reflection increasing interference coating

Ag - R Silver, rear surface mirror coating

5 Indication in drawings

When applying this standard $\text{\textcircled{A}}$ (the symbol for optical coating in accordance with ISO 10110-9) shall be indicated in the drawing in conjunction with the designation in accordance with [Clause 4](#).

6 Materials and layout

The front and rear facing mirrors have different materials and layout (see [Table 1](#)).

Table 1 — Materials and layout

Mirror coating	Material	Layout	Code
Front surface mirror coating	Aluminium	Without protection layer	Al
		With protection layer	Al - GS
		With reflection increasing interference coating	Al - RI
Rear surface mirror coating	Silver	—	Ag - R

7 Minimum requirements

The minimum requirements shall apply to unstressed mirror coatings (see [Table 2](#)). Reflectance of the mirror coatings are given in [Table 3](#).

Table 2 — Minimum requirements for unstressed mirror coatings (metal coatings)

No.	Property	Minimum requirements	Remarks
1	Spectral reflectance	In accordance with Table 3 as well as Figures 1 to 4 .	The spectral reflectance is measured on the planar surface of an identical or similar substrate which was coated in the same run.
2	Scattered light	TS ≤ 0,005 on measurements in accordance with ISO 13696 in conjunction with a substrate surface P3 in accordance with ISO 10110-8 and surface imperfections 5/3 × 0,16 in accordance with ISO 10110-7.	
3	Adhesion	After conditioning method 02, degree of severity 01, in accordance with ISO 9211-4 the coating shall not peel off.	
4	Abrasion resistance	Conditioning method 01, degree of severity 01 in accordance with ISO 9211-4 for coating type Al – GS and Al – RI.	
5	Solar radiation resistance in accordance with ISO 9211-3	Conditioning method 10 with degree of severity 01 in accordance with ISO 9211-3. In accordance with this conditioning method the coating shall comply with the minimum requirements of optical properties. The adhesion in accordance with conditioning method 02 with degree of severity 01 in accordance with ISO 9211-4 shall persist.	
6	Solvent solubility in accordance with ISO 9211-3	Required for solvents that do not affect the substrate. In accordance with conditioning method 12-3, degree of severity 01 in which different solvents may be used, the minimum requirements shall be fulfilled. The adhesion in accordance with conditioning method 02 with degree of severity 01 in accordance with ISO 9211-4 shall persist.	The manufacturer and the user shall agree on the solvents and chemicals for this test. The test is performed in accordance with ISO 9211-3.
7	Chemical durability in accordance with ISO 9211-3	Required for chemicals that do not affect the substrate. In accordance with conditioning method 12-3, degree of severity 01 where different types of solvents can be used the minimum requirements shall be fulfilled. The adhesion in accordance with conditioning method 02 in accordance with ISO 9211-4 shall persist.	The manufacturer and the user shall agree on the solvents and chemicals for this test. The test is performed in accordance with ISO 9211-3.

Table 2 (continued)

No.	Property	Minimum requirements		Remarks
8	Environmental durability according ISO 9022-2	Conditioning method	Degree of severity	In accordance with this conditioning method the coating shall comply with the minimum requirements of the optical properties. The adhesion in accordance with conditioning method 02 with degree of severity 01 in accordance with ISO 9211-4 shall persist.
		10: Cold	05	
		11: Dry heat	04	
		13: Condensed water	04	
		14: Slow temperature change	02	
		In accordance with this conditioning method the coating shall comply with the minimum requirements of the optical properties.		
The adhesion in accordance with conditioning method 02 with degree of severity 01 in accordance with ISO 9211-4 shall persist.				
9	Coating imperfections	Referred to a test area with a diameter of 50 mm: 5/C10 × 0,1 in accordance with ISO 10110-7.		

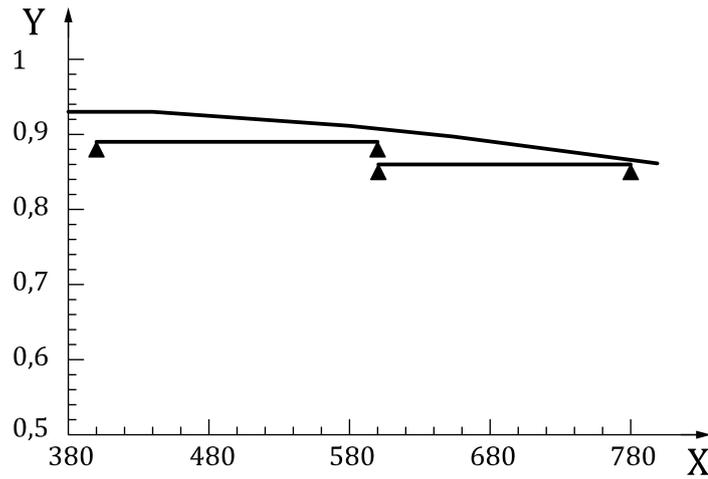
Table 3 — Spectral reflectance of mirror coatings

Coating type	Spectral range nm	Spectral reflectance ρ^a
Al	400 to 600	$\geq 0,89^b$
	>600 to 780	$\geq 0,86^b$
Al – GS	400 to 440	$\geq 0,82$
	>440 to 620	$\geq 0,86$
	>620 to 700	$\geq 0,82$
Al – RI	420 to 500	$\geq 0,88$
	>500 to 600	$\geq 0,93$
	>600 to 700	$\geq 0,88$
Ag – R ^c	400 to 440	$\geq 0,90$
	>440 to 500	$\geq 0,94$
	>500 to 780	$\geq 0,96$

^a Referred to an angle of incidence of 45°, unpolarised (degree of polarization 0).
^b Measured directly after the coating run.
^c Referred to a substrate with a refractive index of about 1,5, negligible absorption and a second surface without antireflective coating.

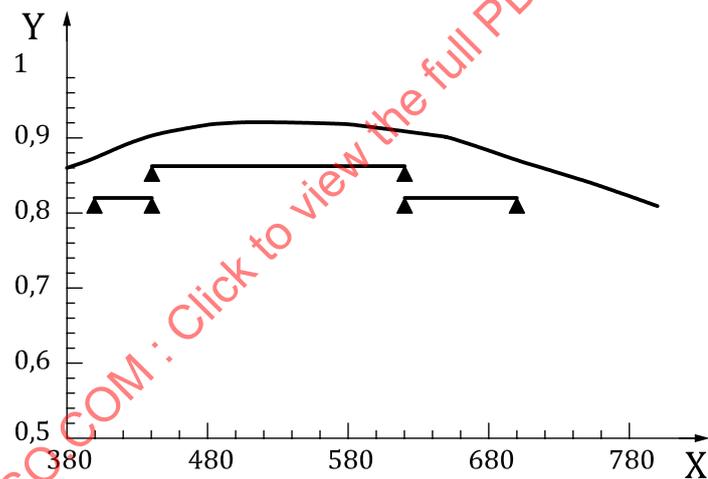
8 Characteristic reflectance curves

In [Figures 1](#) to [4](#) typical spectral and minimum requirements are shown in accordance with the form of ISO 9211-2.



Key
 X wavelength in nm
 Y reflectance

Figure 1 — Al, Aluminium mirror, unprotected



Key
 X wavelength in nm
 Y reflectance

Figure 2 — Al-GS, Aluminium mirror, protected