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**Optics and photonics — Optical  
coatings —**

Part 5:  
**Minimum requirements for  
antireflecting coatings**

*Optique et photonique — Traitements optiques —*

*Partie 5: Exigences minimales pour revêtements anti-réfléchissants*

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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](http://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](http://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](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee 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](http://www.iso.org/members.html).

# Optics and photonics — Optical coatings —

## Part 5:

# Minimum requirements for antireflecting coatings

## 1 Scope

This document specifies minimum requirements for the optical effects and the mechanical, chemical and environmental properties of antireflecting coatings. This document applies to antireflecting coatings 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 9211-2, *Optics and photonics — Optical coatings — Part 2: Optical properties*

ISO 9211-3, *Optics and photonics — Optical coatings — Part 3: Environmental durability*

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

ISO 9022-2, *Optics and photonics — Environmental test methods — Part 2: Cold, heat and humidity*

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/>

**NOTE** The antireflecting coatings are named type U, V and W in accordance with the form of their characteristic reflection curves. Additionally, type X can be applied, the optical properties of which are agreed to be in accordance with ISO 9211-2.

**3.1  
antireflecting coating type U**

single layer coating which is characterized by a single reflection minimum at a wavelength  $\lambda_1$

Note 1 to entry: The spectral position and the value of the reflection minimum result from the layer thickness and the refractive indices of the layer material and the substrate (see [Figure 1](#)).

**3.2  
antireflecting coating type V**

double layer coating which is characterized by a single reflection minimum at a wavelength  $\lambda_1$

Note 1 to entry: Compared to type U the slopes are steeper. The value of the reflection minimum is lower and is to a large extent independent of the refractive index of the substrate (see [Figure 2](#)).

**3.3  
antireflecting coating type W**

multilayer coating with a reflection reduction that is largely independent of the refractive index of the substrate and covers a larger spectral range within the boundary values  $\lambda_1$  and  $\lambda_2$ , where  $\frac{\lambda_2}{\lambda_1} \geq 1,57$

Note 1 to entry: See [Figure 3](#).

**3.4  
antireflecting coating type X**

multilayer coating, the reflection reducing properties of which are described in ISO 9211-2 and which does not match types U, V or W

## 4 Designation

Designation of a reflection reducing coating of type W with the boundary values  $\lambda_1 = 420 \text{ nm}$  and  $\lambda_2 = 660 \text{ nm}$ :

**AR coating ISO 9211-5 - W - 420 - 660**

## 5 Indication in drawings

When applying this document,  $\textcircled{\lambda}$  (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 Minimum requirements

The minimum requirements shall apply to unstressed antireflecting coatings as specified in [Table 1](#). The spectral reflectance for the coating types U, V, W and X is given in [Table 2](#).

**Table 1 — Minimum requirements for unstressed antireflecting coatings**

No.	Property	Minimum requirements	Remarks
1	Spectral reflectance	For types U, V and W in accordance with <a href="#">Table 2</a> and <a href="#">Figures 1 to 3</a> . For type X in accordance with ISO 9211-2.	The spectral reflectance is measured on the planar surface of an identical or similar substrate which was coated in the same run.
2	Spectral absorptance	$\alpha \leq 0,002$ for types U and V $\alpha \leq 0,005$ for type W For type X in accordance with ISO 9211-2.	
3	Scattered light	For types U, V, W and X: TS $\leq 0,005$ for measurements in accordance with ISO 13696 in conjunction with a substrate surface P3 in accordance with ISO 10110-8 and surface imperfections $5/3 \times 0,16$ in accordance with ISO 10110-7.	
4	Adhesion	After conditioning method 02 with degree of severity 01 in accordance with ISO 9211-4, the coating shall not peel off.	
5	Abrasion resistance	Conditioning method 01 with degree of severity 03 in accordance with ISO 9211-4.	
6	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.	
7	Solvent solubility allowance in accordance with ISO 9211-3	Required for solvents that do not affect the substrate. In accordance with conditioning method 12-3 with degree of severity 01 in which different types of 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 of the coating shall agree on the solvents and chemicals for this test. The test is performed in accordance with ISO 9211-3.
8	Chemical durability in accordance with ISO 9211-3	Required for chemicals that do not affect the substrate. In accordance with conditioning method 12-3 with degree of severity 01 in which different types of 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 of the coating shall agree on the solvents and chemicals for this test. The test is performed in accordance with ISO 9211-3.

**Table 1** (continued)

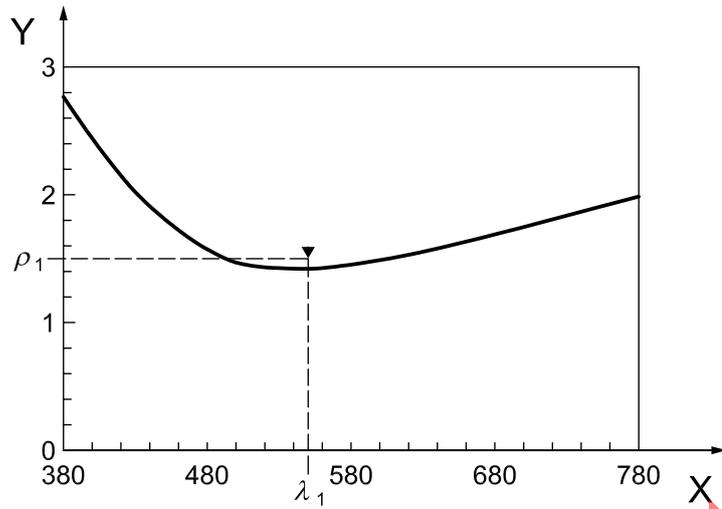
No.	Property	Minimum requirements		Remarks
9	Environmental durability in accordance with ISO 9022-2	Conditioning method	Degree of severity	
		10: Cold	05	
		11: Dry heat	04	
		13: Condensed water	04	
		14: Slow temperature change	02	
In accordance with this conditioning method, the coating shall comply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

**Table 2 — Spectral reflectance for the coating types U, V, W and X**

Type	Spectral reflectance <sup>a</sup>
U	$\rho(\lambda_1) \leq 0,02$ for $n > 1,45$ to 1,5 $\rho(\lambda_1) \leq 0,015$ for $n > 1,5$ to 1,7 $\rho(\lambda_1) \leq 0,01$ for $n > 1,7$
V	$\rho(\lambda_1) \leq 0,002$
W	$\rho(\lambda_1 \text{ to } \lambda_2) \leq 0,005$ for $\frac{\lambda_2}{\lambda_1} \geq 1,57$
X	Defined in accordance with ISO 9211-2
<sup>a</sup> Corresponding to an angle of incidence $\leq 15^\circ$ .	

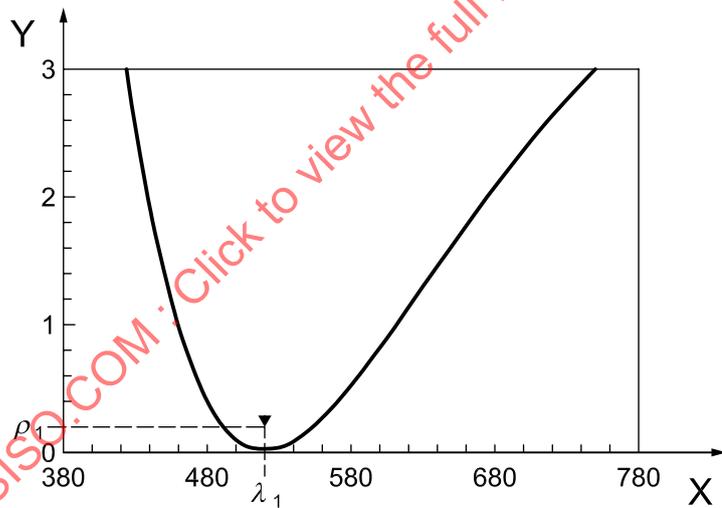
## 7 Characteristic reflectance curves

Figure 1, Figure 2 and Figure 3 show the typical curves and the minimum requirements in accordance with ISO 9211-2.



**Key**  
 X wavelength in nm  
 Y reflectance in %

**Figure 1 — Single layer coating type U**



**Key**  
 X wavelength in nm  
 Y reflectance in %

**Figure 2 — Double layer coating type V**