INTERNATIONAL STANDARD

ISO 9211-8

First edition
2018-12

Optics and photonics — Optical coatings —

Part 8: Minimum requirements for coatings used for laser optics

Optique et photonique — Traitements optiques —

Partie 8: Exigences minimales pour revêtements utilisés pour l'optique laser

Reference number
ISO 9211-8:2018(E)

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Published in Switzerland

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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 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 8:
Minimum requirements for coatings used for laser optics

1 Scope

This document specifies minimum requirements for the optical functions and especially for the laser power handling capability as well as for the resistance against mechanical, chemical and climatic stress of optical coatings. This document applies to optical coatings that are used in laser optics. 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 9022-2, *Optics and photonics — Environmental test methods — Part 2: Cold, heat and humidity*

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 11551, *Optics and optical instruments — Lasers and laser-related equipment — Test method for absorptance of optical laser components*

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

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

ISO 11151-1:2015, *Lasers and laser-related equipment — Standard optical components — Part 1: Components for the UV, visible and near-infrared spectral ranges*

ISO 11151-2:2015, *Lasers and laser-related equipment — Standard optical components — Part 2: Components for the infrared spectral range*

ISO 21254-1, *Lasers and laser-related equipment — Test methods for laser-induced damage threshold — Part 1: Definitions and general principles*

ISO 21254-2, *Lasers and laser-related equipment — Test methods for laser-induced damage threshold — Part 2: Threshold determination*

3 Terms and definitions

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

4 Optical function

The scope of this document covers laser components with surface treatments and substrates identified in accordance with the definitions given in ISO 9211-1. In order to indicate the application in laser devices the letter code defined in ISO 9211-1 shall be extended by an additional leading symbol “L”.

5 Designation of optical functions, their parameters and limit deviations

The specifications of the optical properties and the representation of the spectral characteristics of the laser coatings shall be specified in accordance with ISO 9211-2.

NUMERICAL EXAMPLE

L-HR ISO 9211-8 ρ(1 064 nm) > 0,999

L-AR ISO 9211-8 ρ_s(1 030 nm, 45°) < 0,01

For low power applications see Clause 8. An additional symbol "LOW" shall be added to the designation.

NUMERICAL EXAMPLE

L-HR ISO 9211-8 ρ(633 nm) > 0,999 LOW

6 Indication in drawings

When applying this document, the symbol for optical coating in accordance with ISO 10110-9 shall be indicated in conjunction with the designation in accordance with Clause 4.

7 Materials and layout

The minimum requirements for the described types of function are defined by the area of application in the optical technologies and by the availability of suitable substrates and coating materials. The usable materials and typical layouts depend on the operating conditions and especially on the wavelengths at which the components shall be used.

8 Minimum requirements

The minimum requirements refer to unconditioned coatings. Prior to the test, cleaning of the coating is permissible in accordance with the manufacturer’s recommendation. Additional requirements may be agreed upon and shall be documented.

The coatings shall at least fulfil the minimum requirements for the various wavelength ranges as given in Tables 2 to 6. A distinction is made between low power and high power lasers. In the low power range typical applications have pulse energy densities below 5 mJ/cm^2 or linear power densities below 10 W/cm. The damage threshold values given in Tables 2 to 6 refer to the high power range only. The numerical values in Tables 2 to 6 are examples as measured for specific wavelengths.

All component types shall at least fulfil the minimum requirements for adhesion, cleaning, chemical durability, environmental durability and surface imperfections, as given in Table 1. The requirements are identical for all component types.

If required, other specifications for adhesion, cleanliness, chemical durability, environmental durability, and surface imperfections can be applied or further conditioning methods can be stipulated.

Table 1 — Minimum requirements for adhesion, cleanliness, chemical durability, environmental durability and surface imperfections

No.	Property	Parameter/ Minimum requirements	
1	Adhesion	Conditioning method 02 with degree of severity 03 in accordance with ISO 9211-4.	
2	Cleanliness	Cleaning method and number of cycles by mutual agreement between customer and manufacturer.	
3	Chemical durability	Required for solvents that do not affect the substrate. Solvent solubility in accordance with ISO 9211-3 conditioning method 12-3 with degree of severity 01 except that solvents other than acetone and ethanol are permitted by mutual agreement between customer and manufacturer. Adhesion in accordance with ISO 9211-4 conditioning method 02 with degree of severity 01.	
4	Environmental durability	Conditioning method in accordance with ISO 9022-2	Degree of severity
		10: Cold	05
		11: Dry heat	05
		13: Condensed water	01
		14: Slow temperature change	01
5	Surface imperfections[a]	In accordance with ISO 11151-1 and ISO 11151-2	

[a] The indications for surface imperfections refer to a circular test area with a diameter of 20 mm.

Table 2 — Minimum requirements for wavelength range between 150 nm and 200 nm

No.	Function	Parameter/ Minimum requirements	
1		Absorptance Measurement in accordance with ISO 11551.	
		High power range	Low power range
	High reflecting mirror	2×10^{-2}	3×10^{-2}
	Partial reflector, beam splitter	2×10^{-2}	3×10^{-2}
	Antireflecting coating	1×10^{-2}	3×10^{-2}
2		Total scattering Measurement in accordance with ISO 13696.	
		High power range	Low power range
	High reflecting mirror	2×10^{-2}	3×10^{-2}
	Partial reflector, beam splitter	2×10^{-2}	3×10^{-2}
	Antireflecting coating	1×10^{-2}	1×10^{-2}

[a] The comparison of damage threshold values can be misleading if the measurements were not performed at identical wavelengths, pulse durations or beam diameters. Especially, the extrapolation of damage data can lead to bad or erroneously calculated results and to an overestimation of the laser induced damage thresholds. In the case of toxic materials this can lead to severe health hazards. Examples for units of measurement and scaling of damage thresholds are presented in ISO 21254-1 and ISO 21254-2.

Table 2 *(continued)*

No.	Function	Parameter/ Minimum requirements
3		Laser induced damage threshold[a] Measurement in accordance with ISO 21254-1 and ISO 21254-2
	High reflecting mirror	1 on 1: 1 J/cm^2 at 20 ns
	Partial reflector, beam splitter	1 on 1: 1 J/cm^2 at 20 ns
	Antireflecting coating	1 on 1: 0,5 J/cm^2 at 20 ns

[a] The comparison of damage threshold values can be misleading if the measurements were not performed at identical wavelengths, pulse durations or beam diameters. Especially, the extrapolation of damage data can lead to bad or erroneously calculated results and to an overestimation of the laser induced damage thresholds. In the case of toxic materials this can lead to severe health hazards. Examples for units of measurement and scaling of damage thresholds are presented in ISO 21254-1 and ISO 21254-2.

Table 3 — Minimum requirements for wavelength range between 200 nm to 400 nm

No.	Function	Parameter/Minimum requirements	
1		Absorptance Measurement in accordance with ISO 11551	
		High power range	Low power range
	High reflecting mirror	5×10^{-4}	5×10^{-3}
	Partial reflector, beam splitter	5×10^{-4}	5×10^{-3}
	Antireflecting coating	5×10^{-4}	5×10^{-3}
2		Total scattering Measurement in accordance with ISO 13696	
		High power range	Low power range
	High reflecting mirror	5×10^{-3}	1×10^{-2}
	Partial reflector, beam splitter	5×10^{-3}	1×10^{-2}
	Antireflecting coating	5×10^{-3}	5×10^{-3}
3		Laser induced damage threshold Measurement in accordance with ISO 21254-1 and ISO 21254-2	
	High reflecting mirror	1 on 1: 1 J/cm^2 at 20 ns	
	Partial reflector, beam splitter	1 on 1: 1 J/cm^2 at 20 ns	
	Antireflecting coating	1 on 1: 0,5 J/cm^2 at 20 ns	

Table 4 — Minimum requirements for wavelength range between 400 nm to 1 600 nm

No	Function	Parameter/ Minimum requirements	
1		Absorptance Measurement in accordance with ISO 11551	
		High power range	Low power range
	High reflecting mirror	3×10^{-5}	5×10^{-3}
	Partial reflector, beam splitter	3×10^{-5}	5×10^{-3}
	Antireflecting coating	5×10^{-4}	5×10^{-3}
	Bandpass filter, notch filter (negative filter)	1×10^{-3}	1×10^{-2}
	Long pass filter, short pass filter	1×10^{-3}	1×10^{-2}
	Polarizing beam splitter	1×10^{-3}	1×10^{-2}
	Phase retarding mirror	2×10^{-3}	5×10^{-3}

Table 4 *(continued)*

No	Function	Parameter/ Minimum requirements	
2		Total scattering Measurement in accordance with ISO 13696	
		High power range	Low power range
	High reflecting mirror	2×10^{-4}	1×10^{-2}
	Partial reflector, beam splitter	2×10^{-4}	1×10^{-2}
	Antireflecting coating	2×10^{-4}	5×10^{-3}
	Attenuator	2×10^{-4}	5×10^{-3}
3		Laser induced damage threshold Measurement in accordance with ISO 21254-1 and ISO 21254-2	
	High reflecting mirror	1 on 1: 20 J/cm^2 at 20 ns	
		S on 1: 1 000 J/cm^2 at 400 ns, 1 kHz	
		S on 1: 0,1 J/cm^2 at 150 fs, 1 kHz	
	Partial reflector, beam splitter	1 on 1: 20 J/cm^2 at 20 ns	
		S on 1: 1 000 J/cm^2 at 400 ns, 1 kHz	
		S on 1: 0,1 J/cm^2 at 150 fs, 1 kHz	
	Antireflecting coating	1 on 1: 10 J/cm^2 at 20 ns	
		S on 1: 500 J/cm^2 at 400 ns, 1 kHz	
		S on 1: 0,1 J/cm^2 at 150 fs, 1 kHz	

Table 5 — Minimum requirements for wavelength range between 1,6 µm to 3 µm

No.	Function	Parameter/ Minimum requirements	
1		Absorptance Measurement in accordance with ISO 11551	
		High power range	Low power range
	High reflecting mirror	5×10^{-4}	1×10^{-2}
	Partial reflector, beam splitter	5×10^{-4}	1×10^{-2}
	Antireflecting coating	1×10^{-3}	1×10^{-2}
2		Laser induced damage threshold Measurement in accordance with ISO 21254-1 and ISO 21254-2.	
	High reflecting mirror	1 on 1: 1 J/cm^2 at 20 ns	
	Partial reflector, beam splitter	1 on 1: 1 J/cm^2 at 20 ns	
	Antireflecting coating	1 on 1: 0,5 J/cm^2 at 20 ns	