International Standard

ISO 9211-3

Third edition

Optics and photonics — Optical coatings —

Part 3: Environmental durability

Optique et photonique — Traitements optiques —

Partie 3: Durabilité environnementale

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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 document 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 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 *[or Project Committee]* ISO/TC 172, *Optics and photonics*, Subcommittee SC 3, *Optical materials and components*.

This third edition cancels and replaces the second edition (ISO 9211-3:2008), which has been technically revised.

The main changes are as follows:

— Included ISO 9211-2 in bibliography.

— Add new section that explains the test code notation to use when specifying a coating environmental durability test.

— Remove previous Annex A and move test sequence tables for standard categories into relevant sections.

— Update notation for standard test sequence tables to include conditioning method and degree of severity test code notation.

— Clarify that category O is for non-standard test sequences that are also similar to other standard categories of use.

— Add new section for a general use case when specifying coating environmental durability tests and the sequence they follow. This is used for test sequences that are not similar to any of the standard categories of use.

— Add statement that if specifying a temperature requirement for a coating, this notation is described in ISO 9211-2.

— Add new Annex A that includes the previously shown Table 1.

— Update previous Table 1 to include conditioning method and degrees of severity test code notation.

— Add new relevant degrees of severity from ISO 9022-2 Amd 1 and ISO 9022-4 Amd 1.

— Add conditioning methods and degrees of severity shown in ISO 9211-5 to ISO 9211-8 not listed previously.

— Clarify descriptions in previous Table 1 to match what is listed in the conditioning method table for each test.

— Separate solvent solubility line in previous Tables A.2, A.3 and A.4 to two lines, separating acetone and ethanol.

— Add new Annex B explaining how to use category 0.

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 3: Environmental durability

1 Scope

ISO 9211 (series) describes surface treatments of components and substrates excluding ophthalmic optics (spectacles) by the application of optical coatings and gives a standard form for their specification. It defines the general characteristics and the test and measurement methods whenever necessary, but it is not intended to define the process method.

This document specifies general use and standard categories of use for optical coatings and identifies which environmental tests are necessary to prove that the coatings meet the required specification. The mechanical and chemical properties of coated optical elements, and more generally their environmental durability, can be assessed by a variety of methods. The test methods are generally described in various parts of ISO 9022 and in ISO 9211-4. These test methods are selected to give meaningful results representative of actual exposure of optical elements in their operating environment, alternatively to the minimum requirements as described in ISO 9211-5 to ISO 9211-8, which are coating type related.

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 9022-1, *Optics and photonics — Environmental test methods — Part 1: Definitions, extent of testing*

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

ISO 9022-4, *Optics and photonics — Environmental test methods — Part 4: Salt mist*

ISO 9022-6, *Optics and photonics — Environmental test methods — Part 6: Dust*

ISO 9022-9, *Optics and photonics — Environmental test methods — Part 9: Solar radiation and weathering*

ISO 9022-11, *Optics and photonics — Environmental test methods — Part 11: Mould growth*

ISO 9022-12, *Optics and photonics — Environmental test methods — Part 12: Contamination*

ISO 9022-14, *Optics and photonics — Environmental test methods — Part 14: Dew, hoarfrost, ice*

ISO 9211-4, *Optics and optical instruments — Optical coatings — Part 4: Specific test methods: abrasion, adhesion and resistance to water*

3 Terms and definitions

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

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

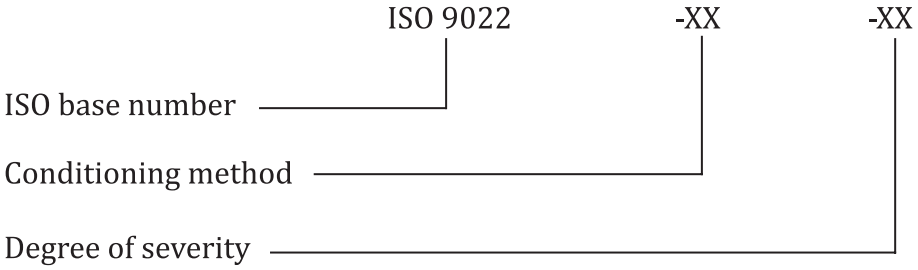
— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 General information for use

4.1 Environmental test code

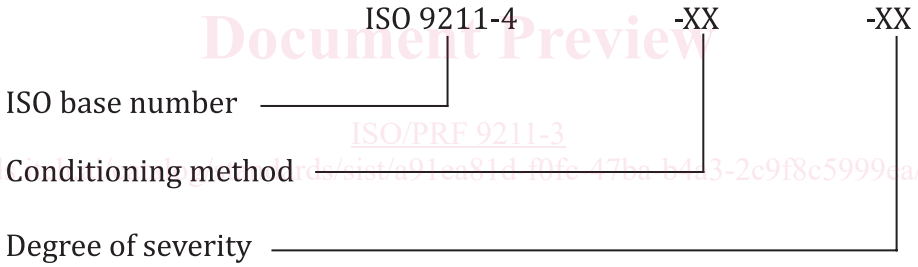
The coating environmental durability tests should be listed according the environmental test code notation. In the case that the ISO base number is the ISO 9022 series, the part of ISO 9022 shall not to be listed, as per the notation in ISO 9022-1, as shown in Figure 1. Only the conditioning method and degree of severity shall be listed following the ISO 9022 base number for the test code.



NOTE The test code notation from ISO 9022-1 is slightly different in that this description does not include the statement "Environmental test". The environmental test name should be included as a descriptor to the environmental test code to avoid confusion, but is not directly a part of the environmental test code.

Figure 1 — Code for environmental tests

If the environmental durability test is one specified from ISO 9211-4, the ISO base number shall be listed as 9211-4, as shown in Figure 2. This notation still includes the conditioning method and degree of severity.



NOTE The test code notation from ISO 9211-4 is slightly different in that this description does not include the statement "Coating environmental durability test". The coating environmental durability test name should be included as a descriptor to the environmental test code to avoid confusion, but is not directly a part of the environmental test code.

Figure 2 — Code for coating environmental durability tests

4.2 Standard categories of use

4.2.1 General

Four standard categories of use and one non-standard category of use are defined. The four standard categories of use represent different environmental conditions that a component may experience. Each category requires either different environmental tests and/or different degrees of severity. These categories are listed below in order of severity of requirement. These categories are a summary of use cases and are not exhaustive of all instances.

A complete description of environmental durability tests, necessary for all standard categories of use, shall be as provided in Annex A.

4.2.2 Category A

This category refers to components in applications which would normally only apply when they are to be mounted internally within sealed units. In this category, handling is in a protected and controlled environment and should only take place with extreme care. Physical contact with the optically coated surface is discouraged. See Table 1 for complete test sequence.

Table 1 — Default test sequence for Category of use A (one test sample is used)

Test step	Test code	Test	Description	Sample 1
1	ISO 9022-10-05	Cold	Expose to a temperature of –25 °C ± 3 °C for 16 h	x
2	ISO 9022-11-03	Dry heat	Expose to an atmosphere of 55 °C ± 2 °C (below 40 % relative humidity) for 16 h	x

4.2.3 Category B

This category refers to applications where components will be exposed only to a controlled environment. Such applications may involve mild abrasion such as occurs with carefully controlled cleaning. See Table 2 for complete test sequence.

Table 2 — Default test sequence for Category of use B (two test samples are used)

Test step	Test code	Test	Description	Sample 1	Sample 2
1	ISO 9211-4-02-01	Adhesion: tape test	Slow tape removal	x	x
2	ISO 9211-4-01-01	Abrasion: cheesecloth/ eraser test	50 strokes cheesecloth	x	
3	ISO 9022-10-07	Cold	Expose to a temperature of – 35 °C ± 3 °C for 16 h		x
4	ISO 9022-11-05	Dry heat	Expose to an atmosphere of 70 °C ± 2 °C (below 40 % relative humidity) for 6 h		x
5	ISO 9022-12-06	Damp heat	Expose to climatic conditions of 90 % to 95 % relative humidity and 55 °C ± 2 °C for 6 h		x
6	ISO 9022-14-02	Slow temperature change	– 25 °C ± 3 °C to + 55 °C ± 2 °C Number of cycles: 5 Dwell time: wait until sample has reached a temperature within at least 3 K of the test chamber temperature but not less than 2,5 h Test chamber temperature change rate: between 0,2 K/min and 2 K/min		x
7	ISO 9022-87-01	Laboratory agent: Acetone (CH_3COCH_3)	5 min	x	
8	ISO 9022-87-01	Laboratory agent: Ethanol (C_2H_5OH)	5 min	x	
9	ISO 9211-4-02-01	Adhesion: tape test	Slow tape removal	x	x

4.2.4 Category C

This category refers to applications where components will be exposed to normal outdoor ambient conditions and cleaning but without severe abrasion and scratching. See Table 3 for complete test sequence.

Table 3 — Default test sequence for Category of use C (three test samples are used)

Test step	Test code	Test	Description	Sample 1	Sample 2	Sample 3
1	ISO 9211-4-02-02	Adhesion: tape test	Quick tape removal	x	x	x
2	ISO 9211-4-01-02	Abrasion: cheesecloth/ eraser test	100 strokes cheesecloth	x		
3	ISO 9211-4-04-01	Resistance to water: exposure to water	Immerse in distilled or deionized water at a temperature of 23 °C ± 2 °C for 6 h			x
4	ISO 9211-4-04-07	Resistance to water: exposure to water	Immerse in boiling distilled or deionized water for 5 min			x
5	ISO 9022-10-07	Cold	Expose to a temperature of −35 °C ± 3 °C for 16 h		x	
6	ISO 9022-11-05	Dry heat	Expose to an atmosphere of 70 °C ± 2 °C (below 40 % relative humidity) for 6 h		x	
7	ISO 9022-12-07	Damp heat	Expose to climatic conditions of 90 % to 95 % relative humidity and 55 °C ± 2 °C for 16 h		x	
8	ISO 9022-14-05	Slow temperature change	− 35 °C ± 3 °C to + 63 °C ± 2 °C Number of cycles: 5 Dwell time: wait until sample has reached a temperature within at least 3 K of the test chamber temperature but not less than 2,5 h Test chamber temperature change rate: between 0,2 K/min and 2 K/min		x	
9	ISO 9022-87-01	Laboratory agent: Acetone (CH_3COCH_3)	5 min	x		
10	ISO 9022-87-01	Laboratory agent: Ethanol (C_2H_5OH)	5 min	x		
11	ISO 9211-4-02-02	Adhesion: tape test	Quick tape removal	x	x	x

4.2.5 Category D

This category refers to applications where components will be exposed to severe outdoor ambient conditions and uncontrolled cleaning with the risk of severe abrasion and scratching. See Table 4 for complete test sequence.