
**Optics and photonics — Optical
coatings —**

**Part 4:
Specific test methods**

Optique et photonique — Traitements optiques —

Partie 4: Méthodes d'essai spécifiques

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 9211-4 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 3, *Optical materials and components*.

This third edition cancels and replaces the second edition (ISO 9211-4:2006), which has been technically revised.

ISO 9211 consists of the following parts, under the general title *Optics and photonics — Optical coatings*:

— Part 1: Definitions

— Part 2: Optical properties

— Part 3: Environmental durability

— Part 4: Specific test methods

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Optics and photonics — Optical coatings —

Part 4: Specific test methods

1 Scope

ISO 9211 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 wherever necessary, but it is not intended to define the process method.

This part of ISO 9211 describes specific test procedures for coating environmental durability tests that are identified in ISO 9211-3 but not described in other normative references. They are typically performed in sequence with other environmental durability tests, as shown in ISO 9211-3:2008, Annex A.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*.
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ISO 9211-1, *Optics and photonics — Optical coatings — Part 1: Definitions*

ISO 29862, *Self adhesive tapes — Determination of peel adhesion properties*

3 Terms and definitions

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

4 Test conditioning

Before and after subjecting a coated specimen (component or witness sample) to any inspection or test, the specimen shall be thoroughly cleaned as required to remove dirt, finger marks, smears, etc. Recommended storage time is at least 12 h after the coating process under ambient atmospheric conditions, or as specified between manufacturer and buyer.

5 Abrasion resistance tests (conditioning method 01: abrasion)

5.1 General

The purpose of these tests is to evaluate to what extent the optical and mechanical properties of optical coatings on components and substrates are affected when subjected to specific abrading conditions at ambient atmospheric conditions.

5.2 Test conditions

5.2.1 General

Abrasion tests shall be conducted using a coating abrasion tester capable of meeting the requirements of 5.2 and 5.3. The length of stroke of the tester shall be approximately 20 mm when the dimensions of the specimen permit. A stroke is defined as one pass in one direction on the surface being tested. The tester shall be operated in a cycling mode. A cycle is defined as one stroke in one direction, followed by a return stroke in the opposite direction. The cycle speed shall be in the range of 30 to 90 cycles per minute. The head of the tester shall be approximately normal to the surface under test during the rubbing operation. The specimen shall be firmly held so that it does not slide during the test.

5.2.2 Moderate abrasion test

The rubbing head of the abrasion tester shall be covered with a pad of cotton cheesecloth conforming to A.1, approximately 5 mm thick and 10 mm wide. Instructions for preparing the cheesecloth pad, cover and fixture are provided in Annex B.

5.2.3 Severe abrasion test

The rubbing head of the abrasion tester shall be affixed with a standard eraser, conforming to A.2. The eraser shall be inserted into the holder so that the exposed length does not exceed 3 mm.

It is permissible to clean the eraser with a clean towel but solvents should not be used. Also, the eraser may be conditioned by rubbing it across a clean, smooth or frosted glass surface to wear away some of the rubber if embedded foreign material is suspected.

5.3 Degree of severity (conditioning method 01: abrasion)

The degrees of severity for conditioning method 01 are given in Table 1.

Table 1 — Degrees of severity for conditioning method 01: abrasion

Degree of severity	01	02	03	04
Abrader	Cheesecloth	Cheesecloth	Eraser	Eraser
Number of strokes	50	100	20	40
Force	5 N ± 1 N	5 N ± 1 N	10 N ± 1 N	10 N ± 1 N

A requirement for a greater number of strokes shall be indicated by adding a multiplier to the degree of severity. For example, a requirement for 150 cheesecloth rubs would be indicated as “degree of severity 01 x 3”; a requirement for 100 eraser rubs would be indicated as “degree of severity 03 x 5”.

5.4 Recovery

Subsequent to the rubbing operation the specimen shall be cleaned as described in Clause 4.

5.5 Evaluation

The film on the specimen shall be visually examined in reflected and/or transmitted light, with the unaided eye, for evidence of physical damage to the coating. The examination shall be performed using the method specified in Annex C, or that given in ISO 14997, or as agreed between the supplier and the user. The method used shall be stated. The coating shall not show any evidence of damage, such as abrasion or coating removal. If slight sleeking or scratching is visible and the cheesecloth or eraser and/or coating is suspected of having foreign material embedded in it, another area of the surface shall be retested using a fresh cheesecloth pad or eraser.

6 Adhesion tests (conditioning method 02: adhesion)

6.1 General

The purpose of these tests is to evaluate to what extent the mechanical properties of optical coatings on components and substrates are affected when subjected to specific tensile or shear stress conditions at ambient atmospheric conditions.

6.2 Test conditions

6.2.1 The adhesive tape used for this test shall be clear in colour with an adhesive strength on steel of at least 9,8 N per 25 mm width when tested in accordance with ISO 29862, Method 1, 180° angle of peel. It shall be 12 mm to 13 mm wide. It shall show no evidence of deterioration and shall be capable of being unwound from the roll at a normal rate of speed without showing evidence of adhesive offsetting, adhesive splitting, or stringing out of adhesive, nor breakage or splitting of the tape backing. The tape shall be free of bare spots or foreign particles or any defect that may affect serviceability or appearance.

6.2.2 Apply approximately 25 mm of tape to the coated surface when the dimensions of the specimen permit, with sufficient tape remaining to securely grasp with a thumb and finger.

6.2.3 Press the tape firmly onto the coated surface. Rub the non-adhesive surface of the tape with a finger to ensure firm contact with the specimen and to work out any air bubbles that may be present.

6.2.4 Unless otherwise required in the relevant specification, do not apply the tape within 2 mm of any rim of the specimen.

6.2.5 Hold the specimen firmly in one hand, and in the other the end of the tape that protrudes beyond the edge of the test specimen.

6.2.6 Remove the tape at an angle perpendicular to the coated surface at one of the rates indicated in Table 2.

6.3 Degree of severity (conditioning method 02: adhesion)

The degrees of severity for conditioning method 02 are given in Table 2.

Table 2 — Degrees of severity for conditioning method 02: adhesion

Degree of severity	01	02	03
Rate of tape removal	Slow (approximately 2 s to 3 s per 25 mm)	Quick (approximately 1 s per 25 mm)	Snap (much less than 1 s per 25 mm)
NOTE The "snap" rate of removal refers to a snapping action of the wrist and fingers.			

6.4 Recovery

Do not clean the specimen prior to evaluation.

6.5 Evaluation

The film on the specimen shall be visually examined in reflected and/or transmitted light, with the unaided eye, for evidence of coating removal. The examination shall be performed using the method specified in Annex C, or that given in ISO 14997, or as agreed between the supplier and the user. The method used shall be stated. The coating shall not show any evidence of coating removal.

Unless otherwise required in the relevant specification, visual discolourations of the coating such as stains, smears, streaks or cloudiness shall be acceptable if the specimen conforms to the optical and other environmental durability requirements of the relevant specification.

7 Crosshatch test (conditioning method 03: crosshatch)

7.1 General

The purpose of this test is to evaluate to what extent the adhesion properties of optical coatings on components and substrates are affected after cutting the coating (distorting the stress and influencing the adhesion).

7.2 Test conditions

7.2.1 Use a cutting device [e.g. a razor blade (suitable for soft substrates) or a diamond scribe] to make six parallel cuts in the coating, $1,5 \text{ mm} \pm 0,5 \text{ mm}$ apart and approximately 15 mm to 20 mm in length, when the dimensions of the specimen permit. Cut through the coating completely but do not cut too deep into the substrate. Rotate the sample and in the same way make six parallel cuts perpendicular to the first set of cuts. Check the cut pattern for flakes or other irregularities and record the results.

7.2.2 Apply adhesive tape as specified in 6.2.1 over the crosshatch pattern in accordance with 6.2.2 to 6.2.5.

7.3 Conditioning

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Remove the tape at an angle perpendicular to the coated surface at a snip rate (much less than 1 s per 25 mm).

7.4 Recovery

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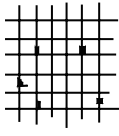
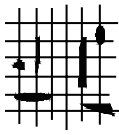
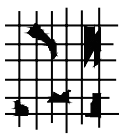

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Do not clean the specimen prior to evaluation. [2982dd560/iso-9211-4-2012](https://standards.iteh.ai/catalog/standards/sist/a38d0207-2911-44b5-9f5b-2982dd560/iso-9211-4-2012)

7.5 Evaluation

Rate the crosshatch results according to Table 3. Magnification may be used.

Table 3 — Rating system for conditioning method 03: crosshatch

Classification	Picture	Description
0	—	The edges of the cuts are completely unchanged; none of the squares are detached.
1		Small flakes of the coating are detached at the intersections; less than 5 % of the total area is affected.
2		Small flakes of the coating are detached along the cuts and the intersections; the area affected is 5 % to 15 % of the total area.
3		Some parts of the squares are detached; the area affected is 15 % to 35 % of the total area.
4		Whole squares are detached; the area affected is 35 % to 65 % of the total area.
5		Flaking and detachment worse than classification 4.

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8 Solubility tests (conditioning method 04: solubility)

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8.1 General

The purpose of these tests is to evaluate to what extent the optical and mechanical performance characteristics of optical coatings on components and substrates are affected after immersion in distilled or deionized water or a salt water solution.

8.2 Test conditions

8.2.1 The test container shall be made of non-reactive material, such as suitable glass or ceramic, with a volume adequate to submerge the test part(s) completely.

8.2.2 The specimen(s) shall be held in the test container using a specimen holder made of non-reactive material, such as polytetrafluoroethylene (PTFE) or acetal polymer.

8.2.3 The water used for tests shall be distilled or deionized. Its resistivity shall be greater than or equal to 0,2 M Ω ·cm, at a temperature of 23 °C \pm 2 °C.

8.2.4 The pH of the water or salt solution shall be between 6,5 and 7,2, measured at a temperature of 23 °C \pm 2 °C. Only diluted, chemically pure hydrochloric acid or chemically pure sodium hydroxide solution shall be used to adjust the pH. The pH shall be measured either electrometrically by means of a glass electrode, or colourmetrically using bromothymol blue as an indicator.

8.2.5 The salt water solution shall be prepared by dissolving sodium chloride in distilled or deionized water at room temperature to obtain a concentration of 45 g/l. The sodium chloride shall not contain more than 1 % impurities in total.

8.2.6 A cyclic test consists of boiling the specimen for 2 min in either distilled or salt water and cooling it for 1 min at room temperature in distilled water.

8.3 Degree of severity (conditioning method 04: solubility)

The degrees of severity for conditioning method 04 are given in Table 4.

Table 4 — Degrees of severity for conditioning method 04: solubility

Degree of severity	Exposure time	Solution
01	6h	Distilled or deionized water
02	24 h	Distilled or deionized water
03	96 h	Distilled or deionized water
04	6 h	Salt water
05	24 h	Salt water
06	96 h	Salt water
07	5 min	Boiling distilled or deionized water
08	15 min	Boiling distilled or deionized water
09	5 min	Boiling salt water
10	15 min	Boiling salt water
11	60 min	Boiling salt water
12	2 min + 1 min	Boiling distilled or salt water ^a followed by distilled water at room temperature

^a The user shall specify whether distilled or salt water is to be used and the number of cycles.

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8.4 Recovery

After immersion, specimens subjected to the water solubility test shall be dried with a soft clean cloth. Specimens subjected to the salt solution shall be gently washed in distilled or deionized water not warmer than 38 °C to remove salt deposits. Specimens then shall be dried with a soft clean cloth or with filtered dry nitrogen gas.

8.5 Evaluation

The film on the specimen shall be visually examined in reflected and/or transmitted light, with the unaided eye, for evidence of flaking, peeling, cracking or blistering. The examination shall be performed using the method specified in Annex C, or that given in ISO 14997, or as agreed between the supplier and the user. The method used shall be stated. The coating shall not show any evidence of physical deterioration.

Unless otherwise required in the relevant specification, visual discolourations of the coating, such as stains, smears, streaks or cloudiness, shall be acceptable if the specimen conforms to the optical and other environmental durability requirements of the relevant specification.

9 Environmental test code

The code for coating environmental durability tests shall be formed as shown in Figure 1:

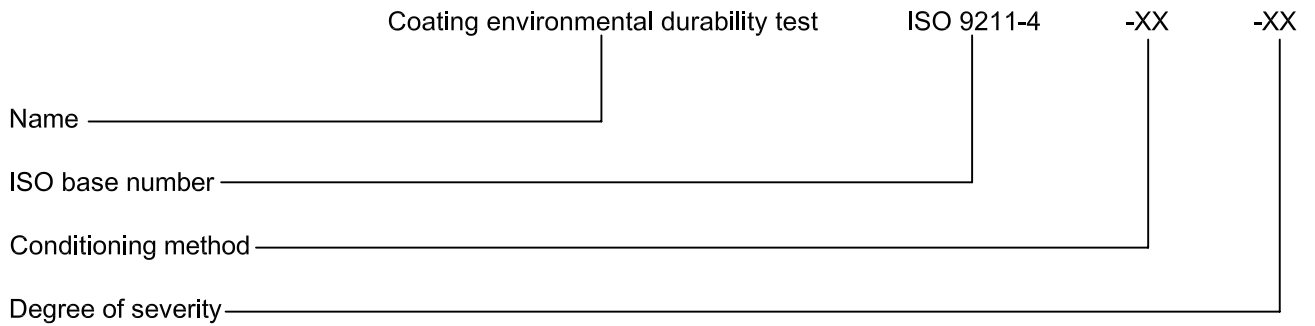


Figure 1 — Code for coating environmental durability tests

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