INTERNATIONAL STANDARD

ISO 8980-4

Second edition
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Ophthalmic optics — Uncut finished spectacle lenses —

Part 4: **Specifications and test methods for anti-reflective coatings**

Optique ophtalmique — Verres de lunettes finis non détourés —

Partie 4: Spécifications et méthodes d'essai relatives aux traitements antireflet

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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 8980-4 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 7, *Ophthalmic optics and instruments*.

This second edition cancels and replaces the first edition (ISO 8980-4:2000), which has been revised to include non-optical specifications.

ISO 8980 consists of the following parts, under the general title *Ophthalmic optics — Uncut finished spectacle lenses*:

— *Part 1: Specifications for single-vision and multifocal lenses*

— *Part 2: Specifications for progressive power lenses*

— *Part 3: Transmittance specifications and test methods*

— *Part 4: Specifications and test methods for anti-reflective coatings*

— *Part 5: Minimum requirements for spectacle lens surfaces claimed to be abrasion-resistant*

Ophthalmic optics — Uncut finished spectacle lenses —

Part 4:
Specifications and test methods for anti-reflective coatings

1 Scope

This part of ISO 8980 specifies optical and non optical requirements, including durability, and test methods for anti-reflective coatings on spectacle lenses.

This part of ISO 8980 does not deal with the following topics:

— transmittance and absorptance;

— the colour of the reflected light.

2 Normative references

The following referenced documents are indispensable for the application 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 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 8980-1, *Ophthalmic optics — Uncut finished spectacle lenses — Part 1: Specifications for single-vision and multifocal lenses*

ISO 8980-2, *Ophthalmic optics — Uncut finished spectacle lenses — Part 2: Specifications for progressive power lenses*

ISO 8980-3, *Ophthalmic optics — Uncut finished spectacle lenses — Part 3: Transmittance specifications and test methods*

ISO 13666, *Ophthalmic optics — Spectacle lenses — Vocabulary*

ISO 14889, *Ophthalmic optics — Spectacle lenses — Fundamental requirements for uncut finished lenses*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13666 and the following apply.

3.1
durability
⟨of anti-reflective coating⟩ ability to resist deterioration of its reflectance characteristics, over time, in normal use

NOTE 1 The major factors contributing to deterioration of an anti-reflective coating are rubbing, heat, UV radiation and humidity.

NOTE 2 The main failure mechanism affecting the durability of anti-reflective coatings is a loss of adhesion. Therefore, requirements of this part of ISO 8980 are related to anti-reflective coating adhesion.

4 Requirements

4.1 General requirements

Anti-reflective coated lenses shall comply with the general requirements concerning the finished spectacle lens specifications in:

- ISO 8980-1;
- ISO 8980-2;
- ISO 8980-3;
- ISO 14889.

NOTE 1 For further information on the properties of anti-reflective coatings, see informative Annex A.

NOTE 2 The reflectance characteristics of an anti-reflective coating should not significantly change due to deterioration of the coating in normal use.

4.2 Luminous and mean reflectances

The luminous reflectance ρ_V and the mean reflectance ρ_M of an anti-reflective coated lens shall be determined by the method specified in 5.2.

If the manufacturer specifies values for luminous and mean reflectances, the measured values shall not exceed the specified values by more than 20 %.

When determined as described in 5.4, the luminous reflectance ρ_V of any anti-reflective coated lens surface shall be less than 2,5 %.

4.3 Usable diameter of coated area

The usable diameter of the coated area for uncut finished spectacle lenses shall be $\geqslant (d_n - 4)$ mm, where d_n is the nominal diameter of the lens, in millimetres, indicated by the manufacturer.

4.4 Durability

Under the conditions described in the test method given in 5.6, five consecutively tested lenses shall be free of significant loss of adhesion as defined in 5.6.4.

A product meets the durability requirements of this part of ISO 8980 if all five lenses tested satisfy this criterion.

5 Testing

5.1 General

This clause specifies type test methods for anti-reflective coatings on spectacle lenses. At least 24 h shall elapse after coating before any type test is carried out. Lenses shall be stored at a temperature of 20 °C to 26 °C.

5.2 Method of determination of reflectance

5.2.1 Apparatus

Use any dual-beam or single-beam spectrophotometer with an incident angle not larger than 17° and with a measurement accuracy sufficient to give the value of the spectral reflectance at all wavelengths λ between 380 nm and 780 nm with an uncertainty of less than 0,1 % (for example, an anti-reflective coating quoted as having 0,5 % reflectance may be measured as having 0,4 % to 0,6 % reflectance). The wavelength increment of measurement shall not be more than 5 nm. The spectral bandwidth (full width at half maximum, FWHM) shall not exceed 5 nm.

The calibration specimen shall have a surface curvature within 0,50 D of that of the spectacle lens to be tested. The back surface of this specimen shall be designed such that no reflection will interfere with the measurement (e.g. both frosted and painted matt black). The calibration specimen shall be of known refractive index $n(\lambda)$ (uncertainty $\Delta n < 0{,}001$) and have no coating (which could affect its surface reflective properties). The surface shall be cleaned.

5.2.2 Spectacle lens preparation

The surface of the spectacle lens under test shall have a radius of curvature not less than 80 mm. The back surface of the lens shall be designed such that no reflection will interfere with the measurement (e.g. both frosted and painted matt black). The surface shall be cleaned.

5.2.3 Measurement

Insert the calibration specimen and calibrate the spectrophotometer to give a value of 100 %. Then insert the spectacle lens. The spectrophotometer will give the value of the spectacle lens to calibration specimen spectral reflectance ratio $R_{\mathrm{T}}(\lambda)$, expressed as percentage. By using this technique, any error due to surface curvature will be eliminated.

Measure the spectacle lens to calibration specimen spectral reflectance ratio over the range 380 nm to 780 nm, at least every 5 nm.

5.3 Determination of spectral reflectance values

The value of the calibration specimen surface spectral reflectance $R_{\mathrm{C}}(\lambda)$ is calculated theoretically from the refractive index.

$$R_{\mathrm{C}}(\lambda) = \left[\frac{n(\lambda)-1}{n(\lambda)+1}\right]^2$$

The value of the spectacle lens surface spectral reflectance is calculated by multiplying the calibration specimen spectral reflectance value by the spectacle lens-to-calibration specimen spectral reflectance ratio:

$$\rho(\lambda) = R_{\mathrm{C}}(\lambda) \times R_{\mathrm{T}}(\lambda)$$

5.4 Determination of luminous reflectance

Calculate the luminous reflectance ρ_V using both the spectral reflectance values $\rho(\lambda)$ and the equation given in ISO 13666.

5.5 Determination of mean reflectance

Calculate the mean reflectance ρ_M using both the spectral reflectance values $\rho(\lambda)$ and the equation given in ISO 13666.

5.6 Determination of durability

5.6.1 Equipment and consumables

5.6.1.1 **Apparatus**, able to produce the environmental cycles as specified in Annex B.

5.6.1.2 **Rubbing tool**, as specified in Annex C.

5.6.1.3 **Inspection facility**, as specified in Annex D.

5.6.2 Test specimens

This test method is applicable to anti-reflective-(AR)coated and hard AR-coated lenses.

Both sides of the lenses shall have a radius of curvature not less than 70 mm.

In order to evaluate a product, five lenses shall be tested.

5.6.3 Test method: Environmental cycling combined with rubbing sequences

5.6.3.1 Clean the lenses with soap and water. Rinse them and dry them with a soft, clean cloth.

5.6.3.2 Check the lenses according to the methods in Annex D. The test lenses shall not have defects such as peeling, scratches, crazing or diffusion.

5.6.3.3 Perform the rubbing sequence described in Annex C on both the convex and the concave sides of all lenses. The rubbing shall be carried out in the centre of each lens surface.

5.6.3.4 Expose the lenses to one environmental sequence of 16 h, as specified in Annex B.

5.6.3.5 Rinse the lenses with water. Gently dry them with a soft, clean cloth, and allow the lenses to cool to room temperature.

5.6.3.6 Perform the rubbing sequence described in Annex C on both convex and concave sides of all lenses, on the same area where the first rubbing sequence was performed.

5.6.3.7 Repeat steps 5.6.3.4 to 5.6.3.6 twice.

NOTE At this point, the lenses will have been subjected to the initial rubbing sequence, followed by three environmental and three rubbing sequences.

5.6.4 Evaluation

Inspect the central 20 mm diameter zone for significant loss of adhesion, on both surfaces of each lens, using the observation conditions described in Annex D.

Significant loss of adhesion is where more than a total of 3 mm^2 of coating has delaminated from either surface. (The delaminated areas on the two surfaces are not summed.) Photographs of lenses passing and failing are provided in Annex E.

6 Information to be made available on request

The values of the luminous reflectance ρ_V and mean reflectance ρ_M and the spectral reflectance curve shall be made available on request for a typical surface with a radius of curvature not less than 80 mm.

7 Reference to this part of ISO 8980

If the manufacturer or supplier claims compliance with this part of ISO 8980, reference shall be made to this International Standard either on the package or in publicly available literature.

Annex A
(informative)

Significance of ρ_V and ρ_M in the description of anti-reflective coated lenses

The luminous reflectance ρ_V represents the ratio of the luminous flux reflected by the lens surface to the incident luminous flux. ρ_V emphasizes the spectral reflectance around the centre of the visible spectrum (around 550 nm) and reduces the importance of the blue and red ends of the spectrum.

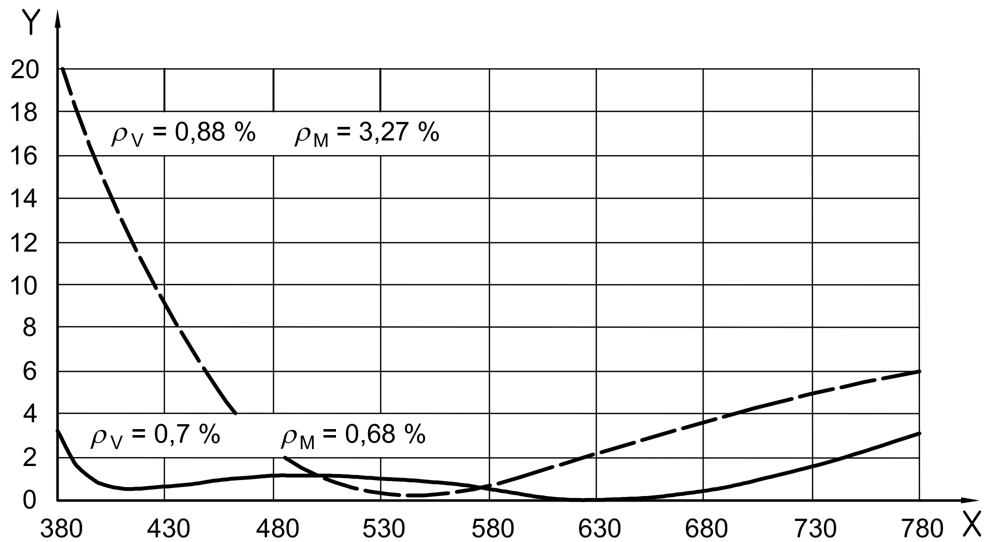
Some types of anti-reflective coating, although having a very low spectral reflectance $\rho(\lambda)$ at the centre of the spectrum, show a marked increase in reflectance at the blue and red ends of the spectrum. Despite having a low luminous reflectance ρ_V, the pronounced coloration of the residual light reflected gives the subjective impression of an overall reflectance higher than suggested by ρ_V.

The mean reflectance ρ_M, which is not weighted by $V(\lambda)$, will, for such types of coating, have a relatively high or poor value. Although an anti-reflective coating having a similar spectral reflectance at the centre of the spectrum and lower (better) reflectance in the blue and red regions will have a similar ρ_V, ρ_M will be lower than for other types of coating.

Hence, the mean reflectance ρ_M gives additional information describing the optical and cosmetic properties of an anti-reflective coating.

NOTE Because types of coating with poor ρ_M show increased reflectance at the ends of the spectrum, glare can result from reflections off the back surface when driving at night. It is expected that additional physiological research will be carried out in this field.

EXAMPLES ρ_V = 0,70 % ρ_M = 0,68 %
ρ_V = 0,88 % ρ_M = 3,27 %



Key

X wavelength, nm

Y reflection, %

Figure A.1

Annex B
(normative)

Environmental sequence

B.1 General considerations

The environmental sequence specified in B.2 to B.5 can be conducted with two types of equipment:

— fluorescent light and condensation (ASTM D 4329-92);

or

— xenon irradiation equipment described in ISO 9022-9, combined with water immersion as described in B.5.

B.2 Conditions for the environmental sequence

For each environmental sequence, the lenses shall be submitted to an exposure of 16 h duration, which consists in cycles based on temperature, light irradiation and humidity exposure. The cycles shall be set to be not less than 30 min and not greater than 8 h.

B.3 Irradiation

The lenses shall be exposed with the convex side facing the radiation source, exposing at least 50 mm in diameter of the centre of the lens. The lenses shall be exposed for at least 50 % of the sequence duration to the UV-visible irradiation specified in Table B.1. The data shall include any radiation reflected by the test chamber interior surfaces, but not infrared radiation emitted from the chamber surfaces.

Additionally, the lower wavelengths being more active, the dose per sequence in the 320 nm to 350 nm region shall be not less than 0,5 MJ/m^2 and not greater than 0,7 MJ/m^2. As a consequence, if the irradiation source emits more than 10 W/m^2 in the 320 nm to 350 nm region, then the UV-visible exposure shall not be continuous and shall be adjusted to a percentage of time defined to meet the specified dose.

Because different sources exhibit different distributions of UVA radiation, both the total UVA radiation and the UVA radiation below 350 nm and above 350 nm shall be controlled, as defined in Table B.1.

Ozone generated during exposure shall be removed from the test chamber.

Table B.1 — Spectral energy distribution of the radiation source

Spectral range		Ultraviolet			Visible		Infrared	
Wavelength band	nm	to 320	320 to 350	350 to 380	380 to 520	520 to 640	640 to 780	780 to 3 000
Irradiance	W/m^2	—	30 to 40 [a]		—	—	—	—
		< 3	10 to 22	14 to 25	< 250	< 210	< 200	< 600

[a] Integrated irradiance between 320 nm and 380 nm.

