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Mineral and sapphire watch-glasses —

Part 4:
Anti-reflective treatment

Verres de montres minéraux et en saphir —

Partie 4: Traitements antireflet

Reference number
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Contents

Page

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 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).

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This document was prepared by Technical Committee ISO/TC 114, *Horology*, Subcommittee SC 13, *Watch-glasses*.

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.

Introduction

Recently anti-reflective treatments are widely used in watch-glasses. Anti-reflective treatments are used to improve legibility of the watch dial by reducing light reflected from the watch-glasses.

When customers are wearing watches, the watches go through temperature variation, corrosion, scratch, sunlight and many other environmental conditions. The properties of the anti-reflective treatments may directly affect the appearance of the watch-glasses and the legibility of the dial, therefore this International Standard aims to clarify the test methods and the evaluations for the anti-reflective treatments.

Mineral and sapphire watch-glasses —

Part 4:
Anti-reflective treatment

1 Scope

This document specifies the terms and definitions, the test methods and the evaluation of results of watch-glasses with anti-reflective treatments.

The document is applicable to sapphire watch-glasses with anti-reflective treatments, and it can also be used as a reference for mineral watch-glasses with anti-reflective treatments.

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 3160-2:2015, *Watch-cases and accessories — Gold alloy coverings — Part 2: Determination of fineness, thickness, corrosion resistance and adhesion*

ISO 4892-1, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO/CIE 11664-1:2019, *Colorimetry — Part 1: CIE standard colorimetric observers*

ISO 11664-2, *Colorimetry — Part 2: CIE standard illuminants*

ISO 14368-3:2003, *Mineral and sapphire watch-glasses — Part 3: Qualitative criteria and test methods*

ISO 23160:2011, *Watch cases and accessories — Tests of the resistance to wear, scratching and impacts*

CIE 15:2018, *Colorimetry*

CIE 85:1989, *Solar Spectral Irradiance*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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/

3.1
luminous transmittance
ratio of the transmitted luminous flux to the luminous flux of the incident radiation

$$\tau_{\mathrm{v}} = \frac{\int_0^{\infty} \tau(\lambda) \Phi_{\mathrm{e},\lambda}(\lambda) V(\lambda) \mathrm{d}\lambda}{\int_0^{\infty} \Phi_{\mathrm{e},\lambda}(\lambda) V(\lambda) \mathrm{d}\lambda}$$

where

$\tau(\lambda)$ is the spectral transmittance of the sample;

$\Phi_{\mathrm{e},\lambda}(\lambda)$ is the spectral radiant flux of the source;

$V(\lambda)$ is the spectral luminous efficiency;

[SOURCE: ISO 80000-7:2019, 7-31.6, modified — The definition has been slightly reworded.]

3.2
luminous reflectance
ratio of the reflected luminous flux to the luminous flux of the incident radiation

$$\rho_{\mathrm{v}} = \frac{\int_0^{\infty} \rho(\lambda) \Phi_{\mathrm{e},\lambda}(\lambda) V(\lambda) \mathrm{d}\lambda}{\int_0^{\infty} \Phi_{\mathrm{e},\lambda}(\lambda) V(\lambda) \mathrm{d}\lambda}$$

where

$\rho(\lambda)$ is the spectral reflectance of the sample;

$\Phi_{\mathrm{e},\lambda}(\lambda)$ is the spectral radiant flux of the source;

$V(\lambda)$ is the spectral luminous efficiency;

[SOURCE: ISO 80000-7:2019, 7-31.4, modified — The definition has been slightly reworded.]

4 Test methods and evaluation of results

4.1 General

The following tests are all separate tests. Except for special instructions, each test is conducted with new samples, and no superposition test is conducted. The selection of test item and test plan can be determined by agreement between the contracting parties.

After the test, the anti-reflective treatment is evaluated by visual inspection and by comparison with referenced samples. The appearance shall be checked in accordance with ISO 14368-3:2003, Annex A. The evaluations of test results are checked according to the requirements given by each test item and, if required, higher acceptance criteria of the test results should be defined by agreement between the contracting parties.

4.2 Optical characterization

The spectral distribution of standard illuminant D65 as specified in ISO 11664-2 and the luminous efficiency of the average human eye for daylight vision ($V(\lambda)=\bar{y}(\lambda)$ for 2° observer) as specified in

ISO/CIE 11664-1:2019, 3.11, shall be used to determine the luminous transmittance τ_v or the luminous reflectance ρ_v.

The selection of the measurement geometry between transmittance and/or reflectance can be determined by agreement between the contracting parties.

4.2.1 Luminous transmittance

Parameters for the digital integration of the transmittance spectrum $\tau(\lambda)$ are: illuminant D65 and standard observer 2°, step width not exceeding 10 nm and range from 380 nm to 780 nm. The luminous transmittance factor is expressed in $\tau_v = Y$ as described in CIE 15:2018, Chapter 7.

$$\tau_v = \frac{\int_{380}^{780} \tau(\lambda) S(\lambda) \bar{y}(\lambda) \mathrm{d}\lambda}{\int_{380}^{780} S(\lambda) \bar{y}(\lambda) \mathrm{d}\lambda}$$

where

$S(\lambda)$ is the relative spectral power distribution of the illuminant D65;

$\bar{y}(\lambda)$ is one of the CIE colour matching function.

NOTE The measuring range between 380 nm to 780 nm can be truncated to another range (e.g. 360 nm to 740 nm) providing the result is not significantly changed (see CIE 15:2018, 7.2).

4.2.1.1 Apparatus with integration sphere

Use a spectrocolorimeter or a spectrophotometer with an integration sphere to obtain the transmittance spectrum with the Specular Component Included (SCI) according to a measuring geometry di:0°or 0°:di (see CIE 15:2018, Chapter 6).

4.2.1.2 Apparatus without integration sphere

Use a spectrocolorimeter or a spectrophotometer without integration sphere to obtain the transmittance spectrum according to a measuring geometry 0°:0° (see CIE 15:2018, Chapter 6). In this case, only the regular transmittance component is measured.

NOTE In case of a polarized light source (grating on the beam path) and due to the birefringent effect of the sapphire, it is recommended to align the optical axis of the sapphire with the polarization axis of the beam in order to minimize the fringes amplitude on the transmittance spectrum.

4.2.2 Luminous reflectance and colour

Parameters for the digital integration of the reflectance spectrum $\rho(\lambda)$ are: illuminant D65 and standard observer 2°, step width not exceeding 10 nm and range from 380 nm to 780 nm. Reflectance factor is expressed in $\rho_v = Y$ as described in CIE 15:2018, Chapter 7, and colour is expressed in $L^*a^*b^*$ values as described in CIE 15:2018, 8.2.

Use a spectrocolorimeter or a spectrophotometer with an integration sphere to obtain the reflectance spectrum in reflection mode with the Specular Component Included (SCI) according to a measuring geometry di:8°or 8°:di (CIE 15:2018, Chapter 6).

$$\rho_v = \frac{\int_{380}^{780} \rho(\lambda) S(\lambda) \bar{y}(\lambda) \mathrm{d}\lambda}{\int_{380}^{780} S(\lambda) \bar{y}(\lambda) \mathrm{d}\lambda}$$

where

$S(\lambda)$ is the relative spectral power distribution of the illuminant D65;

$\bar{y}(\lambda)$ is one of the CIE colour matching function.

NOTE 1 The measuring range between 380 nm to 780 nm can be truncated to another range (e.g. 360 nm to 740 nm) providing the result is not significantly changed (see CIE 15:2018, 7.2).

In order to measure the pure reflectance, only the light reflected by the watch-glass is collected by the detector. Particularly, light beams transmitted through the watch-glass and further reflected on a back support should not be included in the signal detected (see Figure A.2). It might be necessary to check if other light sources (ambient light, reflection on various support material or setting surface for example) do not affect the measure in a significant manner.

NOTE 2 When colour parameters are measured, other colour spaces can be used such as L^*C^*h, xyY or $L^*u^*v^*$ (according to CIE 15:2018, Chapter 8).

4.2.3 Evaluation of results

Acceptance criteria of the test results should be defined by agreement between the contracting parties. Reference values of luminous transmittance, luminous reflectance and colour are given in Annex A.

4.3 Adhesive force

4.3.1 Test method

Use an adhesive tape with a peel adhesion of 2,9 N/cm to 3,3 N/cm. The tape is adhered to the treated surface, ensuring that bubbles between the tape and the treated surface are eliminated. After 10 s, tear the tape quickly with the force perpendicular to the treated surface. The tape used shall not leave any glue residues on the treated surface.

4.3.2 Evaluation of results

After the test, the anti-reflective treatment shall show no chap, bubble, delamination and peel-off.

4.4 Humidity test

4.4.1 Test method

The watch-glasses with anti-reflective treatments are placed in the constant temperature and humidity equipment. The temperature inside the chamber is set to 40 °C, with a tolerance of ±2 °C. The relative humidity inside the chamber is set to 93 %, with a tolerance of ±5 %. The test is carried out for at least 48 h.

4.4.2 Evaluation of results

After the test, the anti-reflective treatment shall show no chap, bubble, delamination and peel-off.

4.5 Thermal shock test

4.5.1 Test method

Place the samples in a thermal chamber stabilized at 70 °C ± 2 °C without humidity contribution during 2 h. Then soak them immediately in deionized water at 5 °C ± 2 °C during 30 s minimum. Repeat this cycle 5 times minimum. Samples shall be dried after each cycle.

