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Timekeeping instruments — Watch external parts made of hard material — General requirements and test methods

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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 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*.

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

In recent years, hard materials such as tungsten carbide, ceramics, etc., have found several applications in the horological industry, particularly for the external parts of watches, and more particularly in watchcases and some of their accessories such as bezels, crowns, wristbands and clasps.

Their properties in terms of hardness, wear resistance or finish quality (brightness) bring many undeniable advantages for this type of application.

This document deals with constitutive components of external parts of watches. Given the variety of possibilities in the mounting of these elements, it is not possible to define and to specify “a complete watch made of hard material”.

Manufacturers of hard materials have developed know-how with the aim of satisfying the legal requirements and the criteria of horological standardization, without standards nor specifications that can serve as references. The aim of this document is to clarify the general requirements and the test methods for the horological external parts made of hard material.

Timekeeping instruments — Watch external parts made of hard material — General requirements and test methods

1 Scope

This document concerns whole watches, in which all or some of the components of the external parts are made of hard material, with the exception of watch glasses.

It applies to all elements made in massive material whose hardness is greater than or equal to 1 200 Vickers.

It describes the performance in terms of resistance to mechanical and thermal shocks, to corrosion, to scratches, to sunlight exposure and also to the wear of its components.

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 1413:2016, *Horology — Shock-resistant wrist watches*

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 9227:2017, *Corrosion tests in artificial atmospheres — Salt spray tests*

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

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
external part
<horological context> part of a watch added to the movement and contributing to its external presentation, protection, fixing, control such as the watchcase, the bezel, the crown, the push buttons, the wristband and the clasp

3.2
hard material
material whose Vickers hardness is equal to or higher than 1 200 HV1

3.3
massive
<component> having a composition that is macroscopically homogeneous across its entire section

3.4
brittleness
<material or component> susceptibility to breaking, under the effect of a static or dynamic stress, without being significantly plastically deformed

4 Requirements, method of control and acceptance criteria

4.1 General

The requirements of this document apply to the elements of external parts of watches made in hard and massive material, according to the definitions in Clause 3.

NOTE These materials can contain allergens or toxic materials such as nickel or cobalt.

The watch external parts made of hard material shall not present any shape which may be harmful for the user.

The control method and the acceptance criteria of these materials, constituting the prerequisites, are reported in Annex A.

In the case of tests involving mechanical solicitations (see 4.2, 4.7 and 4.8), the number of samples to be tested shall be sufficient to include the usually large dispersion of measurement inherent to the brittleness behaviour of hard materials. A statistical approach should be adopted (according to Annex C).

It is possible to apply all the tests or a selection of them to assemblies or to certain individual components. The definition of which components are to be tested and the test conditions to be achieved shall be given special attention in advance in order to highlight those parts that are typically sensitive under conditions of ordinary use.

In the case of hard materials that are additionally coated, the surface-related tests should be interpreted differently (wear, scratches, hardness, etc.).

The existence of porosity is admitted as long as the requirements below are fulfilled.

4.2 Mechanical shock resistance

4.2.1 Requirements and control method

The purpose of this test is to verify the mechanical behaviour of the tested elements or assemblies.

The external elements of watches made of hard material shall comply with the specific requirements of ISO 1413:2016, 5.3. However, the height to be used shall be 0,75 m because of the lower shock resistance of hard materials, of which the consumer should be made aware.

4.2.2 Acceptance criteria

The examination of the elements made of hard material shall not reveal any permanent deterioration affecting its functions, its performance or its appearance (flaws or broken components).

The examination of the wristband shall not reveal any failure and not present any loss of components.

The assembly of the watch head, the wristband and its functional elements (clasp, loop, etc.) shall stay functional.

4.3 Thermal shock resistance

4.3.1 Requirements and control method

The purpose of this test is to evaluate the behaviour of assemblies containing at least one element made of hard material.

The elements of external parts of watches made of hard material shall meet the specific requirements according to the following method:

— Place the samples in a thermal chamber stabilized at 70 °C ± 2 °C without humidity contribution during 2 h.

— Soak them immediately in deionized water at 5 °C ± 2 °C during 30 s minimum.

— Repeat this cycle five times minimum. Samples shall be dried after each cycle.

— Observe the horological external parts and record visible variations.

Other heating methods can be used but shall be specified in the report.

4.3.2 Acceptance criteria

No visible degradation shall be observed on the components or assembly tested.

4.4 Corrosion resistance

4.4.1 Requirements and control method

The purpose of this test is to evaluate hard material elements or assemblies against corrosive agents.

The elements of external parts of watches made of hard material shall meet the specific requirements, concerning the following tests, of ISO 9227:2017, 5.2.2 and ISO 3160-2:2015, 7.4.

4.4.2 Acceptance criteria

To be determined by the concerned parties.

4.5 Wear resistance

4.5.1 Requirements and control method

The purpose of this test is to evaluate the potential degradation of the element made of hard material due to random wear.

The elements of external parts of watches made of hard material shall meet the specific requirements of ISO 23160:2011, 4.1.

4.5.2 Acceptance criteria

To be determined according to ISO 23160:2011, 4.1.6.

The wear resistance shall be high due to customers' expectations.

4.6 Scratch resistance

4.6.1 Requirements and control method

The purpose of this test is to evaluate the potential degradation of the element made of hard material. Due to customers' expectations, the abrasive load shall be adapted in order to provide more discriminating tests than those described in ISO 23160:2011, 5.3.

The elements of external parts of watches made of hard material shall meet the specific requirements of the ISO 23160:2011, 5.2, 5.3 and 5.4, using sharp edge alumina abrasive (Corundum F70), see Table 1.

Table 1 — Characteristics of the Corundum F70

Particle size	Indicative density	Hardness	Composition
$Dv_{0,5}$ 210 µm	3,96 g/cm^3	1 900 HV ± 100 HV	Al_2O_3

4.6.2 Acceptance criteria

To be determined according to ISO 23160:2011, 5.6.

The scratch resistance shall be high due to customers' expectations.

4.7 Impact resistance

4.7.1 Requirements and control method

The purpose of this test is to evaluate the impact resistance of a watch head and its bracelet when exposed to accidental friction against rough, hard and abrasive surfaces.

The elements of external parts of watches made of hard material shall meet the specific requirements of ISO 23160:2011, 6.2, 6.3 and 6.4, particularly regarding impacts, accidental falls, and shocks in luggage/handbags.

4.7.2 Acceptance criteria

To be determined according to ISO 23160:2011, 6.6.

4.8 Sunlight resistance

4.8.1 Requirements and control method

The purpose of this test is to verify the colour stability of elements made of hard material when exposed to sunlight.

4.8.1.1 Equipment

The test equipment used is made of a closed chamber provided with test specimen holders and one or more light sources correctly filtered, such as a Xenon arc lamp or metallic halide lamp emitting a radiance with a spectrum close to the one of the sun at sea level (according to CIE 085:1989, Table 4). Filtering should minimize irradiance under 290 nm and above 800 nm.

An airflow sweeping the test specimens shall be used to control the temperature.

The test specimen holder is made to ensure a uniform irradiance on all sample surfaces, with a ±10 % tolerance on the irradiance fixed between 290 nm and 400 nm. If necessary, a rotating test specimen holder device will help meet this prescription.

This equipment includes devices which allow the measurement of irradiance on test specimens and also of the temperature and humidity in the chamber. Irradiance shall be regulated between 290 nm and 400 nm. A temperature and humidity regulation is recommended.

The irradiance measuring device as well as the black standard thermometer used for the measurement of the maximum temperature attainable by samples shall comply with ISO 4892-1.

The test equipment can be equipped with devices for sample immersion or watering cycles. The deionized water used during the immersion or watering cycles shall be pure enough (conductivity <5 µS/cm; <1 µg/kg of solid material) to avoid stains on the test specimens.

4.8.1.2 Test conditions

According to the specificity of horological external parts, the following conditions are recommended for the full duration of the test:

a) Irradiance between 290 nm and 400 nm at sample level: 60 W/m^2 maximum;

b) Exposure time: 36 h minimum;

c) Black standard temperature (BST according to ISO 4892-1): 65 °C maximum;

d) Relative humidity: 60 % ± 5 %;

e) The minimum energy dose in the 290 nm to 400 nm range shall be 7,8 MJ/m^2.

NOTE Energetic dose (J/m^2) = irradiance (W/m^2) × exposure duration (s).

Test temperature and humidity significantly influence the ageing rate of the exposed sample. The lamps may have different distribution of wavelengths in their spectrum depending on the type, age or the type of reflecting environment surrounding the samples. For these reasons, differences in results may appear between tests performed in different facilities or in the same installation using different test parameters. In the context of real exposures (in vivo), differences are also observed.

Different test conditions, such as irradiance, temperature indicated by the black standard thermometer, relative humidity and test duration shall be mutually agreed upon between the stakeholders.

When watering cycles are required, refer to ISO 4892-2.

4.8.1.3 Operating procedure

a) The samples to be tested are laid flat on the test specimen holder, the surface to be tested is oriented toward the luminous source.

b) Unless there is a referenced sample perfectly identical to the samples to be tested, a part of the surfaces to be tested is hidden with an aluminium foil or any equivalent solution.

c) A periodic examination of samples can be carried out during the test. In that case, results shall be mentioned in the test report.

d) During the examination, evaluate the evolution by comparing with the referenced sample or the unexposed surface.

e) Place the sample on a background offering a great contrast with its colour. It shall be illuminated above the control surface with a white light of a higher than 500 lx intensity, close to natural light. A standard D65 lamp of an intensity of more than 500 lx shall be used when arbitrations are necessary.

f) The change of colour (discoloration index) is determined by comparison with a grey scale according to ISO 105-A02 or by spectrocolorimetric measurement, for example according to ISO/CIE 11664-4.

g) The results are expressed in change of colour compared to an energetic dose rather than the duration of exposure.

h) The test report shall indicate in detail the type of luminous source used as well as all the applied parameters [at the minimum those described in 4.8.1.2 a) to d)]. Light source(s) shall be replaced when the specified irradiance cannot be reached anymore. Expose horological external parts to a light whose spectrum is close to the sun's spectrum, with a controlled energetic illumination, a temperature higher than the normal wear conditions and in an atmosphere of controlled and determinate humidity.

The control is made by comparison of the visual colour variation based on a reference sample.

4.8.2 Acceptance criteria

No colour variation shall be visible at 30 cm with the naked eye.

4.9 Mechanical behaviour of assembled elements

The purpose of these tests is to ensure that the consumers are made aware that it is in normal use that the expectations in term of durability and resistance to external stresses are fulfilled.

The levels of solicitation, intensities and the duration of the tests are to be determined between the stakeholders.

Considering the great number of possible combinations of assembled elements, the applicable test methods shall be determined according to the nature of the components to be tested. For this reason, no test is detailed in this chapter, but examples of possible tests are described in Annex B.

Annex A
(informative)

Hard materials

A.1 Hard material

A.1.1 Massive material

A.1.1.1 Control method

Prepare a metallographic section of a representative sample.

Check the massive character and measure the hardness into the bulk.

In the case of composite material, make sure that the size of the indentation footprint is significantly higher than the characteristic size of the microstructure.

A.1.1.2 Acceptance criteria

The massive character is verified by the homogeneity of the microstructure across its whole section.

The hardness is checked on an average of five hardness measurements, made through the entire cross section of the specimen, and shall be higher than or equal to 1 200 HV1. The test force can be adapted to satisfy the point A.1.1.

A.1.2 Mechanical properties (flexural strength and elastic modulus)

Table A.1 gives some non-exhaustive examples of minimum mechanical values for some generic forms of hard material.

Table A.1 — Mechanical properties (flexural strength and elastic modulus)

Material	Flexural strength MPa	Elastic modulus GPa
Oxide ceramic	≥675	≥198
Tungsten carbide cermet	≥1 400	≥500
Titanium carbide cermet	≥900	≥320

Annex B
(informative)

Test examples for mechanical behaviour of assembled elements

B.1 General

Due to the high number of possible assemblies, the following tests are just given as examples for mechanical behaviour of assembled elements.

B.2 Acceptance criteria

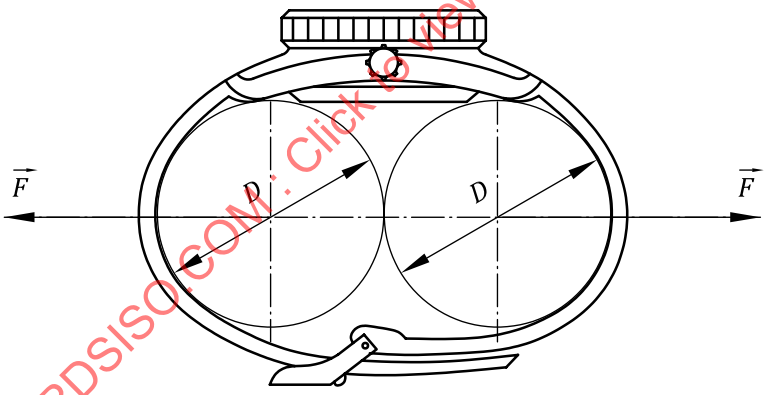
Acceptance criteria of the test results should be defined by agreement between the concerned parties.

B.3 Test examples

B.3.1 Example 1: Resistance of attachments

The bracelet of the watch being tested shall be closed.

The watch shall be subjected to an external force (see Figure B.1).



Key

$\vec{F}$ applied force in N (the force $\vec{F}$ applied shall be determined between the concerned parties)
D diameter ≈ 30 mm

Figure B.1 — Representation of the test for resistance of attachments

Nothing shall become detached from the watch nor be displaced when the watch is tested.

B.3.2 Example 2: Random movements of bracelet

The portion of the bracelet is fixed by one of its ends on a circular holder. The second end of the bracelet is free. The holder rotates as indicated on Figure B.2, driving the bracelet. The movement of the bracelet is random.

The rotation speed is 50 r/min and the test is carried out during 1 h.