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Optics and photonics — Optical materials and components — Test method for striae in infrared optical materials

Optique et photonique — Matériaux et composants optiques — Méthodes d'essai pour déterminer les stries des matériaux optiques infrarouges

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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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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics,* Subcommittee SC3, *Optical materials and components*.

Optics and photonics — Optical materials and components — Test method for striae in infrared optical materials

1 Scope

This document specifies the principle, apparatus, condition, sample, procedure and data processing of measuring striae in infrared optical materials.

It is applicable to the determination of striae in infrared optical materials, such as infrared optical glass, which is opaque to visible wavelengths and whose transmission optical spectra are beyond 0,78 µm.

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 10110-7, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 7: Surface imperfections*

ISO 10110-8, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 8: Surface texture; roughness and waviness*

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

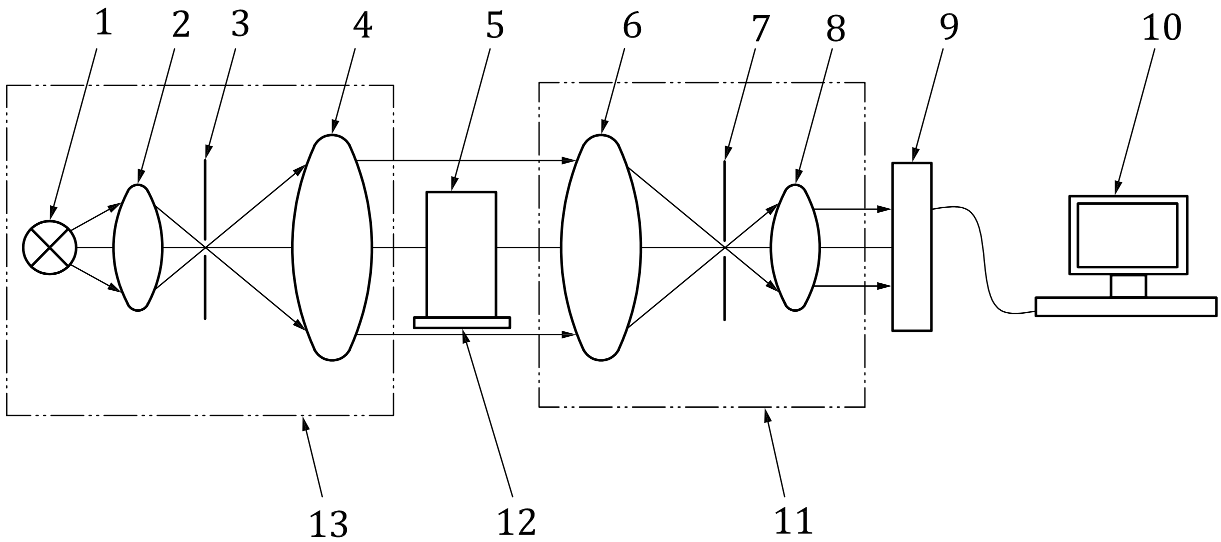
— IEC Electropedia: available at http://www.electropedia.org/

3.1
striae
regions of resembling bands, layers or rods formed due to short range severe deviations of refractive index in infrared optical materials, observed only by infrared detecting devices

3.2
striae value
average grey level of *striae* (3.1) multiplying the percentage of striae area per thickness of infrared optical materials

4 Principle

The principle of this test is to illuminate a sample with collimated infrared radiation and image the material in a Schlieren or projection imaging system. The striae will be imaged and measured, and then the area and the product of striae area percentage to the mean grey level will be calculated. When the projection optical system is adjusted to a beam-contracting telescope system, it is known as a projection measurement system. And when the projection optical system is adjusted to a camera system which utilizes a knife edge device, it is known as a Schlieren measurement system. The schematic diagram of striae measurement in infrared optical materials is shown in Figure 1.



Key

1 light source
2 condenser
3 light source diaphragm
4 infrared collimating optics
5 sample
6 lens 1 of projection optical system
7 knife edge device or diaphragm
8 lens 2 of projection optical system
9 image sensor
10 computer image collecting, processing and displaying system
11 projection optical system
12 sample adjustment stage
13 collimated infrared light source

Figure 1 — Schematic diagram of the measurement for striae in infrared optical materials

5 Apparatus

5.1 Apparatus arrangement

The apparatus consists of a collimating infrared light source system, a sample adjustment stage, a projection optical system, an image sensor, and a computer image collecting, processing and displaying system.

5.2 Collimating infrared light source system

The collimated infrared light source system consists of a light source, a condenser, a light source diaphragm, and an infrared collimating optics. The diaphragm shall be placed at the focus of the infrared collimating optics. The emission spectrum of the system shall cover or be within the transmission spectrum of the sample. The nonuniformity of light intensity distribution shall not be more than 5 %. The radiation intensity of the light source shall meet the requirement of the response of the image sensor. The emergent light aperture of the system should be more than the diameter of the sample.

5.3 Projection optical system

The projection optical system consists of lens 1, lens 2 and a knife edge device or diaphragm. The knife edge device or diaphragm shall be placed on the rear focal plane of lens 1. The beam-contracting telescope system which is used for the projection measurement consists of lens 1 and lens 2, with the rear focal point of the former coinciding with the front focal point of the latter along the direction of an optical axis. The camera system which is used for the Schlieren measurement consists of lens 1, lens 2

and a knife edge device or a diaphragm which is placed near the rear focal point of lens 1. The camera system has moving lens 2.

5.4 Knife edge device

The straightness of blade of knife edge device should meet the requirements of corresponding standards. And it needs to be movable and precisely adjustable on the vertical directions to the blade.

5.5 Image sensor

The working spectrum of an infrared image sensor should be within the transmission spectrum of the sample measurement. The spatial resolution corresponding to the image sensor should be not more than 0,25 mm.

5.6 Computer image collecting, processing and displaying system

5.6.1 The computer image collecting and processing system consists of a computer and its processing software. The computer image collecting and processing system collects and processes the output signals of the image sensor and transfers them to the displaying system.

5.6.2 The displaying system consists of a screen and an electronic ruler. The contrast of the screen shall be greater than 1 000:1 and the resolution shall be greater than that of the image sensor.

5.6.3 The expanded uncertainty of measurement of the electronic ruler shall be not more than 0,05 mm.

5.7 Standard grey level sample

The standard grey level sample should be made of an infrared material whose transmittance is 50 % of the maximum grey level of striae. The transmission of standard grey level sample shall be uniform. The sample will be used to calibrate the image sensor.

6 Test conditions

6.1 Environmental temperature

The environmental temperature shall be steadily kept at any temperature between 15 °C and 35 °C, with the temperature tolerance being no more than ±2°C.

6.2 Relative air humidity

The relative air humidity should be less than 80 %.

7 Sample

7.1 Surface roughness

The surface roughness R_q specified in ISO 10110-8 of the sample shall be better than 0,012 µm.

7.2 Scratches and digs of surface

The scratches and digs specified in ISO 10110-7 on the surfaces of the sample shall be less than 5/6 × 0,50 L6 × 0,008.

8 Procedure

8.1 Projection measurement

8.1.1 Turn on the power supply and adjust the intensity of the light source to the normal operating range of the measurement system and then remain stable for 30 min.

8.1.2 Clean the surfaces of both the measurement sample and the standard grey level sample separately.

8.1.3 Place the standard grey level sample on the sample stage and thermally soak the sample within the measurement environment for a period of time that allows it to achieve a thermal stability.

8.1.4 Calibrate the image sensor with the standard grey level sample. After that, take it off.

8.1.5 Place the sample on the sample stage and thermally soak the sample within the measurement environment for a period of time that allows it to achieve a thermal stability.

8.1.6 Align the geometric centre of the sample with the centre of the view field of the projection optical system.

8.1.7 Adjust lens 2 of the projection optical system to make the rear focal point of lens 1 coincide with the front focal point of lens 2 along the direction of an optical axis so that the projection optical system becomes a beam-contracting telescope system for a projecting measurement.

8.1.8 Observe the projecting image on the screen and rotate the sample until the maximal area of the striae image appears on the screen.

8.1.9 Collect the images of the bubbles and inclusions with the image sensor. Use the software of the computer data collection, processing, and displaying system to process the image data.

8.2 Schlieren measurement

8.2.1 Turn on the illumination and measurement equipment and adjust the intensity of the light source such that its irradiation power meets the responding requirements of the image sensor. Allow illumination and measurement equipment to reach a stable state.

8.2.2 Clean the surfaces of both the measurement sample and the standard grey level sample separately.

8.2.3 Place the standard grey level sample on the sample stage and thermally soak the sample within the measurement environment for a period of time that allows it to achieve a thermal stability.

8.2.4 Calibrate the image sensor with the standard grey level sample. After that, take it off.

8.2.5 Place the measurement sample on the sample stage and thermally soak the sample within the measurement environment for a period of time that allows it to achieve a thermal stability.

8.2.6 Align the geometric centre of the sample with the centre of the view field of the imaging system.

8.2.7 Place a knife edge device near the rear focal point of lens 1 and move lens 2 so that a camera system for Schlieren measurement is established. Adjust lens 2 so that the striae of the sample images clearly on the image sensor.

8.2.8 Observe the striae image on the screen and rotate the sample until the maximal area of the striae image appears on the screen.

8.2.9 Collect the images of the bubbles and inclusions with the image sensor. Use the software of the computer data collection, processing, and displaying system to process the image data.

9 Data processing

9.1 Measure both the length and width of every region of striae and calculate the area of each region of striae as well as the total area of all regions of striae with the software.

9.2 Calculate the area percentage of the striae regions to the measured region of the sample with the software.

9.3 Determine the grey level of each striae region with an electronic criteria ruler of grey levels in the software. Calculate the average value of the grey level of the striae with the software to gain the average optical path difference of the sample. Calculate the PV value of the optical path difference of each striae of the sample.

9.4 Evaluate the test results according to related classification standards or by referring to the corresponding standard in ISO 10110 series with the consideration of infrared features. Or calculate the striae value by multiplying the average grey value of the striae area by the percentage of the total striae area with the software.

10 Test report

The test report shall include at least the following (see Annex A):

a) laboratory name and contact information;

b) test method and instrument;

c) test wavelength;

d) client;

e) sample name, cross-sectional area and thickness;

f) environmental temperature and humidity;

g) the location, shape, grey level, length, width and area of striae, the striae value of the sample;

h) tester, reviewer and test date;

i) remarks.