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**Optics and optical instruments —
Preparation of drawings for optical
elements and systems —**

**Part 4:
Material imperfections — Inhomogeneity and
striae**

*Optique et instruments d'optique — Indications sur les dessins pour
éléments et systèmes optiques —*

Partie 4: Imperfections des matériaux — Hétérogénéité et stries

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Foreword

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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.

International Standard ISO 10110-4 was prepared by Technical Committee ISO/TC 172, *Optics and optical instruments*, Subcommittee SC 1, *Fundamental standards*.

ISO 10110 consists of the following parts, under the general title *Optics and optical instruments — Preparation of drawings for optical elements and systems*:

- Part 1: *General*
- Part 2: *Material imperfections — Stress birefringence*
- Part 3: *Material imperfections — Bubbles and inclusions*
- Part 4: *Material imperfections — Inhomogeneity and striae*
- Part 5: *Surface form tolerances*
- Part 6: *Centring tolerances*
- Part 7: *Surface imperfection tolerances*
- Part 8: *Surface texture*

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- *Part 9: Surface treatment and coating*
- *Part 10: Table representing data of a lens element*
- *Part 11: Non-toleranced data*
- *Part 12: Aspheric surfaces*
- *Part 13: Laser irradiation damage threshold*

Annex A of this part of ISO 10110 is for information only.

Optics and optical instruments — Preparation of drawings for optical elements and systems —

Part 4:

Material imperfections — Inhomogeneity and striae

1 Scope

ISO 10110 specifies the presentation of design and functional requirements for optical elements in technical drawings used for manufacturing and inspection.

This part of ISO 10110 specifies rules for the indication of allowable inhomogeneity and striae in optical elements.

2 Definitions

For the purposes of this part of ISO 10110, the following definitions apply.

2.1 inhomogeneity: Gradual variation of the refractive index within an optical element, defined as the difference between maximum and minimum values of the refractive index within the element.

NOTE — Inhomogeneity is caused by a variation of the chemical composition and other effects within the bulk material.

2.2 striae: Inhomogeneities having small spatial extent.

NOTE — Striae can appear in the form of sharply defined cordlike regions, especially when the glass was made by the clay-pot melting process. The tank melting process, which can cause band-like striae structures, is more common today for production of optical glass.

3 Specification

3.1 Classes of inhomogeneity

Measurement of the inhomogeneity within an optical element is often difficult to carry out in a nondestructive manner. Therefore the specification of an inhomogeneity class for an optical element is primarily useful for the selection of the raw material.

For characterization of inhomogeneity, six classes are defined. They correspond to the allowable variation of refractive index within the optical element. The values are fixed by table 1.

Table 1 — Inhomogeneity classes

Class	Maximum permissible variation of refractive index within a part 10^{-6}
0	± 50
1	± 20
2	± 5
3	± 2
4	± 1
5	$\pm 0,5$

3.2 Classes of striae

In contrast to inhomogeneity, striae within a finished part can be easily observed. Therefore the specification of the striae class for an optical element serves not only the selection of the raw material, but also allows the checking of the degree of compliance of the finished part with the specification.

For the purpose of this part of ISO 10110, striae are divided into five quality classes. For classes 1 to 4, striae are considered only if they cause an optical path difference Δr of at least 30 nm. Under this provision striae can be tested and classified by their projected area perpendicular to the optical path through the element. Class 5 allows also the specification of tolerances for striae causing an optical path difference of less than 30 nm.

Classes 1 to 4 are related to the density of striae, which is defined as the ratio of effective projected area of striae to the area of the test region. The values are fixed by table 2.

Class 5 applies to optical elements with highest quality requirements. The restriction to striae exceeding 30 nm optical path difference does not apply to this class. It is to be noted that for very weak striae the specification of a maximum density is not useful.

Striae causing an optical path difference $\Delta r > 150$ nm are usually not to be expected in optical glasses and filter glasses.

Table 2 — Classes of striae

Class	Density of striae causing an optical path difference of at least 30 nm in %
1	≤ 10
2	≤ 5
3	≤ 2
4	≤ 1
5	Extremely free of striae Restriction to striae exceeding 30 nm does not apply Further information to be supplied in a note to the drawing

4 Indication in drawings

These material imperfections are indicated in drawings by a code number, followed by a slash, and the class numbers for inhomogeneity and striae.

4.1 Code number

The code number for inhomogeneity and striae is 2.

4.2 Structure of indication

The indication shall read as follows:

2/A; B

where *A* is the class number for inhomogeneity according to table 1 and *B* is the class number for striae according to table 2.

If no specification for inhomogeneity is needed, *A* shall be replaced by a dash.

If no specification for striae is needed, *B* shall be replaced by a dash.

4.3 Location

The indication shall be entered near the optical element to which it refers. If necessary, the indication may be connected to the element by a leader. Preferably, it should be associated with the other indications of material imperfections (stress birefringence and bubbles, see ISO 10110-2 and ISO 10110-3). Examples of such an indication are given in 4.4 and in ISO 10110-1:1996, annex A.

Alternatively, for lens elements, the indication may be given in a table in accordance with ISO 10110-10.

4.4 Example of indication

Figure 1 shows, as an example, an optical element of inhomogeneity class 3, striae class 2.

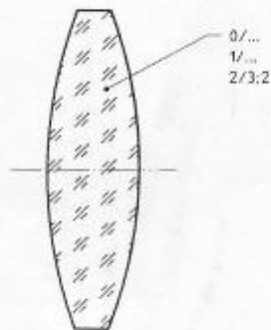


Figure 1 — Example of inhomogeneity and striae tolerance indication

Annex A
(informative)

Bibliography

- [1] ISO 10110-1:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 1: General.*
- [2] ISO 10110-2:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 2: Material imperfections — Stress birefringence.*
- [3] ISO 10110-3:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 3: Material imperfections — Bubbles and inclusions.*
- [4] ISO 10110-10:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 10: Table representing data of lens element.*

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