
**Optics and photonics — Optical
materials and components —
Specification of calcium fluoride used
in the infrared spectrum**

*Optique et photonique — Matériaux et composants optiques —
Spécification de fluorure de calcium utilisé dans le spectre infrarouge*

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Foreword

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This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 3, *Optical materials and components*.

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

This document applies to the classification of calcium fluoride used in the infrared spectrum.

Calcium fluoride is used for infrared optical systems such as optical windows and lenses. The specifications for its use in the infrared spectrum are different than those used in the visible range.

The crystal structure of calcium fluoride is referred to as the fluorite structure. A single crystal of calcium fluoride is composed of the crystal lattice with no grain boundaries. The birefringence of the crystal depends on the light propagation direction with respect to the crystal axis.

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Optics and photonics — Optical materials and components — Specification of calcium fluoride used in the infrared spectrum

1 Scope

This document specifies calcium fluoride used in the infrared spectral range from 0,78 μm to 10 μm .

The material specified in this document can also transmit light in other spectral domains (ultraviolet and visible).

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 10110-18, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 18: Stress birefringence, bubbles and inclusions, homogeneity, and striae*

ISO 12123, *Optics and photonics — Specification of raw optical glass*

ISO 80000-7, *Quantities and units — Part 7: Light and radiation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 80000-7 and the following 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

regular transmittance

ratio of the regularly transmitted part of the (whole) transmitted flux to the incident flux

[SOURCE: ISO 11382:2010, 3.1]

3.2

internal transmittance

ratio of the radiation flux reaching the internal exit surface of the layer to the flux that enters into the layer after crossing the entry surface

[SOURCE: ISO 15368:2001, 3.3]

3.3

optical homogeneity

measure of the refractive index variation within a single piece of optical material and being the difference between the maximum and minimum values of the refractive index within the optical glass

[SOURCE: ISO 12123:2018, 3.16]

3.4

impurity

material other than calcium fluoride

3.5

bubble

gaseous void in the bulk optical material of generally circular cross section

Note 1 to entry: Bubbles and solid inclusions are treated the same in assessing the quality of optical glass.

[SOURCE: ISO 12123:2018, 3.19]

3.6

inclusion

localized bulk material imperfections

EXAMPLE Bubbles, striae knots, small stones, sand and crystals.

Note 1 to entry: These terms are also applicable in the given wavelength range.

[SOURCE: ISO 12123:2018, 3.18]

3.7

single crystal

solid with a regular polyhedral shape without grain boundaries

3.8

polycrystal

many crystalline parts that are randomly oriented with respect to each other

3.9

crystal lattice

regular pattern of atoms, ions or molecules in a crystalline substance

3.10

grain boundary

interface between two crystalline parts

3.11

sub grain boundary

interface between two crystalline parts, but its influence is equivalent to the single crystal

4 Tolerances

4.1 Refractive index variation

The terms and definitions of ISO 10110-18 and ISO 12123 are appropriate and shall be used.

Six classes are defined depending on the maximum difference between measured refractive index, n_{ms} , and the nominal refractive index, n_{nom} , as shown in [Table 1](#).

Table 1 — Refractive index variation classes

| Grade ($\lambda = 4 \mu\text{m}$) ^a | NP 0001 | NP 0010 | NP 0100 | NP 0500 | NP 1000 | — |
|--|------------------|-----------------|--------------|--------------|-------------|----------|
| $ n_{ms} - n_{nom} $ ^b | $\leq 0,000\ 01$ | $\leq 0,000\ 1$ | $\leq 0,001$ | $\leq 0,005$ | $\leq 0,01$ | $> 0,01$ |
| ^a Wavelength shall be reported for a specific case (e.g. $4 \mu\text{m}$ in the case shown). ^b n_{ms} shall be measured under the same conditions (temperature, etc.), as specified for n_{nom} . NOTE See Annex A . | | | | | | |

4.2 Optical homogeneity (homogeneity of refractive index)

The terms of ISO 12123:2018, 4.6 are appropriate and shall be used.

The homogeneity of the refractive index across the volume of the material is important. It is assumed that the material temperature is uniform across the volume.

The homogeneity may depend on the size and the form of the piece.

Seven classes of index homogeneity are defined, depending on the variation dn inside the volume of the piece, as shown in [Table 2](#).

Table 2 — Homogeneity of refractive index

| Grade | NH 0004 | NH 0010 | NH 0040 | NH 0100 | NH 0400 | NH 1000 | — |
|-------|-------------------|------------------|------------------|-----------------|-----------------|--------------|-----------|
| dn | $\leq 0,000\ 004$ | $\leq 0,000\ 01$ | $\leq 0,000\ 04$ | $\leq 0,000\ 1$ | $\leq 0,000\ 4$ | $\leq 0,001$ | $> 0,001$ |

4.3 Bubbles and inclusions

The terms of ISO 12123:2018, 4.8 are appropriate and shall be used.

Five classes of bubbles and inclusions are defined, depending on the cross section or numbers, as shown in [Tables 3](#) and [4](#).

Table 3 — Bubbles and inclusions: maximum permissible cross section

| Grade | IC 03 | IC 10 | IC 25 | IC 50 | — |
|--|-------|-------|-------|-------|---------|
| Maximum permissible cross section (mm ² per 100 cm ³) | 0,03 | 0,1 | 0,25 | 0,5 | $> 0,5$ |

Table 4 — Bubbles and inclusions: maximum number

| Grade | IN 010 | IN 030 | IN 070 | IN 140 | — |
|---|--------|--------|--------|--------|---------|
| Maximum number (per 100 cm ³) | 10 | 30 | 70 | 140 | > 140 |

5 Indications

[Table 5](#) gives classifications of calcium fluoride used in the infrared spectrum.

Table 5 — Classifications of calcium fluoride used in the infrared spectrum

| Grade | Minimum absorption ^a a1/a2/a3 | Refractive index variation | Optical homogeneity | Bubbles and inclusions |
|-------|---|----------------------------|---------------------|------------------------|
| A | OK/OK/OK | Specify the grade | Specify the grade | Specify the grade |
| B | OK/OK/— | Specify the grade | Specify the grade | Specify the grade |
| C | OK/OK/— | — | — | Specify the grade |
| D | OK/OK/— | — | — | — |
| E | —/—/— | — | — | — |

NOTE —: not specified.

^a No unusual absorption in wavelength range, from 0,78 μm to 3 μm (a1), from 3 μm to 5 μm (a2); and from 5 μm to 10 μm (a3).