INTERNATIONAL STANDARD

ISO 11382

First edition
2010-10-01

Optics and photonics — Optical materials and components — Characterization of optical materials used in the infrared spectral range from 0,78 µm to 25 µm

Optique et photonique — Matériaux et composants optiques — Caractérisation des matériaux optiques utilisés dans la bande spectrale infrarouge de 0,78 µm à 25 µm

Reference number
ISO 11382:2010(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11382 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 3, *Optical materials and components*.

Introduction

Many standards for optical glass exist that are primarily used for the visible range, however, it is not easy to apply these standards directly to infrared materials.

Often, the properties of infrared materials are known with less certainty than those used in the visible range because the methods of measurements are different, incomplete or inaccurate.

Optics and photonics — Optical materials and components — Characterization of optical materials used in the infrared spectral range from 0,78 µm to 25 µm

1 Scope

This International Standard provides guidelines for the description of data sheets for infrared materials. It specifies the nomenclature and the properties of infrared materials which are reported on such data sheets. These data sheets do not necessarily contain information on every property identified in this International Standard.

This International Standard also specifies the parameters needed to characterize optical materials intended for use in the infrared spectral range from 0,78 µm to 25 µm and provides various methods to be used for measuring these parameters.

This International Standard is applicable only to materials used in the manufacture of passive optical components. The properties of materials used in active applications (e.g. optoelectronics) are not taken into account.

Materials specified in this International Standard can also transmit in other spectral domains (microwaves, visible or ultraviolet).

2 Normative references

The following referenced documents are indispensable for the application 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 10110-3, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 3: Material imperfections — Bubbles and inclusions*

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

ISO 15368, *Optics and optical instruments — Measurement of reflectance of plane surfaces and transmittance of plane parallel elements*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12123, ISO 80000-7 and the following apply.[1)]

3.1
regular transmittance
ratio of the regularly transmitted part of the (whole) transmitted flux to the incident flux

3.2
regular reflectance
specular reflectance
ratio of the regularly reflected part of the (whole) reflected flux to the incident flux

3.3
absorptance
ratio of the absorbed radiant flux to the incident flux

3.4
scatter
scatterance
ratio of the scattered radiant flux to the incident flux

3.5
standard uncertainty
uncertainty of the result of a measurement expressed as a standard deviation

3.6
expanded uncertainty
quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand

4 Symbols and units

For the purposes of this document, the following symbols and units apply.

d thickness of the sample, expressed in millimetres

α absorptance

δ scatter

λ wavelength, expressed in micrometres

ρ reflectance

τ transmittance

5 Nomenclature

5.1 General

The optical materials covered by this International Standard shall be identified as follows:

a) the name (see 5.2);

1) These terms and definitions are consistent with those given in IEC 60050-845 and ISO/IEC Guide 98-3.

b) the manufacturer reference (see 5.3);

c) the material structure (optional) (see 5.4);

d) the manufacturing process (see 5.5);

e) a reference to this International Standard.

5.2 Name

Either the trademark or the generic name (e.g. germanium or sapphire), followed by reference to the method of manufacture, shall be given in the nomenclature.

5.3 Manufacturer reference

A reference to the manufacturer shall be given in the nomenclature.

5.4 Material structure

If known, the type of the material structure shall be given, i.e. the following:

— amorphous material (e.g. glasses and some plastics);

— polycrystalline material;

— crystal (natural or synthetic);

— ceramics, etc.

5.5 Manufacturing process

The manufacturing process shall be given in the nomenclature; this description may be simplified (e.g. CVD instead of chemical vapour deposition). If a change in the manufacturing process modifies one or several properties of the material, another reference shall be used.

NOTE A great number of materials which transmit in the infrared spectral range exist in nature. However, due to their scarcity, small size, or impurity levels, the optical materials are usually manufactured or refined by industrial processes.

5.6 Form of nomenclature

The nomenclature shall be expressed in sequence, separated by dashes, as shown in the following examples.

EXAMPLE 1 Germanium – Manufacturer A – Monocrystalline n type – Zone fusion – ISO 11382:2010

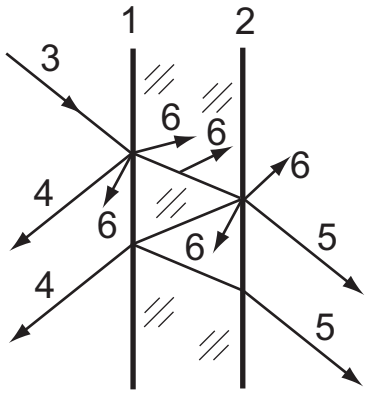
EXAMPLE 2 ZnS – Manufacturer B – Polycrystalline – Hot isostatic pressed – ISO 11382:2010

6 Optical properties

6.1 General

The methods for obtaining data should be reported. If the data are quoted from a reference, the reference document and publication data date shall be reported.

The material is assumed to be in the form of a plane-parallel element with optically polished surfaces 1 and 2, as shown in Figure 1.



Key

1, 2 optically polished surfaces
3 incident light beam
4 reflected part
5 transmitted part
6 scattered part

Figure 1 — Schematic of the light propagation through an element

The light beam incident on the schema given in Figure 1 is divided into

— a reflected part,

— a transmitted part,

— a scattered part, and

— an absorbed part.

If m denotes a surface number, the light beam incident can be described by Equations (1) to (3), as follows:

$$\tau_m + \rho_m + \alpha_m + \delta_m = 1 \tag{1}$$

$$\tau_t = \frac{\tau_1 \tau_i \tau_2}{1 - \tau_i^2 \rho_1 \rho_2} \text{ or } \tau_t = \frac{\tau_s^2 \tau_i}{1 - \tau_i^2 \rho_s^2} \tag{2) (3}$$

where

τ_t is the transmittance of the element;

τ_m is the regular transmittance of the surface m;

τ_1 is the regular transmittance of surface 1;

τ_2 is the regular transmittance of surface 2;

τ_s is the regular transmittance of the surface m when surfaces 1 and 2 are identical;

τ_{dm} is the scattered transmittance of the surface m;

τ_i is the internal transmittance of the element;

ρ_m	is the regular reflectance of the surface m;
ρ_1	is the regular reflectance of surface 1;
ρ_2	is the regular reflectance of surface 2;
ρ_s	is the regular reflectance of the surface m when surfaces 1 and 2 are identical;
ρ_{dm}	is the scattered reflectance of the surface m;
α_m	is the absorptance of the surface m;
$\delta_m = \rho_{dm} + \tau_{dm}$	is the total scatter of the surface m.

6.2 Transmittance

6.2.1 Specification to be provided

The measurement shall be made in accordance with ISO 15368.

The transmittance shall be measured at 20^{+3}_{-1} °C. The standard thicknesses of the specimens shall be (2 ± 0,1) mm, (5 ± 0,1) mm or (10 ± 0,2) mm.

The transmittance shall be represented by a graph, with the wavelength (or wave number) as the X-axis, and the transmittance as the Y-axis. Uncertainty [e.g. standard uncertainty ($\pm\sigma$) or expanded uncertainty ($\pm k\sigma$) with $k = 2$] for the transmittance shall be provided by error bars on the curves, or in a statement in the graph description.

The following shall be reported:

— the thickness of the sample (in the case of multiple curves, with suitable annotation, denoting different thicknesses should be on the same graph);

— the temperature of the piece during the measurement, with its uncertainty of measurement;

— the value of the parameters affecting the transmittance (e.g. resistivity for a semiconductor).

Unless otherwise reported, the incident beam is assumed to be normal to the surface and unpolarized.

An example is given in Figure 2.