INTERNATIONAL STANDARD

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Optics and photonics — Optical materials and components — Test method for refractive index of infrared optical materials

Optique et photonique — Matériaux et composants optiques — Méthode d'essai de l'indice de réfraction 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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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of 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 www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 17328:2014), which has been technically revised.

The main changes compared to the previous edition are as follows:

— clarification of the description of the device;

— addition of contents to the test report.

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 measurement of relative refractive index to the air for infrared optical materials.

Two categories of major methods for measuring the refractive index of infrared materials exist. These are interferometric methods and minimum deviation methods. In this document, a test method using minimum deviation for infrared materials is described. The same method is applicable to materials used in the visible spectral range, either. It has the advantages of being applicable to more kinds of materials compared with interferometric methods and of ease of data processing because of the simple measurement principle.

Although the refractive index is temperature-dependent, this document describes a measurement method at a stable temperature (ambient air temperature).

Optics and photonics — Optical materials and components — Test method for refractive index of infrared optical materials

1 Scope

This document provides a standard method for measuring the relative refractive index to the air of infrared materials used in the infrared spectral range from 0,78 μm to 25 μm.

This document excludes methods for measuring the refractive index of birefringent materials and methods for measuring the complex refractive index.

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 11382:2010, *Optics and photonics — Optical materials and components — Characterization of optical materials used in the infrared spectral range from 0,78 μm to 25 μm*

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 https://www.electropedia.org/

3.1
refractive index
n
ratio of the velocity of the electromagnetic waves at a specific wavelength in a vacuum to the velocity of the waves in the medium

[SOURCE: ISO 12123:2018, 3.1]

3.2
relative refractive index
ratio of the *refractive index* (3.1) of the material of the specimen to the *refractive index* (3.1) of the material in contact with the specimen at a specific wavelength

3.3
angle of minimum deviation
δ
angle between the ray incident upon the specimen prism and the ray exiting the specimen prism at its minimum value, which occurs when the ray inside the specimen prism makes equal angles with the entrance and the exit faces of the specimen prism

4 Method for measuring

4.1 General

In this document, the technique of the minimum deviation method for measuring refractive index is described.

The minimum deviation method shall be applied for measuring refractive index.

4.2 Principle

As shown in Figure 1, when the monochromatic light beam is refracted by the specimen prism with minimum deviation, the relative refractive index of the specimen prism to the air at the wavelength of the monochromatic light beam is described by the following Formula (1):

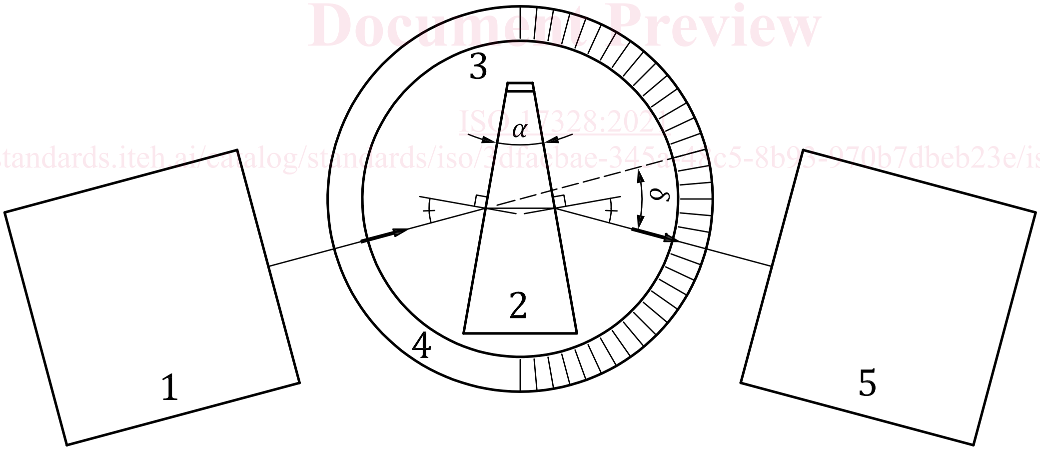
$$n_{rel} = \frac{\sin[(\alpha + \delta)/2]}{\sin(\alpha/2)} \tag{1}$$

where

n_{rel} is the relative refractive index of the specimen prism to the air;

α is the apex angle of the specimen prism;

δ is the angle of minimum deviation of the monochromatic light beam refracted by the specimen prism.



Key

1 monochromatic light source optics

2 specimen prism

3 rotating stage

4 goniometer

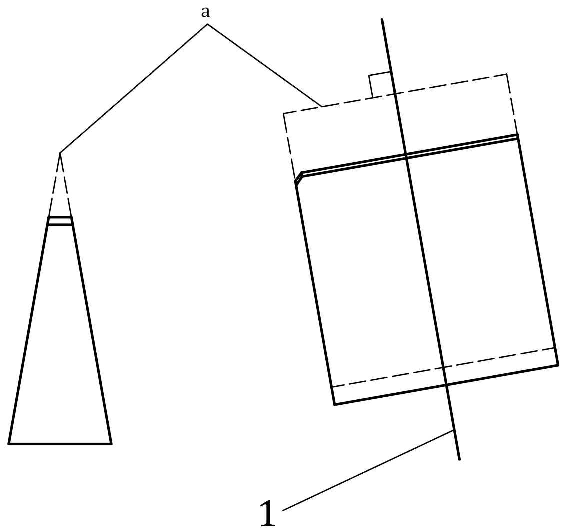
5 detector optics

α apex angle of the specimen prism

δ angle of minimum deviation

Figure 1 — Schematic of the minimum deviation method

The monochromatic light beam shall be parallel to the plane of section of the specimen prism, (see Figure 2, item 2).



Key

1 plane of section

a Ridge line.

Figure 2 — Ridge line and the plane of section of the specimen prism

4.3 Apparatus and procedure for measurement

The apparatus for measurement shall be equipped with the following:

a) a method to emit a collimated monochromatic light beam of a specified wavelength to the specimen prism;

b) a method to vary the angle of the collimated monochromatic light beam to the entrance face of the specimen prism;

c) a method to determine the direction of the monochromatic light beam refracted by the specimen prism;

d) a method to indicate the angle of minimum deviation, δ;

e) a method to measure the temperature of the specimen prism.

Examples of apparatus for measurement of the angle of minimum deviation are shown in Annex A. A procedure for measurement is also described in Annex A. In addition, the absolute value of the angle of deviation error is described in Annex B.

See Figure 1.

4.4 Wavelength of light beam for measurement

The wavelengths of measurement shall adequately sample the spectral range of interest to enable curve fitting of the data to a dispersion formula, allowing calculation of the relative refractive index at any arbitrary wavelength within the spectral range.

5 Specimens

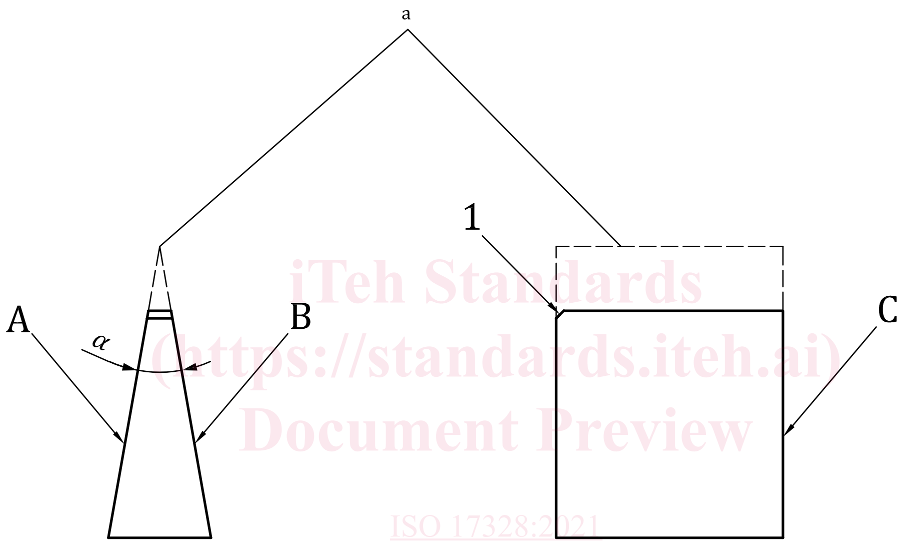
5.1 The shape and dimensions of the specimen prism

The specimen shall be a wedged prism made of the material to be measured. The entrance face and the exit face shall be polished.

An example of the shape of the specimen prism is shown in Figure 3. The optimum apex angle (such that error in measurement of the apex angle is least severe) for a material of the relative refractive index, n_{rel}, is given by Formula (2):

$$\alpha = 2\arctan\left(1/n_{\mathrm{rel}}\right) \tag{2}$$

For low index materials, this relation may result in undesirably large apex angles; this relation shall be used as guidance.



∡ A, C = 90° ± 0° 2' 30"

∡ B, C = 90° ± 0° 2' 30"

Key

1 chamfer

α apex angle of the specimen prism

A entrance face of the specimen prism

B exit face of the specimen prism

C side face of the specimen prism

a Ridge line.

Figure 3 — Shape of the specimen prism

5.2 Surface accuracy

The surface accuracy of the entrance face and the exit face of the specimen prism shall be measured with an interferometer. Any measured power term shall not be subtracted from measurement data. A surface flatness error should be 150 nm P-V or less over the entire clear aperture of the specimen prism faces.