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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 committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 3, *Optical materials and components*.

Introduction

This International Standard applies to the measurement of relative refractive index to the air for infrared optical materials.

Two major methods for measuring the refractive index of infrared materials exist. These are interferometric methods and minimum deviation methods. In this International Standard, a test method using minimum deviation for infrared materials is described, which is also used in the visible spectral range. 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.

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

1 Scope

This International Standard 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.

The scope of this International Standard excludes methods for measuring the refractive index of birefringent materials and methods for measuring the complex refractive index.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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.

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

[SOURCE: ISO 12123:2010, 3.1]

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

3.3
angle of minimum deviation
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 exit faces of the specimen prism

4 Method for measuring

4.1 General

In this International Standard, 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 Formula (1):

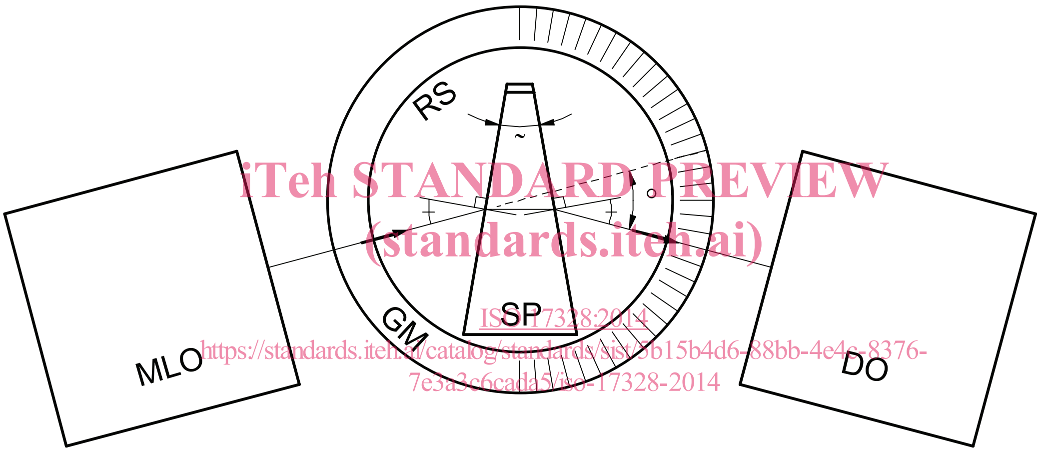
$$n_{\mathrm{rel}} = \frac{\sin\left[\left(\alpha + \delta\right)/2\right]}{\sin\left(\alpha / 2\right)} \quad (1)$$

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.

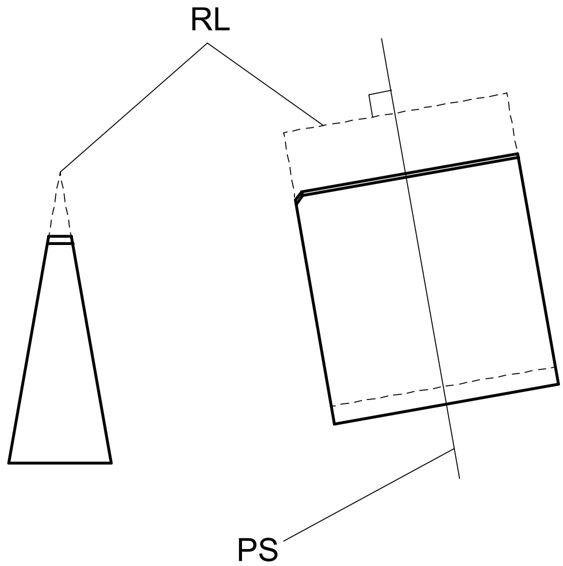


Key

MLO monochromatic light source optics
SP specimen prism
RS rotating stage
GM goniometer
DO detector optics
δ angle of minimum deviation
α apex angle of the specimen prism

Figure 1 — Schematic of the minimum deviation method

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



Key

RL ridge line

PS plane of section

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 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.

NOTE 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

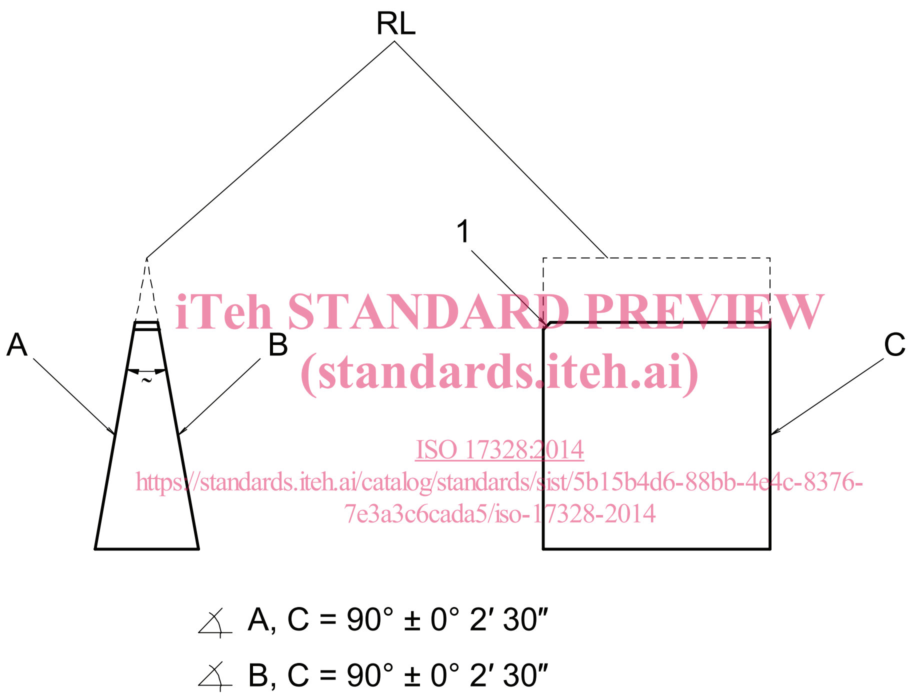
5.1 The shape and dimensions of the specimen prism

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

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

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



Key

1 chamfer

RL ridge line

α apex angle of the specimen prism

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.

6 Test report

The test report shall specify the following:

a) specimen name in accordance with ISO 11382:2010, 5.6;

b) date, place, measurer's name;

c) temperature, humidity, air pressure of ambient air;

d) apex angle of the specimen prism;

e) temperature of the specimen prism;

f) surface accuracy of the entrance face and the exit face;

g) wavelengths and bandwidth (full width at half maximum) of wavelengths for measurement;

h) angles of minimum deviation;

i) relative refractive indices to the air.

Values of c), d), e), g), h), and i) shall be specified with values of uncertainty.

