SLOVENSKI STANDARD
oSIST prEN ISO 11551:2019

01-januar-2019

Optika in optični instrumenti - Laserji in laserska oprema - Preskusna metoda za absorpcijo optičnih laserskih komponent (ISO/DIS 11551:2018)

Optics and photonics - Lasers and laser-related equipment - Test method for absorptance of optical laser components (ISO/DIS 11551:2018)

Optik und Photonik - Laser und Laseranlagen - Prüfverfahren für den Absorptionsgrad von optischen Laserkomponenten (ISO/DIS 11551:2018)

Optique et photonique - Lasers et équipements associés aux lasers - Méthode d'essai du facteur d'absorption des composants optiques pour lasers (ISO/DIS 11551:2018)

Ta slovenski standard je istoveten z: **prEN ISO 11551**

ICS:

31.260	Optoelektronika, laserska oprema	Optoelectronics. Laser equipment

oSIST prEN ISO 11551:2019 **en**

DRAFT INTERNATIONAL STANDARD
ISO/DIS 11551

ISO/TC **172**/SC **9** Secretariat: **DIN**

Voting begins on: **2018-11-13** Voting terminates on: **2019-02-05**

Optics and photonics — Lasers and laser-related equipment — Test method for absorptance of optical laser components

Optique et photonique — Lasers et équipements associés aux lasers — Méthode d'essai du facteur d'absorption des composants optiques pour lasers

ICS: 31.260

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/DIS 11551:2018(E)

Contents

Page

Foreword iv
Introduction vi
1 Scope 1
2 Normative references 1
3 Terms and definitions 1
4 Symbols and units of measure 1
5 Preparation of test sample and measuring arrangement 2
6 Characteristic features of the laser radiation 3
7 Test procedure 4
7.1 General 4
7.2 Calibration 4
7.2.1 Calibration of the power signal 4
7.2.2 Calibration of the temperature signal 4
7.2.3 Calibration of the thermal response 4
7.2.4 Measurement of the background signal 5
7.3 Determining the absorptance 5
8 Evaluation 5
8.1 General 5
8.2 Elimination of drift 6
8.3 Exponential method 6
8.4 Pulse method 6
9 Test report 7
Annex A (informative) **Effects changing absorptance** 10
Annex B (informative) **Influence of signal distortions** 12
Annex C (informative) **Algorithm for parameterizing the temperature data** 15
Bibliography 16

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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee 9, *Laser and electro-optical systems*.

This third edition cancels and replaces the second edition ISO 11551:2003-11 which has been technically revised.

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

a) Section Introduction: The assumptions were revised in the second paragraph. Minor wording and example adjustment in third paragraph.

b) Section 4: Table for symbols and units was corrected.

c) Section 5: More detailed specification of environmental conditions for UV- and IR applications are provided in second paragraph. ISO 7 specification was deleted.

   In fourth paragraph Annex A is explicitly mentioned for the dependence of absorption on other test parameters.

   In fifth paragraph Annex B is explicitly mentioned to account for the critical issue of finite heat conductivity.

d) Section 7.2.3: In the first paragraph the calibration procedure is specified in more detail, including the consideration of the heating scheme for thick samples. Note 1 is complemented by the restriction for thin samples. Note 2 is complemented with the consideration of heating scheme for finite heat conduction.

e) Section 7.3: In the first paragraph the specifications for the ambient temperature drift were clarified.

   The requirements to the total temperature rise during heating were generalized.

In the third paragraph the terminology “pre-irradiation” was replaced by “drift record”. The description of the duration of the cooling period was complemented.

f) Section 8.1: In the first paragraph “heat capacity” was replaced by “specific heat capacity”.

g) Annex A.1: “irradiation dose” added as influencing parameter.

h) Annex A.3: Generalization of nonlinear absorption dependencies.

i) Annex B.3: More detailed comments on the convergence of the temperature curves in Fig. B.1. Correction of Formulas B.2 and B.3. Additional paragraph with explanations for thick test samples, including two references.

Introduction

To characterize an optical component, it is important to know its absorptance. When radiation impinges upon a component, a part of that radiation is absorbed, increasing the temperature of the component. In this document only the part of the absorbed power/energy, that is converted into heat, is measured. If enough energy is absorbed, the optical properties of the component may be changed, and the component may even be destroyed. Absorptance is the ratio of the radiant flux absorbed to the radiant flux of the incident radiation.

In the procedures described in this document, the absorptance is determined calorimetrically as the ratio of power or energy absorbed by the component to the total power or energy, respectively, impinging upon the component. The assumption is made that the absorptance of the test sample is constant within the temperature fluctuations experienced by the component during the measurement.

For most optical bulk materials, the absorptance depends on the position of the irradiating beam on the sample surface. Several infrared materials exhibit a strong dependence of absorptance on temperature, especially at high temperatures.

Optics and photonics — Lasers and laser-related equipment — Test method for absorptance of optical laser components

1 Scope

This document specifies procedures and techniques for obtaining comparable values for the absorptance of optical laser components.

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 31-6, *Quantities and units — Part 6: Light and related electromagnetic radiations*

ISO 11145, *Optics and photonics — Lasers and laser-related equipment — Vocabulary and symbols*

ISO 14644-1:1999, *Cleanrooms and associated controlled environments — Part 1: Classification of air cleanliness*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11145 and ISO 31-6 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
absorptance
a
ratio of the radiant flux absorbed to the radiant flux of the incident radiation

Note 1 to entry: The definition of absorptance used for this document is limited to absorptance processes which convert the absorbed energy into heat. For certain types of optics and radiation, additional non-thermal processes may result in absorption losses which will not be detected by the test procedure described here (see Annex A).

4 Symbols and units of measure

Table 1 — Symbols and units of measure

Symbol	Term	Unit
C_i	Thermal capacity of test sample, holder, etc.	J/(K)
$d_{\sigma x}$, $d_{\sigma y}$	Beam width on test sample	mm
M_i	Mass of test sample, holder, etc.	kg
P	cw power	W

Table 1 *(continued)*

Symbol	Term	Unit
P_{av}	Average laser power for continuous pulse mode operation	W
P_{pk}	Typical peak power for repetitive pulse mode operation	W
t_B	Duration of irradiation	s
Δt	Time interval	s
T_{amb}	Ambient temperature	K
ΔT	Temperature difference	K
a	Absorptance	1
β	Angle of incidence	Rad
γ	Thermal loss coefficient	1/s
λ	Wavelength	nm

5 Preparation of test sample and measuring arrangement

Storage, cleaning and the preparation of the test samples are carried out in accordance with the manufacturer's instructions for normal use.

The environment of the testing place shall be adapted to the application and test wavelength. It should consist of dust-free filtered air with less than 50 % relative humidity. The residual dust shall be reduced in accordance with cleanroom class 7 as defined in ISO 14644-1:1999. However, some specific spectral ranges might require nitrogen purged environments (deep UV) or zero humidity (several IR wavelengths). Nitrogen quality for the deep UV range should be at 99.999 % or higher. If these conditions cannot be supplied, absorption within the surrounding atmosphere will be included in the test result. In this connection, an environment free from draughts is very important in order to keep thermal disturbances and heat loss by convection as small as possible. Measurements in ambient atmosphere and vacuum may have different influences on the measured absorptance.

A laser shall be used as the radiation source. To keep errors as low as possible, the laser power chosen for measurements is as high as possible but without causing any deterioration to the component.

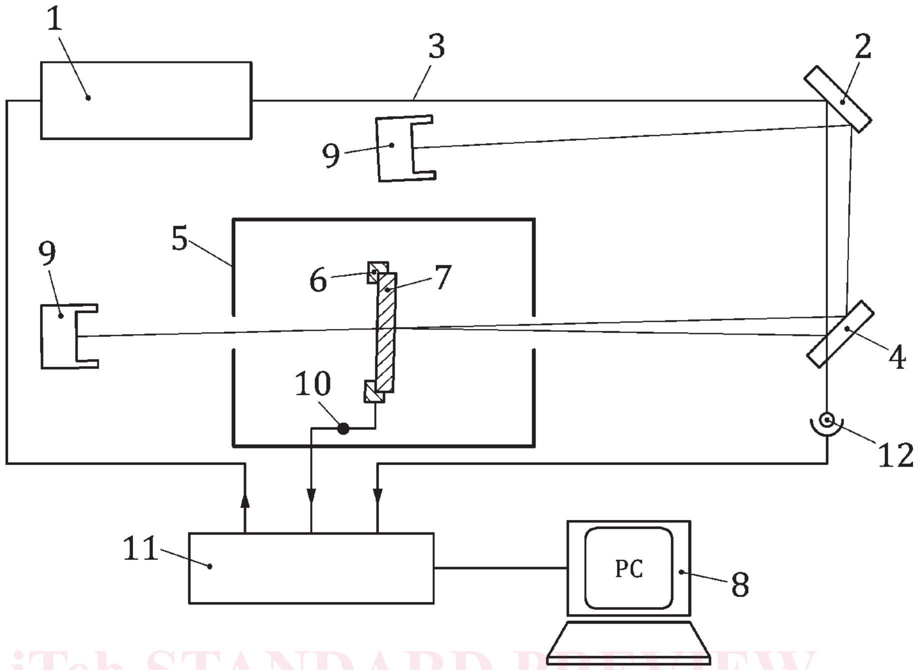
Wavelength, angle of incidence and state of polarization of the laser radiation used for the measurement shall correspond to the values specified by the manufacturer for the use of the test sample. If ranges are accepted for these three quantities, any combination of wavelength, angle of incidence and state of polarization may be chosen from those ranges. The absorption of an optical component can depend on further parameters, e. g. power density or irradiation dose. In such cases, the measurement sequence needs to be chosen individually. For more details please refer to Annex A.

The sample is mounted in a suitable holder. The thermal sensors are either connected directly to the sample surface, or attached to the sample holder. Good thermal contact between sensor and sample or between holder and sample shall be achieved. Precaution shall be taken to avoid a possible drop in thermal conductance between temperature sensor and test sample. The position of the thermal sensors in dependence on sample geometry and sample material is critical with respect to absolute calibration. For detailed information please refer to Annex B.

In order to increase the precision of the measurements, the sample should be mounted inside a chamber designed for thermal shielding, with apertures for the laser beam. Special attention shall be given to ensure that the temperature measurement itself does not cause a change of the sample temperature.

Suitable diaphragms should be placed in the beam path in front of and behind the test sample to ensure that only the test sample is irradiated by the measuring beam and that reflected or stray radiation will not strike the holder or the chamber walls. The number of transmissive optics employed for beam guiding should be minimized in order to reduce possible distortions by multi-reflections or scattered radiation. The transmitted and reflected partial beams shall be directed on to beam dumps with minimized back scatter.

Figure 1 shows a schematic measuring arrangement. The curved folding mirror M1 is recommended for imaging the laser output window on to the sample in order to avoid diffracted radiation influencing the measurement.



Key

1 laser
2 mirror M1
3 optical axis
4 mirror M2
5 test chamber
6 sample holder
7 test sample
8 personal computer
9 beam stop
10 thermal sensor
11 control unit
12 power detector

Figure 1 — Typical arrangement for measurement of the absorptance

6 Characteristic features of the laser radiation

The following physical quantities are needed for characterizing the laser radiation used for the test:

— wavelength λ;

— angle of incidence β;

— state and degree of polarization;

— beam widths on the test sample $d_{\sigma x}$, $d_{\sigma y}$;

— average power P_{av} for cw or continuously pulsed lasers;

— typical peak power P_{pk} and pulse energy Q in the case of continuously pulsed lasers;

— duration of irradiation t_B.