
**Lasers and laser-related equipment —
Test methods for laser-induced damage
threshold —**

**Part 1:
Definitions and general principles**

*Lasers et équipements associés aux lasers — Méthodes d'essai
du seuil d'endommagement provoqué par laser —*

Partie 1: Définitions et principes de base



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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 21254-1 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 9, *Electro-optical systems*.

This first edition of ISO 21254-1:2011, together with ISO 21254-2:2011, cancels and replaces ISO 11254-1:2000 and ISO 11254-2:2001, which have been technically revised.

ISO 21254 consists of the following parts, under the general title *Lasers and laser-related equipment — Test methods for laser-induced damage threshold*:

- *Part 1: Definitions and general principles*
- *Part 2: Threshold determination*
- *Part 3: Assurance of laser power (energy) handling capabilities*
- *Part 4: Inspection, detection and measurement* [Technical Report]

Introduction

Optical components can be damaged by laser irradiation of sufficiently high energy or power. At any specified laser irradiation level and operation mode of the laser source, the probability for laser damage is usually higher for the surface of a component than for the bulk. Thus, the limiting value of an optical component is frequently given by the damage threshold of its surface which might be coated to influence the optical properties. Bulk damage is observed if the electrical field strength in the bulk of the component is enhanced by self-focusing, interference, scattering or other effects. Also, imperfections, such as inclusions, dislocations, colour centres or inhomogeneities, can reduce the power-handling capability in the bulk of an optical component. Damage by single laser pulses is often induced by defects or mechanical stress in the coating, contamination of the surface, or optical absorption, leading to catastrophic heating of the surface. For multiple-pulse operation, not only reversible mechanisms induced by thermal heating and distortion but also irreversible damage mechanisms induced by ageing, microdamage, moisture damage and generation or migration of defects are observed. The various parts of this International Standard are concerned with the determination of irreversible damage of the optical surfaces and the bulk of an optical component under the influence of a laser beam. Depending on the environmental conditions, damage is a function of the material properties and the laser parameters, in particular wavelength, spot size and irradiation duration.

This part of ISO 21254 is dedicated to the fundamentals and general principles of the measurement of laser-induced damage thresholds (LIDTs). On the basis of the apparatus and measurement protocols described in ISO 21254-1, ISO 21254-2 and ISO 21254-3, this part of ISO 21254 outlines procedures for damage testing under different conditions. The protocols for the determination of the 1-on-1 and S-on-1 damage thresholds are described in ISO 21254-2. The 1-on-1 test is a damage threshold measurement procedure that uses one shot of laser radiation on each unexposed site on the specimen surface. In contrast to this, the S-on-1 measurement programme is based on a series of pulses with constant energy density applied to each unexposed site of the specimen surface. This test reflects the operational conditions of the sample in typical applications but, compared to the 1-on-1 measurement protocol, the experimental effort necessary for S-on-1 tests is significantly higher. ISO 21254-3 concentrates on the assurance of the power or energy density handling capability of optical surfaces, leaving samples that pass the test undamaged. ISO/TR 21254-4, which considers damage detection methods and the inspection of tested surfaces, is a Technical Report which complements ISO 21254-1.

Lasers and laser-related equipment — Test methods for laser-induced damage threshold —

Part 1: Definitions and general principles

WARNING — The extrapolation of damage data can lead to an overestimation of the laser-induced damage threshold. In the case of toxic materials (e.g. ZnSe, GaAs, CdTe, ThF₄, chalcogenides, Be, Cr, Ni), this can lead to serious health hazards. See Annex A for further comments.

1 Scope

This part of ISO 21254 defines terms used in conjunction with, and the general principles of, test methods for determining the laser-induced damage threshold and for the assurance of optical laser components subjected to laser radiation.

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 10110-7, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 7: Surface imperfection tolerances*

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

ISO 11146-1, *Lasers and laser-related equipment — Test methods for laser beam widths, divergence angles and beam propagation ratios — Part 1: Stigmatic and simple astigmatic beams*

ISO 11146-2, *Lasers and laser-related equipment — Test methods for laser beam widths, divergence angles and beam propagation ratios — Part 2: General astigmatic beams*

ISO 21254-2, *Lasers and laser-related equipment — Test methods for laser-induced damage threshold — Part 2: Threshold determination*

ISO 21254-3, *Lasers and laser-related equipment — Test methods for laser-induced damage threshold — Part 3: Assurance of laser power (energy) handling capabilities*

ISO/TR 21254-4, *Lasers and laser-related equipment — Test methods for laser-induced damage threshold — Part 4: Inspection, detection and measurement*