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Lasers and laser-related equipment — Test method for angle resolved scattering

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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.

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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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 9, *Laser and electro-optical systems*.

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

In 2004, increasing demands from industry for qualified angle resolved scattering (ARS) measurements led to a discussion note to start activities for a completely new standard on ARS measurements of optical components in SC 9/WG 6, which was later discussed again in 2008. This new attempt was in particular driven by, but not limited to, the development of optical components for the deep ultraviolet spectral region, where scatter losses by material and surface imperfections cause critical limitations. It was then agreed to support the development of a new working draft.

Since then, there has been an increased interest in a standard procedure that is easy to apply for practical applications ranging from high-end surfaces, coatings, and materials, structured components like diffraction gratings, to radiation shaping elements like display foils and diffusors used at wavelengths ranging from the EUV and DUV to the IR spectral regions.

Two standards exist that describe measurements of angle resolved scattering:

— ASTM E 2387-19[15];

— SEMI ME 1392-0116[16].

Another related document is ISO 13696 which describes procedures to measure the Total Scattering (TS) of optical components.

Radiation scattering caused by imperfections of optical components can critically affect the performance of optical systems. Radiation scattered into large angles usually means a loss of radiant power and thus reduced throughput. Radiation scattered into smaller angles can lead to image degradation. Knowledge of the angular distribution of scattered radiation is thus essential in order to assess the quality of optical components.

This standard describes a testing procedure for the corresponding quantity, the angle resolved scattering (ARS), which is defined by the measured scattered intensity (scattered radiant power normalized to incident radiant power and solid angle of detection) as a function of the scattering angles.

Angle resolved scattering data can be used as input for stray-radiation calculations in optical design software. Other information like the Total Scattering (defined in ISO 13696) or other integrated scattering quantities can be derived from angle resolved scattering by numerical integration. In addition, although not covered in this document, analysing angle resolved scattering can provide information about the origins of scattering such as interface roughness, particles, defects, sub-surface damage, and bulk inhomogeneities.

Lasers and laser-related equipment — Test method for angle resolved scattering

1 Scope

This document describes procedures for the determination of the angle resolved scattering by optical components such as coated or uncoated optical elements, photonic structures, and materials that can be transparent, translucent, or opaque. It comprises scattering into the scattering sphere around the specimen usually separated into the backward and forward hemispheres. The procedures apply to wavelengths of radiation ranging from 5 nm in the extreme ultraviolet to 15 µm in the infrared spectral ranges.

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11145 and the following 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 http://www.electropedia.org/

3.1
scattered radiation
fraction of the incident radiation that is deflected from the specular optical path

[SOURCE: ISO 13696:2002, 3.1.1]

3.2
detector solid angle
$\Delta\Omega_s$
solid angle of the detector aperture with respect to the origin of coordinates

3.3
angle resolved scattering
ARS
radiant power ΔP_s scattered into a direction (θ_s, ϕ_s) relative to the incident radiant power P_i and the *detector solid angle* (3.2) $\Delta\Omega_s$:

$$\tilde{f}(\theta_s, \phi_s) = \frac{\Delta P_s(\theta_s, \phi_s)}{P_i \Delta\Omega_s}$$