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Optics and photonics — Measurement of optical elements and optical systems —

Part 4: Interpretation and evaluation of surface form and wavefront deformation tolerances specified in ISO 10110

Optique et photonique — Mesurage de composants et systèmes optiques —

Partie 4: Interprétation et évaluation des tolérances de forme de surface et de déformation du front d'onde spécifiées dans l'ISO 10110

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Foreword

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This document was prepared by ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

This third edition cancels and replaces the second edition (ISO 14999-4:2015), which has been technically revised.

The main changes are as follows:

— The limitation to interferometric measurements techniques only was removed in the title and in the document. The standard explicitly applies also for results of other measurement techniques. Notes were added at locations where differences between interferometric and other measurement techniques have to be accounted for.

— Notes were added regarding alignment removal functions, the wavefront spherical approximation, and the irregularity.

— For the slope deviation specification, a circular test area was added.

— The Zernike residual RMS specification was added, along with the required function and value definitions.

— Calculations of slope deviation where added.

— Definition of curvature deviation was added.

— Annex regarding estimation of peak to valley values was added.

— Some notes were moved in Clause 3 to an appropriate position in the body of the text.

A list of all parts in the ISO 14999 series can be found on the ISO website.

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.

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Introduction

This document provides a theoretical frame upon which are based indications from ISO 10110-5 and/or ISO 10110-14.

A table listing the corresponding nomenclature, functions, and values used in ISO 10110-5 and ISO 14999-4 is given in ISO 10110-5:2026, Annex B.

ISO 10110-5 refers to deformations in the form of an optical surface and provides a means for specifying tolerances for certain types of surface deformations in terms of “nanometres”.

ISO 10110-14 refers to deformations of a wavefront transmitted once through an optical system and provides a means of specifying similar deformation types in terms of nanometres or optical “wavelengths”.

As it is common practice to measure the surface form deviation interferometrically as the wavefront deformation caused by a single reflection from the optical surface at normal (90° to surface) incidence, it is possible to describe a single definition of interferometric data reduction that can be used in both cases. One “fringe spacing” (as defined in ISO 10110-5) is equal to a surface deformation that causes a deformation of the reflected wavefront of one wavelength.

Certain scaling factors apply depending on the type of interferometric arrangement, e.g. whether the test object is being measured in single pass or double pass.

Due to the potential for confusion and misinterpretation, units of nanometres rather than units of “fringe spacings” or “wavelengths” are to be used for the value of surface form deviation or the value of wavefront deformation, where possible. Where “fringe spacings” or “waves” are used as units, the wavelength is also to be specified.

In the last years several measurement techniques other than interferometric ones have been established that allow measurement of surface form deviations of optical elements and wavefront deformations. These techniques include tactile measurements of optical surfaces, combinations of coordinate measurements machines with optical sensors, and wavefront measurements techniques based on the Shack-Hartmann principle or lateral shearing interferometry. These techniques can be used to obtain the measurement data needed to describe the surface form deviation or wavefront deformations. The calculation rules described in this standard apply to these data sources as well.

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Optics and photonics — Measurement of optical elements and optical systems —

Part 4: Interpretation and evaluation of surface form and wavefront deformation tolerances specified in ISO 10110

1 Scope

This document applies to the interpretation of data relating to the measurement of the surface form deviations of optical elements or the wavefront deformations of optical systems. Often the measurement data are generated by using interferometric techniques, but other measurement techniques also generate measurement data to describe the surface form deviations or wavefront deformations.

This document gives definitions of the optical functions and values specified in the preparation of drawings for optical elements and systems, made in accordance with ISO 10110-5 and/or ISO 10110-14 for which the corresponding nomenclature, functions, and values are listed in ISO 10110-5:2026, Annex B.

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 10110-5, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 5: Surface form tolerances*

ISO 10110-14, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 14: Wavefront deformation tolerance*

ISO/TR 14999-2, *Optics and photonics — Interferometric measurement of optical elements and optical systems — Part 2: Measurement and evaluation techniques*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology 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/

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