Available online at www.sciencedirect.com
SCIENCE DIRECT®
Optics Communications 257 (2006) 16–26
OPTICS COMMUNICATIONS
www.elsevier.com/locate/optcom

Experimental intensity patterns obtained from a 2D shearing interferometer with adaptable sensitivity

G. García-Torales [b,*], G. Paez [a], M. Strojnik [a], J. Villa [c], J.L. Flores [b], A. González Alvarez [b]

[a] Centro de Investigaciones en Óptica, Loma del Bosque 115, León Gto., MX, CP 37000, Mexico
[b] Universidad de Guadalajara, Av. Revolución 1500, Guadalajara Jal., MX, CP 44840, Mexico
[c] Universidad Autónoma de Zacatecas, Av. López Velarde 801, Zacatecas, Zac., MX, CP 98000, Mexico

Received 10 November 2004; received in revised form 1 July 2005; accepted 5 July 2005

Abstract

The interferometric intensity patterns from a 2D shearing interferometer are shown and discussed. The intensity patterns can be obtained in two different approaches incorporating differential and extended wavefront controlled displacements. The reliable directional sensitivity of this interferometer allows the optimization of the measurement parameters to estimate the wavefront of the intensity patterns by regularization techniques.

PACS: 42.15.E; 07.60; 42.87; 07.60.L

Keywords: Optical design; Optical instruments; Optical testing; Shearing Interferometers

1. 2D shearing interferometer

The growing interest in the development of new techniques of fabrication and testing of symmetrical and asymmetrical optical elements, is a consequence of the requirement for compactness and light weight of modern optical devices [1–6]. Frequently, their complex fabrication and testing can become the principal disadvantage [7]. Specially, asymmetric components produce intensity patterns with a high fringe density; due to large optical path differences introduced in relation to the available reference components. Because of the high fringe density, moiré patterns are formed, avoiding the unique recovery of the phase information. Shearing interferometers are self-referenced: they compare the wavefront under test with itself. In order to discriminate between rotationally and non-rotationally

* Corresponding author. Tel./fax: +52 33 36 19 84 71.
E-mail address: ggarcia@cucei.udg.mx (G. García-Torales).
URL: http://www.cucei.udg.mx (G. García-Torales).

0030-4018/$ - see front matter
doi:10.1016/j.optcom.2005.07.014

symmetric aberrations, standard shearing techniques require at least two intensity patterns with orthogonal shear directions. Usually, shearing is obtained by using a plane parallel plate to displace the wavefront in two orthogonal directions [8–13]. Least squares numerical methods are usually employed to estimate the wavefront of these intensity patterns [14–16].

Fig. 1 shows our implementation of the 2D shearing interferometer based on the Mach–Zehnder configuration. Light from a laser source is expanded and filtered illuminating the positive lens under test, producing a collimated beam. The beam splitter BS1 separates the collimated beam in two equal intensity beams, *A* and *B*. The wavefront *A* is directed through the shearing system, while the wavefront *B* passes through the compensation system preserving their states of polarization. The superposition of the wavefronts *A* and *B*, generates a modulated interferometric intensity pattern is recorded for a posterior processing. Shearing and compensation systems consist in a pair of identical wedge prisms individually mounted in a rotary holder perpendicular to the direction of propagation of the incident wavefronts *A* and *B*. These holders allow independent and continuous variation of the angular prism position, ω_1 and ω_2 from 0° to ±360°. Prisms of the compensation system are settled to accomplish the minimum deviation between wavefronts *A* and *B*. Minimum deviation is reached when the top of the first prism is lined up with the bottom of the second prism, forming a plane parallel plate with a diagonal gap between them, e.g., the relative angle between prisms $\varpi = \pm 180°$, e.g., $\omega_1 = 0°$ and $\omega_2 = \pm 180°$. Maximum deviation is reached when $\varpi = 0$, e.g., $\omega_1 = 0°$ and $\omega_2 = 0°$. Fig. 1 also shows the object, the detection, and the image plane in the vectorial shearing interferometer. The distance z_i is measured from the first surface of the first wedge to the detection plane, placed after the beam splitter BS2. This shearing interferometer has an afocal-imaging configuration that allows the selection of the most convenient distance for the image detection. However, the detection plane should be located close to the beam splitter BS2 in order to maximize the area of interference between the deviated and the original wavefronts.

The interferometric Mach–Zehnder configuration is extensively used in optical testing [17,18]. Using our configuration, the calibration is easier than using mirrors because the grater freedom degrees. In the case of the prisms, the selection of each prism orientation and separation gives

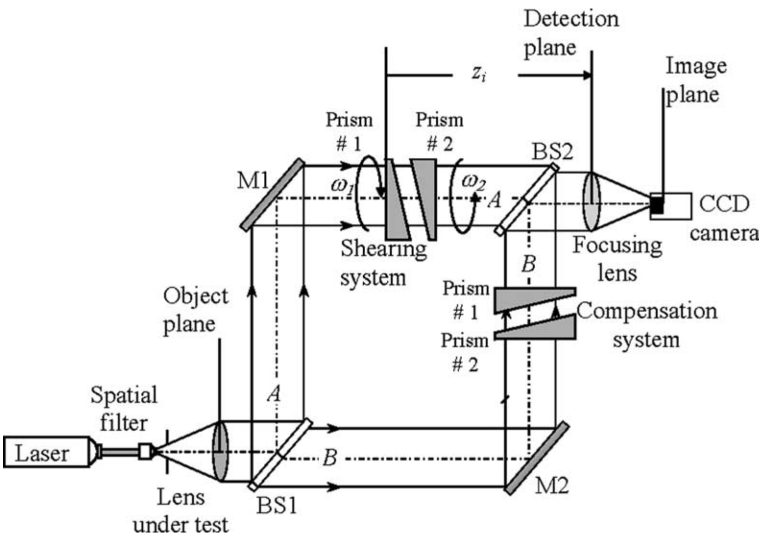

Fig. 1. Experimental setup of the vectorial shearing interferometer used in the testing of a positive lens in transmission showing the location of object, detection, and image planes in the vectorial shearing interferometer.