Real-time quantitative holographic interferometry using sillenite crystals for the study of varying objects

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ABSTRACT

Holographic interferometry (HI) [1,2] is a reknown method for monitoring deformations of diffuse objects. Attractive recording media for hologram recording in HI are the photorefractive crystals (PRCs) [3,4,5] of the sillenite family (BSO, BGO, BTO) because of their high energetic sensitivity compared to others. Holograms are stored by local modulation of refractive index obtained by charge migration from illuminated to dark zones.

In HI one observes the superimposition of two wavefronts coming, e.g., from the same object before and after a deformation has occured. This leads to an interference pattern (interferogram) containing a term proportional to $\cos(\phi)$ where ϕ is the phase difference between both object wavefronts. One generally considers the real-time HI, in which the first object wavefront is stored and reconstructed as a hologram, the second wavefront being the current object directly transmitted through the hologram, and the double-exposure HI in which both different wavefronts are recorded and simultaneously reconstructed. For long many authors have shown qualitative measurement using HI with PRCs [3-7] but there have been few attemps to connect such interferometer with quantitative determination of ϕ [8-12].

Dirksen *et al.* [10] have demonstrated the use of double-exposure connected with Fourier Transform [2,13] (FT) calculation of ϕ, requiring the acquisition of only one interferogram. In their case they performed stroboscopic sequences of double-exposure interferograms that were visualized at video frame rate. In order to have short response time, high incident intensities are required for diffuse reflecting objects, needing then a frontal collecting objective. Recently we have presented [11,12] a holographic interferometer using anisotropic self-diffraction in BSO for measurement of deformations and defects detection on large diffuse objects and that is connected with phase-shifting (PS) calculation of ϕ [2,13]. The method is the real-time HI which is well adapted to the use of PS, provided that the erasure time is long, i.e. for low incident intensities.

In our set-up, a BSO crystal, sandwiched between two polarizers, is set in front of the optical head and followed by a CCD camera with an imaging objective. With this system, for conventional object without special reflecting surface treatment and using 2.2 Watts of Ar3+ laser power @ 514 nm, interferograms can be observed on object fields of about 30x20 cm^2 (crystal size 1x1 cm^2 and 26 mm objective focal length). Also no frontal collecting objective is used since a compact system is seeked.

In this paper we present a real-time experiment in which a first hologram of the object at the rest is recorded. The object is then stimulated, e.g. by thermal loading, and when it is thermally relaxing, successive interferograms are acquired during short readout sequences that weakly disturb the recorded hologram, due to its long erasure time. This has an interest in non-destructive testing since transient behaviour can appear in the stimulated objects. The processing of the time varying interferograms is only possible by FT and no longer by temporal PS as shown in [11,12].

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