Optical Measurement of 3-D Deformation in Transparent Materials

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Deformation of volume holograms, such as shrinkage during processing [1], can cause deviation in the angle or wavelength for the Bragg matching condition [2], and aberrations in the reconstructed image. This problem, usually associated with the investigation of holography materials, has received much attention. The deformation models used in the literature are relatively simple, since their target is simple linear deformation. In this paper, we present a generalized theory that can deal with arbitrary deformations. We derived a general expression of the response of a volume grating to arbitrary deformation, using a perturbative approach. We constructed experiments, as shown in Figure 1, to measure the effect of the deformation due to a point-load exerted normally on the surface of a hologram on the diffracted field from both plane-wave transmission and reflection hologram. The experiment results, as Figure 2 shows, are consistent with the theory. Using this technology, we can determine the deformation itself, based on a set of observations of the field diffracted from a known (pre-deformation) volume hologram.

Figure 1: Experimental geometry when a point load is exerted on (a) a transmission hologram; (b) a reflection hologram

Figure 2: Experimental and simulated results when a point load is exerted on (a) a transmission type hologram and (b) a reflection type hologram

REFERENCES: