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WAVELENGTH SELECTIVITY & SENSITIVITY

Introduction

In trying to calculate the effect of recording a hologram with one wavelength, λ', and reconstructing with another, λ, the important fact to consider is the difference between a plane hologram and a volume hologram. A plane hologram is one in which the fringes are located on the surface of the medium whereas a volume hologram has fringes that exist throughout the medium; in photographic emulsions, for example, a plane hologram has fringes on the surface of the emulsion and a volume hologram has planes that exist throughout the emulsion. The different situations are created by the angle between the reference and object beams at the medium. If the fringe spacing is larger than the thickness of the medium then a plane hologram results, if, however, the fringe spacing is of the order of, or smaller than the thickness of the medium then planes are created within the medium. For the situation in fig.1. the fringe spacing is given by equation 1

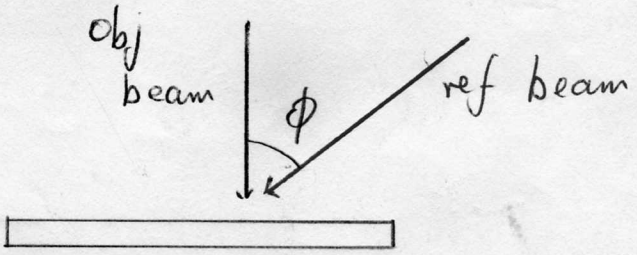

Fig. 1.

$$d = \frac{\lambda'}{\sin\phi} \qquad (1)$$

d = distance between fringes
λ' = recording wavelength
ϕ = angle between beams

For an emulsion of approximately 5 microns thick the limiting interbeam angle for a plane hologram is 7°.

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Plane Holograms

In the plane hologram case the method of wavefront reconstructing is diffraction by the interference fringes on the surface of the medium as shown in fig.2.

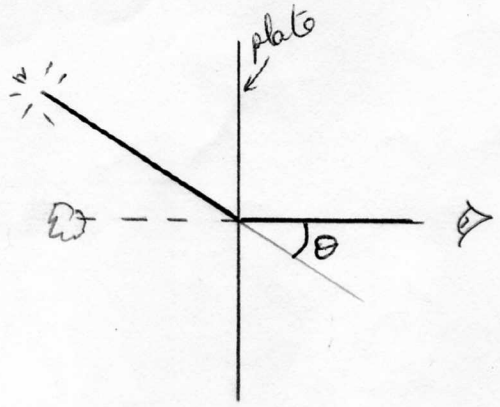

Fig.2.

In this case the angle of diffraction is given by equation 2.

$$\lambda = d \sin\theta \qquad (2)$$

λ = illuminating wavelength
d = fringe spacing

Combining equations 1 and 2 the effect of making the hologram with one wavelength and illuminating with another is given by equation 3

$$\frac{\lambda}{\lambda'} = \frac{\sin\theta}{\sin\phi} \qquad (3)$$

So, for example, if a hologram were made with a HeNe laser with an interbeam angle of 30° (assuming an appropriate emulsion thickness for plane hologram creation) then for the image to be viewed in the same position with a beam of 540nm the beam would have to be inclined at 25 (fig.3.)