

# Noise Gratings Recorded in Silver Halide Volume Holograms

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With recent advances in holographic technology, many types of holographic optical elements (HOEs) are being used in different optical systems. Typically these HOEs are recorded as volume phase holograms. Bleached photographic emulsions are an important medium for making volume phase HOEs because of the relatively high sensitivity and ease of processing of the material, improved processing chemistries, and the repeatability of results. However, photographic emulsions consist of fine-grained silver halide crystals suspended in a gelatin base, so the effect of noise gratings on holograms recorded in this material is significant.<sup>1</sup> Noise gratings are spurious structures recorded at the same time as the desired HOE due to the interference of the object and reference beams with the light scattered by the silver halide grains that make up the photographic emulsion. The noise gratings give rise to a reduction in the efficiency and in the quality of the intentionally formed HOE.

We recorded noise gratings in Agfa 8E75 HD plates with a single beam of coherent light of 633 nm from a helium-neon laser. The incident beam interfered with its own scattered radiation field to record the hologram. We measured the transmittance of the plates after processing as a function of the reconstruction angle. The scattered field from noise gratings causes a drop in the transmitted intensity when the single-beam hologram is reconstructed under conditions similar to those used for recording as seen in the figure to the right. We have represented a typical plot of the transmittance as a function of the reconstruction angle. In this figure,  $\Delta I_n$  represents the efficiency of the noise gratings and  $\Delta I_{as}$  corresponds to the average absorption and scattering of the processed hologram. For bleached emulsions we found that  $\Delta I_n$  depends to a great extent on the processing chemistry used.<sup>2</sup> By using different chemical compositions for the bleaching bath, we found that it is possible to analyze and optimize the bleaching action during the processing if we analyze the characteristics of the noise gratings.<sup>2</sup> These experiments support the important conclusion that it is possible to find bleaches that reduce the negative effect of noise gratings.

We also studied the influence of the coherence of the recording light on the efficiency of the noise gratings.<sup>3</sup> It has been shown that  $\Delta I_n$  for noise gratings recorded using a single beam of partially coherent light is much lower than  $\Delta I_n$  when coherent light is used. Although it is possible to

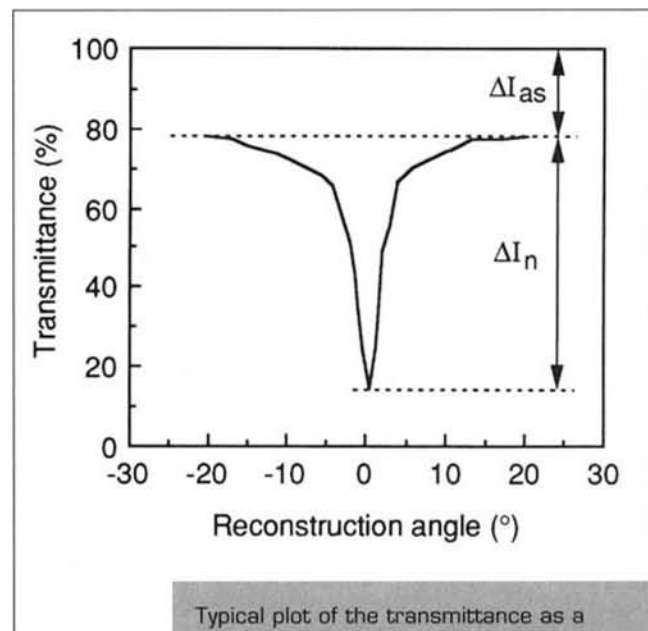
record HOEs with similar characteristics with the two types of light, we have experimentally shown that partially coherent light eliminates the negative effect of noise gratings.

Other studies on noise gratings included development of a statistical model<sup>4</sup> that allows us to study the behavior of  $\Delta I_n$  as a function of incident exposure, the theoretical and experimental analysis of the influence of polarization on the efficiency of noise gratings recorded in bleached holograms,<sup>5</sup> and the experimental analysis of noise gratings recorded during the formation of holographic lenses.<sup>6</sup>

All the studies on noise gratings briefly described here give information about the mechanism of formation, the characteristics, and possible ways to eliminate noise gratings generated by scattering when HOEs are recorded in photographic emulsions.

## REFERENCES

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Typical plot of the transmittance as a function of the reconstruction angle for noise gratings recorded with a single beam of light and definition of the diffraction efficiency of the noise gratings,  $\Delta I_n$ , and the average absorption and scatterings,  $\Delta I_{as}$ .