

Self-enhancement and angular properties of vector and scalar gratings in organic glasses

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Summary

Self-enhancement of vector and scalar holographic gratings recorded in different organic molecular glasses have been experimentally studied. Diffraction efficiency (DE) angular dependence of these gratings was also studied and compared with theoretical calculations.

Introduction

Organic materials, especially azobenzene compounds, are of a wide interest for applications in holography and nonlinear optics because they enable much easier tailoring of their properties than inorganic ones [1]. Optical information recording processes can be also substantially different in different materials. In this paper, we have studied vector and scalar holographic grating (HG) recording in organic molecular glassy films produced in our Faculty making accent to self-enhancement (SE) of gratings and to their DE angular dependence. These two features of vector gratings have not been studied until now, as far as we know. However, they can have practical importance, e.g., for creation of holographic optical elements.

SE of a nonstationary hologram is the increase in its DE over time under the stimulus of a single beam light irradiation or simply in the dark [2,3]. The SE effect was reported for the first time in 1973 by Gaylord *et al* [4] for phase holograms in LiNbO₃:Fe crystals. Three types of SE can be distinguished: (i) coherent SE due to the holographic recording by diffracted waves; (ii) incoherent SE due to the contrast and/or transmission increase of a hologram by incoherent light; (iii) relaxational (or dark) SE due to the contrast and/or transmission increase of a hologram by thermostimulated relaxation processes. All three SE types can take place simultaneously. SE can also be regarded as a two-stage hologram recording method, which is profitable when the recording energy or exposure time is limited at the first stage. Such a recording method also has advantage of a large vibration stability at the second stage. SE characterizes recording processes as well.

Experiments and results

The following organic molecular glasses spin-coated as about 1 μm thick films on glass substrates have been studied: 1) **8a** or 3-(4-(bis(2-(trityloxy)ethyl)amino)phenyl)-2-(4-(2-bromo-4-nitrophenyl) diazenyl)phenyl)acrylonitrile; 2) **16** or 2-(ethyl(4-((2-nitro-4-triphenyl) diazenyl) phenyl) amino) ethyl-4-((4-bis (2-(trityloxy)ethyl)amino) phenyl) diazenyl)-3-nitrobenzoate; 3) **W50** or 2-(2-(4-((4-bis(2-(trityloxy)ethyl)amino)phenyl) diazenyl)styryl)-6-styryl-4H-pyran-4-ylidene)-2H-indene-1,3-dione; 4) **W75** or 2-(3-(4-

(- (4-(bis (2-(trityloxy) ethyl) amino) phenyl) diazenyl) styryl)-5,5-dimethylcyclohex-2-enylidene) malononitrile. Vector and scalar HG with a period of 2 μm were recorded and read out at 532 nm with *s-p* and *p-p* polarized beams, correspondingly.

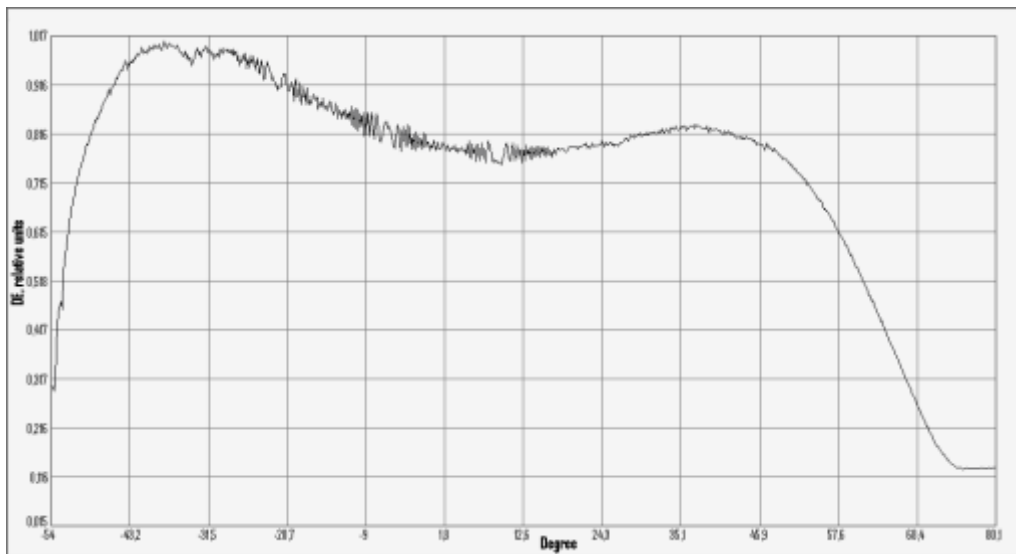


Fig.1. Diffraction efficiency dependence on the readout angle of the vector HG recorded in **W-75** film. Zero degree angle corresponds to the normal incidence.

SE studies were carried out by the HG recording up to the initial DE of 0.06-0.1% with the following readout by the *p*-beam only. SE increase up to 41 times have been achieved for *p-p* HG in the sample **8a**, and up to 4.3 times for *s-p* HG in the sample **W-50**. DE decay rather than SE took place in other cases. This is the first SE observation of vector gratings, to our knowledge.

DE readout angle dependences were qualitatively the same for both scalar and vector (Fig.1) gratings. The observed asymmetry of these curves are in agreement with the calculations for phase gratings according to Kogelnik's theory [5] for HG with Klein's factor $Q < 1$.

Self-diffraction efficiency exposure dependences have been also measured in all cases. The maximum value of 37% was achieved for *p-p* HG and 7.2% for *s-p* HG in the sample **W-75**. Photobleaching of samples by 4-60% was also observed.

Conclusions

SE and angular properties of vector gratings have been experimentally studied in comparison with scalar gratings in organic glasses. It was found that these properties do not differ qualitatively. **W-75** films enable efficient recording at 532 nm.

References

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