Diffraction efficiency of reflection gratings in azobenzene films

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INTRODUCTION

Holographic recording of reflection gratings (RG) in thin films is practically unexplored because the main advantage of these gratings, a high spectral sensitivity, mainly manifests itself in the case of large RG thickness. Our previous transmission holographic grating recording studies in molecular azobenzene glassy films with the thickness of 1-3 μm have revealed a steady decrease of diffraction efficiency (DE) at small grating period Λ=0.5μm [1]. Is this decrease connected with the recording mechanism or only with the Rayleigh light scattering which decreases the visibility of the recording interference pattern? What is the situation at still smaller gratings periods? Is it generally possible to record RG in such thin films? The answer to these questions is given in this study.

EXPERIMENTS AND RESULTS

We have recorded reflection gratings (RG) in ZWK-3 [(W-50):2-(2-(4-((4-(bis(2-trityloxy)ethyl)amino)phenyl) diazenyl)styryl)-6-styryl-4*H*-pyran-4-ylidene)-1*H*-indene-1,3(2*H*)-dione, thickness d=2 μm] , ZWK-2TB [2-(2-(4-((4-(bis(2-(trityloxy)ethyl)amino)phenyl) diazenyl)styryl)-6-tert-butyl-4*H*-pyran-4-ylidene)-1*H*-indene-1,3(2*H*)-dione, d=2 μm], ZWK-3 thick [d=6 μm, WE-3 thick [2-(4-((4-(bis(2-(triphenylsilyloxy)ethyl) amino)phenyl)diazenyl)benzylidene)-1*H*-indene-1,3(2*H*) -dione, d≈3 μm] molecular azobenzene glassy films by 532 and 633 nm laser beams with Λ=0.182 μm and Λ=0.217 μm, respectively. The results of measurements were compared with the transmission grating corresponding parameters at Λ=2 μm.

The highest diffraction efficiency DE=0.91% has been achieved in ZWK-2TB film when RG was recorded at 532 nm and read out at 633 nm. Generally, RG recording efficiency was about 10 times lower than in the case of transmission gratings with Λ=2 μm.

No dominant role of Rayleigh light scattering on DE was found. Evidently, recording mechanism peculiarities were responsible for DE decrease at small periods.

Scattering length of 30-45 nm was deduced from measurements.

Surprisingly high DE values were found in the case of RG recorded at 532 nm and read out at 633 nm (Fig.1) when large deviation from the Bragg condition [2] took place. Possible explanations will be discussed in the presentation.

CONCLUSIONS

1. The possibility of RG recording azobenzene molecular glassy films is experimentally verified. Maximum DE=0.91% was achieved. However, the RG recording efficiency was considerably smaller than in the case of transmission gratings at Λ=2 μm.
2. Rayleigh light scattering is not the main factor decreasing DE when the grating period is decreased. Light scattering length was about 30 nm at 532 nm and 40-45 nm at 633 nm.
3. Unexpectedly high DE values are found at large deviations from the Bragg condition.

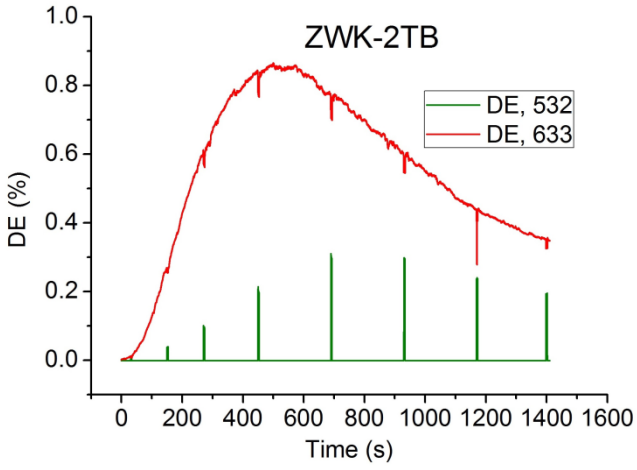

Figure 1. Diffraction efficiency exposure time dependences of the reflection grating recorded in ZWK-2TB film by 532 nm light and read out at 532 and 633 nm. Λ= 182 nm, readout angles $\theta_{inc}(532)=20^0$, $\theta_{inc}(633)=25^0$.

References

[1] A.Ozols, P. Augustovs, V.Kokars, K.Traskovskis, D.Saharov, Effect of holographic grating period on its relaxation in a molecular glassy film, *IOP Conf. Series:Materials Science and Engineering*, 2013, **49,** 012043 , doi:10.1088/1757-899X/49/1/012043.

[2] H.Kogelnik, Coupled wave theory for thick hologram gratings, 1969, **48** (9), pp. 2909-2947.