PHOTOINDUCED SURFACE PATTERING IN LOW MOLECULAR ORGANIC GLASSES

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Abstract

In this work photoinduced surface pattering in low molecular organic glasses via holographic recording was studied. The studied glasses possess good light sensitivity and deep surface relief grating can be recorded due to fast aligment of the molecules in the presence of light electric field and the following mass transport. This makes low molecular organic glasses as a promising material for holographic recording and fabrication of electrooptical devices.

Holographic recording in organic molecular glasses was performed with 532nm solid-state diode-pumped laser Verdi-8. Very rapid holographic grating recording and surface relief formation at small recording beam intensities was observed. Recorded grating diffraction efficiency's and surface relief depth dependence on recording beams polarization state was studied. The surface relief was studied with AFM.

Key words: *surface relief grating, organic glasses, holographic recording.*

Introduction

Organic glasses are very promising material for many applications in electronic and optoelectronic. They have many advantages in comparison to polymers: organic glasses possess well-defined molecular structure, no molecular-weight distribution, and no undefined or undesired end groups [1-4]. Azobenzene containing organic glasses are suitable for holographic recording and in this paper polarization state dependence on surface relief grating (SRG) formation in three different low molecular organic glasses was studied.

Experimental

The chemical structure of studied low molecular organic glasses (LMOG) is shown in Fig. 1 a-c. Theirs transmittance spectra are shown in Fig. 2. The samples were prepared using chloroform as a solvent. Weight ratio of LMOG in solution was 2-4%. Solution was purified using PTFE filter with pore size of 0.45 μm, then solution was applied on glass substrate by spin-coating method.

Holographic recording was performed using experimental set-up shown in Fig. 3. For recording solid-state diode pump laser Verdi-8 (532 nm) was used. Laser beam was split by polarization sensitive beam splitter, afterwards two beams of equal intensity was diverted by mirrors and crossed on the sample surface. Intensity of recording beams was I = 0.25 W/cm^2. Angle between recording beams was θ = 30º, thus the grating period was Λ = 1 μm. The polarization state of recording beams was varied by using half wave plates. Read-out was performed by diode laser with wavelength λ_2 = 653 nm and *p* polarization state. Intensity of reading beam was $I_{\lambda 2}$=11mW/cm^2. Diffraction maximum of the first order was measured by photodiode which was connected to a PC.

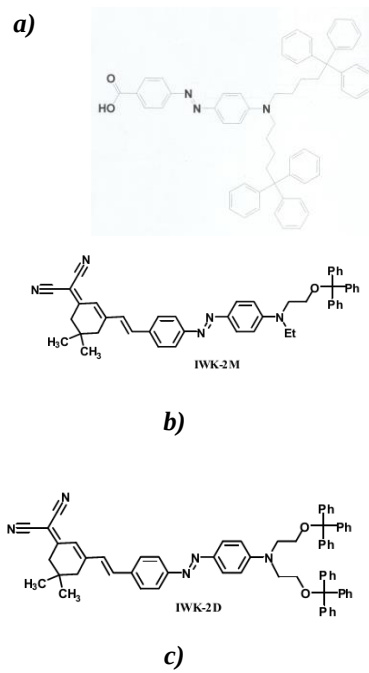

Fig. 1. Chemical structure of a) KRJ-8; b) IWK-2M; c) IWK-2D

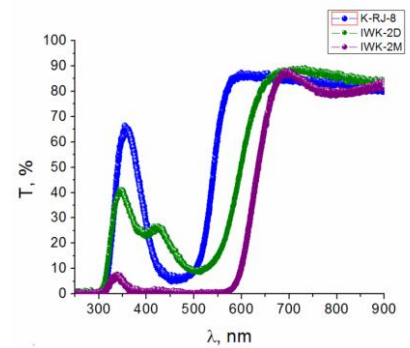

Fig. 2 Transmittance spectrum of LMOG

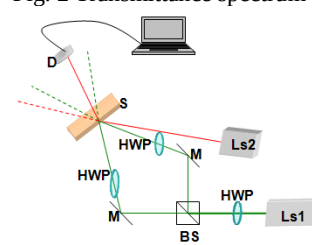

Fig.3. Experimental set-up. Ls1 – recording laser λ_1 = 532nm, Ls2 – diode laser, λ_2 = 653nm, HWP – half-wave plate, BS-beam splitter, M – mirror, S - sample, D - diode

Results and discussion

Holographic recording with *pp*, *ss* and *+45/-45* polarization states in three different LMOG samples on polarization state was performed. In figure 4 is showed SRG formation velocity, which is described by tgα, where α is an angle between linear part of diffraction efficiency curve and exposure axis [5]

in IWK-2D, IWK-2M and KRJ-8 samples [6]. If usually in organic compounds +45/-45 polarization state gives the best result [7], then in LMOG it is not always correct. In KRJ-8 results correspond to others organic compounds: +45/-45 forms SRG the best; *pp* gives slightly worse results, but *ss* forms weak or does not form SRG at all. The depth of SRG in KRJ-8 exceeds the thickness of the sample 1.5 times. Different behavior in IWK-2M and IWK-2D was observed. In IWK-2M *pp* polarization state formed SRG faster than *+45/-45*. In the case of IWK-2D *pp* polarization formed very weak SRG, but *ss* did not form SRG in both compounds. Explanation of such polarization state dependence could be bleaching of IWK-2M and IWK-2D compounds. Intensity modulation of *pp* and *+45/-45* on the sample surface is shown in figure 7. In the case of *pp* polarization state, intensity is two times higher than in *+45/-45*. Higher intensity causes higher spectral changes in material, thus diffraction

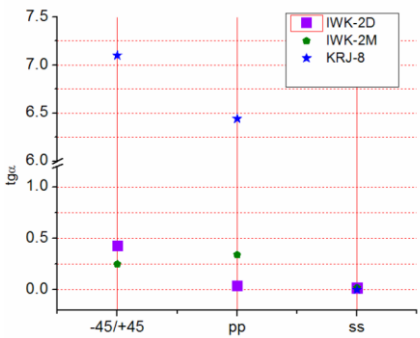

Fig. 4. Surface relief grating formation velocity in LMOG

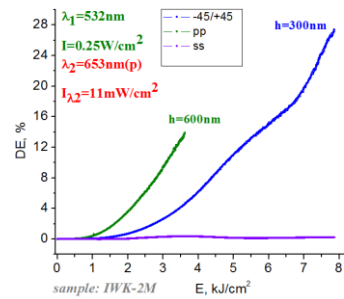

Fig. 5. Diffraction efficiency of recording in IWK-2M with different polarization state

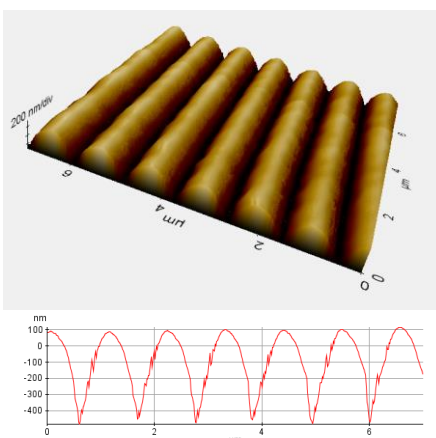

Fig. 6. Surface relief obtained in IWK-2M using *pp* polarization state by AFM

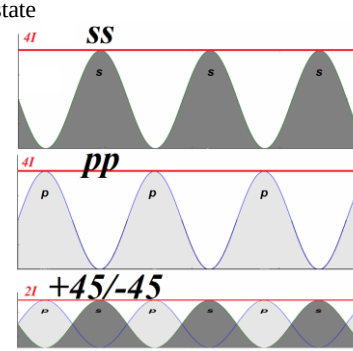

Fig. 7. Intensity modulation on the surface using *pp*, *ss*, *+45/-45* polarization state

efficiency and subsequently tgα is higher than the case of *+45/-45*. Spectral changes were observed visually after recording – the illuminated area became yellowish.

The depth *h* of SRG also does not correspond to DE in IWK-2M (figure 5). Two times higher value of DE in the case of *+45/-45* polarization state gives two times shallower SRG in comparison to *pp*.

Conclusions

Efficient and deep SRG formation in low molecular organic glass KRJ-8, IWK-2D and IWK-2M was observed. The most rapid SRG formation was obtained in KRJ-8 sample.

SRG formation and tgα dependence on polarization state of recording beams in KRJ-8 correspond to other studies organic compounds.

In IWK-2D and IWK-2M compounds dependence on polarization state of recording beams and the value of tgα is affected by two processes – SRG formation and photobleaching.

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