RIGA TECHNICAL UNIVERSITY

SEPTEMBER 10-12, 2014
RIGA, LATVIA

inter academia

THE 13TH INTERNATIONAL CONFERENCE ON GLOBAL RESEARCH AND EDUCATION

INTER-ACADEMIA 2014

DIGEST

Dependence of Holographic Photosensitivity Intensity of Azobenzene Molecular and Chalcogenide Glassy Films

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Summary

The dependence of photosensitivity light intensity on holographic grating recording in three azobenzene molecular glassy films (denoted as WE-3, ZWK-3, ZWK-2TB) and one amorphous chalcogenide film $As_{40}S_{15}Se_{45}$ (As-S-Se) has been experimentally explored in the intensity range from 0.0034 to 1.03 W/cm^2. It was found out that photosensitivity increases when recording light intensity is increased. The physical reasons are discussed and a simple mathematical model is given explaining the obtained results.

Introduction

Amorphous organic and chalcogenide materials have been widely investigated because of interesting physics involved and because they can be used in a number of possible applications in optical information storage, nonlinear optics, dynamic holography, holographic optical elements [1-3]. In order to successfully manipulate these materials by light, it is necessary to know the effect of light intensity. These measurements are quite time consuming, therefore, this information is not widely available [2,3].

In [2] it was found out that steady state photo induced anisotropy of azo dye polymer films increases with the increase of light intensity. Photosensitivity of amorphous chalcogenide As_2Se_3 [3] and As_2S_3 [4] films also increases when recording light intensity is increased. In the latter case, the existence of intensity threshold (I_{thr}) was found to be depending on the fixed diffraction efficiency(η), film thickness(d) and grating period(Λ). In the case of $\eta = 3\times10^{-5}$ %, Λ=1.0μm, d=10.5μm, $I_{thr}\approx10^{-5}$W/cm^2 was observed. In this paper we have experimentally studied photosensitivity light intensity dependence in three azobenzene molecular glassy films and in one chalcogenide As-S-Se glassy film. We have got qualitatively similar results as in [4].

Experiments and results

Transmission holographic gratings with the period of 2.0 μm were recorded in the above-mentioned films by two equally strong symmetrically incident 633 nm He-Ne laser beams with *p-p* polarizations and self-diffraction efficiency (SDE) was continuously measured. The studied azobenzene molecular glasses were synthesized by our group. They included WE-3 or 2-(4-(bis(2-triphenylsilyloxy)ethyl)amino)phenyl)diazenyl)benzylidene)-1-indene-1,3(2*H*)-dione, ZWK-3 or 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, ZWK-2TB or 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. About μm thick films were spin-coated onto the glass substrates. To characte film photosensitivity, we have determined the recording energies *E=It* intensity, *t*- exposure time) corresponding to *SDE*=0.096% and SDE=0.25 at certain intensity values, mainly *I*=0.011, 0.034, 0.10, 0.32 and 1.1 W/cm^2. Besides, so called Lin sensitivities, $S=(SDE)^{0.5}E^{-1}$ corresponding SDE_{max} were determined. SDE exposure time dependences and E dependences for ZWK-3 film are presented in Fig.1 and Fig. 2.

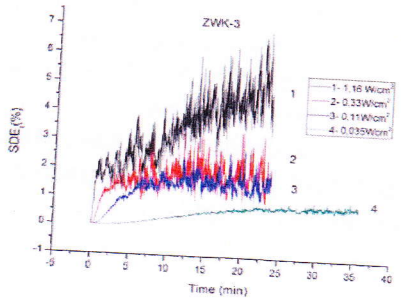

Fig.1. SDE exposure time dependences at four intensities for ZWK-3 film.

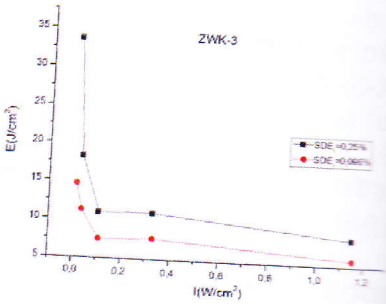

Fig.2. Recording energy intensity dependences at two fixed SDE values for ZWK-3 film.

Conclusion

The main result in the case of all films is that photosensitivity generally increases when the recording light intensity is increased. In the case of azobenzene films, this behaviour can be explained by competing processes of chromophore photoorientation perpendicularly to the light electric vector and their thermal disorientation. A simple mathematical model is proposed explaining the observed intensity dependences. Similar model considering competing photostructural and relaxational structural changes [4] can be applied in the case of As-S-Se.

Acknowledgment

This work has been supported by the European Social Fund within the project No.2013/0028/1DP/1.1.1.2.0/13/APAI/VIAA/054.

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