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Study of multiple record of the optical information on photothermoplastic mediums (PTPM) in the holographic way

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In the given work results of experiments on carrying out of cyclic record on PTPM are resulted by holographic way. The optical scheme is resulted, allowing automating process of record of elementary holograms in the form of diffraction gratings on PTPM and their definitions diffraction efficiency. The mechanism of occurrence of "parasitic" memory PTPM due to photostructural transformations into thin layers CGS is considered.

1. INTRODUCTION

One of the requirements to recording material of the optical information is recurrence, i.e. possibility of using the mediums information for a multiple record. On available literary data a photothermoplastic materials save register ability before 1000 and more cycles a record-deleting.

As registering environments were used two-layer photothermoplastic mediums (PTPM) such as "a photoconductor - thermoplastic", obtained on the basis of layers of the chalcogenide glass semiconductors (CGS) of a composition $(As_2S_3)_{0,3}$ $(As_2Se_3)_{0,7}$, marked by a method of a vacuum deposition on lavsan substrate the metalized by a semitransparent layer of chromium. Thickness of layers CGS made 2,3 ± 0,1 μm.

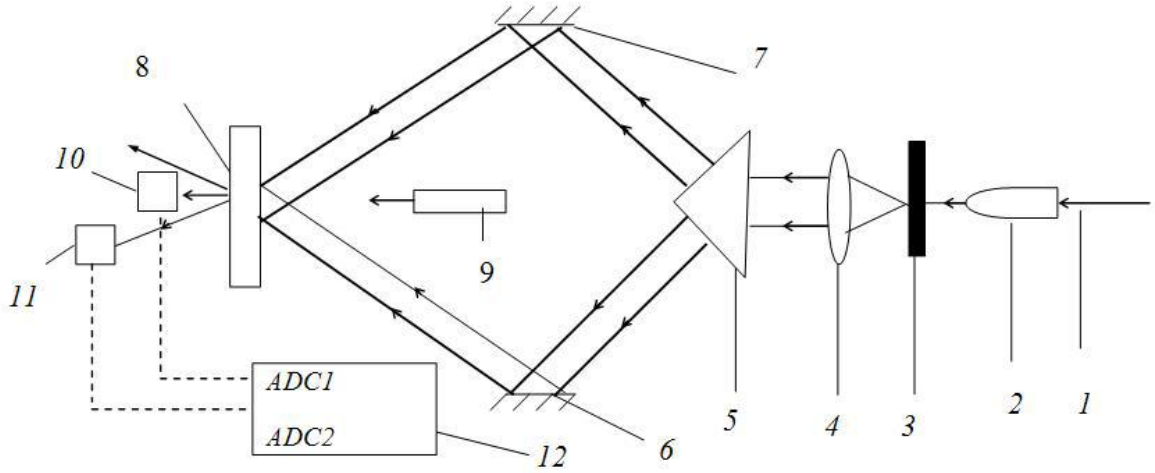
As thermoplastic layers were used layers (d=0,7 μm) an copolymer of the styrol and butylmethacrylate in the ratio 1:1, were deposited through ditch watering from toluene solution.

2. EXPERIMENTAL PART

On these mediums experiments on cascade registration of the optical information by holographic way by imposing one entering the one image on another with change of a corner of record are lead.

The optical scheme has been developed for the decision of this problem (Fig.1), allowing to automate process of record of elementary holograms as diffraction gratings on PTPM [3]. The diffraction effectiveness of written down holograms was defined on was defined on intensities of zero and first orders in restored diffraction to a picture and registered by a photodetector interfaced to the COMPUTER. According to the designed program of the COMPUTER calculates the diffraction effectiveness and outputs the data on the monitor.

On the basis of the developed optical scheme it is possible to receive on PTPM diffraction gratings with the sanction up to 2000 mm^{-1}, depending on thickness of a thermoplastic layer d.



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Fig. 1 Installation for record of an optical signal on PTPM: 1) - a beam of the laser; 2) - a microobjective; 3) - a diaphragm; 4) - a collecting lens; 5) - a prism; 6, 7) - mirrors (R=1); 8) - a cell of record; 9) - the scanning laser; 10, 11) - photo diodes; 12) - Analog-digital converters ADC1 and ADC2, interfaced to the COMPUTER

The medium is located in a cell of record 8. By means of a heating element in a cell of record PTPM it is warmed up to temperature at which viscosity of a thermoplastic layer becomes sufficient for its deformation under action ponderomotive forces. Then, simultaneously with displaying the image on surface PTPM the uniform electric charge arising between a negative electrode and corona by a string of a cell of record is put. Due to photoconductivity of a semi-conductor layer redistribution of a charge on a thermoplastic layer between the shined and dark sites of the photothermoplastic carrier is carried out. When in shined places PTPM intensity of an electric field on a thermoplastic layer reaches size at which ponderomotive become more forces of elasticity of thermoplastic, on the last there is a deformation. The above light exposure of the photothermoplastic medium, the above density of deformation of its surface that allows to receive a holographic lattice high diffraction efficiency.

For restoration of the written down holograms the following part of the optical scheme was used: the beam of the scanning laser 9, passing through formed diffraction grating, forms maxima of intensity zero and following orders, i. e. serves as the tool for definition diffraction to efficiency written down interference pictures. Photo diodes 10, 11 serve for definition of intensity of maxima. Analog-digital converters (ADC) 12 serve for measurement of sizes of a current of photo diodes and data transmission on the COMPUTER. For management of process of data acquisition with ADC the developed program which application allows receiving dependences diffraction efficiency from time of record, frequencies, temperatures and potential corona an electrode was used.

For realization of repeated record on one sample the scheme has been equipped rotating in a plane of the staff (PTPM) by a cell of record that allowed varying a corner of record of the image from 0 up to 360^0.

Record of the first grating (frame) was realized for out at temperature T_r=66 ^{0}C and a pressure on corona electrode U_c=5,5 κV during 5 s. For carrying out of the subsequent record alignment of a surface of a thermoplastic layer due to endurance during certain time was carried out at temperature of deleting T_d. In given experiment $T_d = T_r$. Optimum time of alignment (deleting) for the given type of a thermoplastic material made 25 s.

Record of the subsequent frame was carried out at turn of a cell on the set corner. Conditions of record were kept. Diffraction efficiency of the written down holographic gratings was defined automatically during record.

3. RESULTS AND DISCUSSION

For PTPM record diffraction grating with a maximum is characteristic at the frequencies corresponding thickness of a thermoplastic layer d ($1/3d \le f_{max} \le 1/2d$) (Fig.2).

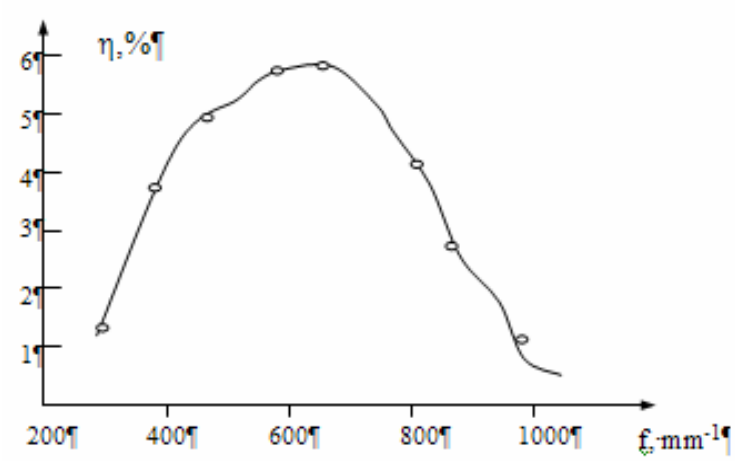


Fig.2. Dependence diffraction efficiency of a grating on PTPM from frequency of record

Lead experiments have shown, that at a level 0,7 η_{max} the size of cyclicity of record makes 20÷25. At the frequencies close to resonance, cyclicity of record decreases in 2÷2,5 times. The received lattices are formed due to occurrence of deformation "holed" type which depth depends on frequency of a formed raster.

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At achievement of a maximum diffraction efficiency depth "holes" becomes match with thickness thermoplastic a layer that leads to greater electric fields inside "holes" [4]. In a combination to temperature and light exposure in places of formation "holes" in layers CGS there can be the photostructural transformations [2, 5] leading sharp change of electric properties of layer CGS [6].

At the subsequent record this effect is shown as memory of the previous influence of heat, light and an electric field. It low cyclicity of record diffraction gratings in the field of resonant frequencies speaks.

For acknowledgement of this assumption samples PTPM with the put raster were processed in toluene for removal of a thermoplastic layer, and then poisoned in alkaline etchant within several seconds for reception effective diffraction pictures (Fig.3).

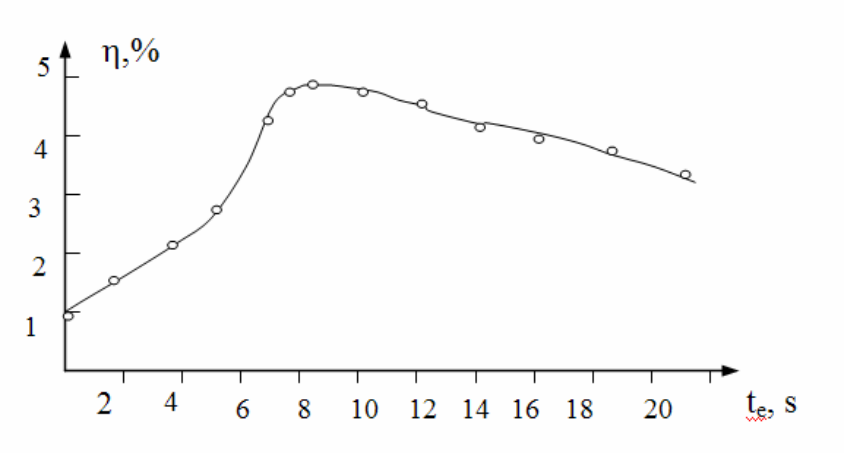


Fig.3 Dependence diffraction efficiency of a gratings on layer GGS from time of etching

The resulted experiments have shown that probable effect of the mechanism of display of memory in PTPM is formation of photostructural transformations in thin photosensitive layers CGS during record diffraction gratings (Fig.4) and as consequence reduction of cyclicity of record.

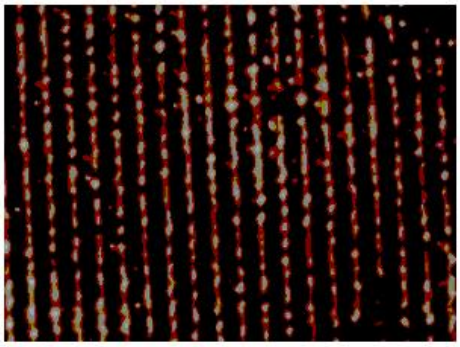


Fig. 4. Relief screened the image of a surface of layer CGS after chemical processing

Results of experiments on cyclic record on PTPM are presented on Fig.5. The restored image was photographed by the digital chamber having USB a socket by means of which it can communicate with a computer. Using modern methods of processing of the image, the convenient kind for calculations and measurements is given to the received photos.

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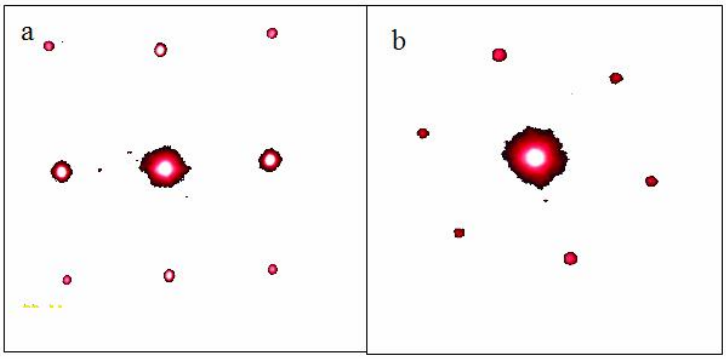


Fig.5 The Restored gratings

On Fig.5a the restored image from two written down gratings, and on Fig.5.b - from three gratings is presented. Similar images can be received at record of Furies-holograms (Fig.6).

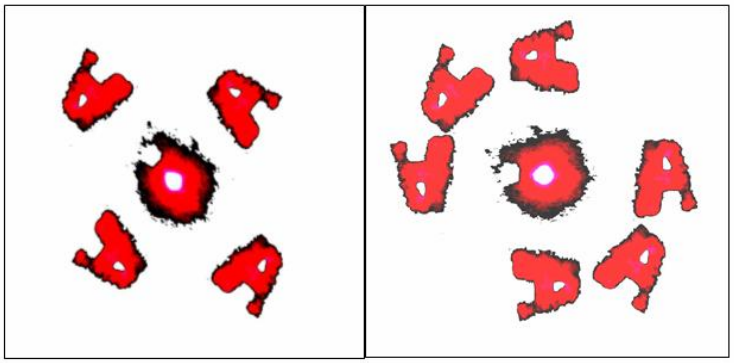


Fig.6 The Restored Furies-holograms

From figure it is visible, that intensity diffraction maxima does not depend on a corner of registration of the optical information. However diffraction efficiency of each subsequent record falls on 8-10 % in comparison with previous.

It speaks "holed" deformation of a thermoplastic layer. Due to thermal influence there is «smoothing-out holes» the previous lattice and as consequence decrease diffraction efficiency.

Thus, the developed method of record of the optical information on PTPM specifies perspective of realized of multiple registration of the optical information for the decision of problems of optical processing the information in the holographic way.

1. A.I. Zyubrik Materialy dlya opticheskoi zapisi informacii. - Lvov, 1982.
2. Neserebryanye fotograficheskie processy. Pod red. L. N. Kartujanskogo.- Chemistry, Moscow, 1984.
3. Y.E. Kortiukova «Ustroistvo dlya registracii opticheskoi informacii na fototermoplasticheskih nositelyah golograficheskim sposobom s ispol'zovaniem EVM».- Works of conference PDMM-2006, p.325-331, The Russian Academy of Science, Vladivostok, 2006.

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4. L.M. Panasyuk, A.M. Nastas «Peredacha prostranstvennyh chastot fototermoplasticheskim nositelem pri lunochnoj strukture deformacii». - Magazine of a scientific and applied photo. p. 26-29, V.42, N.5, 1997. .

5. T.I. Goglidze, I.V. Dement'ev, Y.E. Kortiukova, E.A. Senokosov. «Nekotorye osobennosti zapisi opticheskoi informacii na sloyah hal'kogenidnyh stekloobraznyh poluprovodnikov i fototermoplasticheskih nositelyah na ih osnove». -Bulletin Dniester State University. S.: Physicotechnical and mathematical sciences. p. 28-32, № 1 (19), 2004. .

6. L.M. Panasyuk. «Fototermoplasticheskaya zapisi na sisteme poluprovodnik-termoplastik. Nekotorye osobennosti formirovaniya izobrajenii». - Sb.: Sposoby zapisi informacii na besserebryanyh nositelyah. p.14-24, Kiev, 1997.

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