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THE SPECTRAL DEPENDENCE OF RELIEF GRATINGS DIFFRACTION EFFICIENCY DIRECTLY FORMED IN NANOMULTILAYERS As_2S_3-Se

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Abstract. *In this work the measurements of the spectral dependence of relief gratings diffraction efficiency formed in As_2S_3–Se nanomultilayers were carried out on the modernized spectrophotometer SF-46. It was shown that a characteristic feature of the spectral dependence of the diffraction efficiency of gratings was non-monotonic decay of its values in the spectral region of 550-1000 nm. The maximum values of the diffraction efficiency of gratings recorded in the NML structure As2S3–Se was observed in spectral region of 550nm.*

Keywords: *surface relief grating, diffraction efficiency, spectral dependence, chalcogenide glasses.*

Chalcogenide glasses, photo-induced properties and application of this materials as recording media are extensively studied. It was shown that diffraction gratings could be obtained on chalcogenide photosensitive materials that involves exposure of the thin film to an interference pattern. During the holographic recording two coupling gratings are formed simultaneously:

1 - phase grating, due to modulation of the refractive index and

2 - amplitude grating, resulting from the changes of absorption coefficient.

Recently, new structure based on multilayer composition of chalcogenide glasses have attracted much attention for the fabrication of surface relief structures [1]. New possibility to direct formation of surface relief gratings on chalcogenide multilayer structures without any subsequent processing under a interference light irradiation was shown in [2]. Several theoretical models were proposed to explain the mechanism of surface relief grating formation but the mechanism is still not fully explained.

To obtain a multi-layer structure by thermal evaporation in vacuum has created a special attachment to the vacuum post VUP-4, allowing simultaneous evaporation of two materials on a rotating substrate. In addition there was created an additional power supply system of the second evaporator, a mechanical system to control the opening of valves.

Nanomultilayers (NML) of the composition As_2S_3–Se were prepared by computer controlled cyclic thermal vacuum deposition of two materials As_2S_3 and Se from two separated boats on continuously rotated glass substrate at room temperature in one vacuum deposition cycle.

The monitoring and determining of the total NML film thickness was carried out during the thermal evaporation by 2 interference thickness sensors at λ=0.94 μm in transmission mode. Resulting sample was NML structure of the composition As_2S_3–Se with total thickness of 1700 nm.

We have first recorded the visible transmission spectrum of the obtained structure. The interference in transmission indicates the good quality of thin films. From transmission spectra the optical constants such refractive index, absorption coefficient and thickness of films were calculated using method proposed by Swanepoel. Direct one step relief grating formation by laser beams on the surface of amorphous chalcogenide NML was realized. An interferometric holographic recording was used to record grating based on DPSS single mode laser operated at wavelength λ=532nm and averaged beam power density 225 mW/cm^2. The holographic gratings with a period of Λ=1,0 μm were recorded by two symmetrically angled laser beams respecting to the sample surface normal. The intensity ratio 1:1 of recording beams was used in order to achieve maximum interference fringes contrast. The two beams were then combined, by using two mirrors, and interfered on the NML structure.

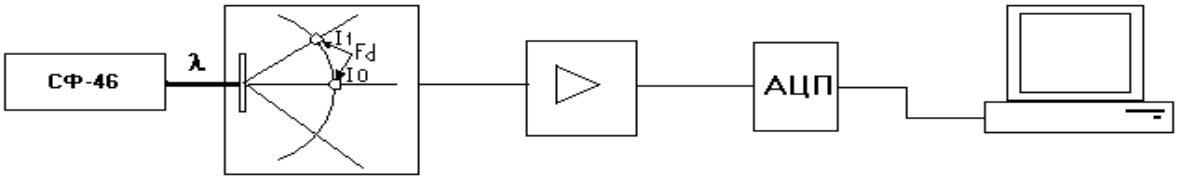

Fig. 1. The general scheme of measurement of the spectral dependence of the diffraction efficiency.

Measurements of the spectral dependence of relief gratings diffraction efficiency formed in nanomultilayers As_2S_3–Se conducted on the modernized for this purpose, the spectrophotometer SF-46.

Modernization of spectrophotometer SF-46 was that the solution to this problem in the camera of the examined sample set movable axis with a silicon photodiode for measuring passed through the sample the light beams I_O and I_1. There is also a pre-amplifier of analog signals I_O and I_1,which are then transferred to analog-to-digital converter and further readings are displayed on a computer monitor [1].

The intensities of light Io transmitted through the grating and I_1diffracted in the first order at various wavelengths in the spectral region 550-1000 nm were measured on the spectrophotometer SF-46. The calculation of the diffraction efficiency of the gratings was carried out according to the following formula $\eta = \frac{I_1}{I_0 + 2I_1} * 100\%$.

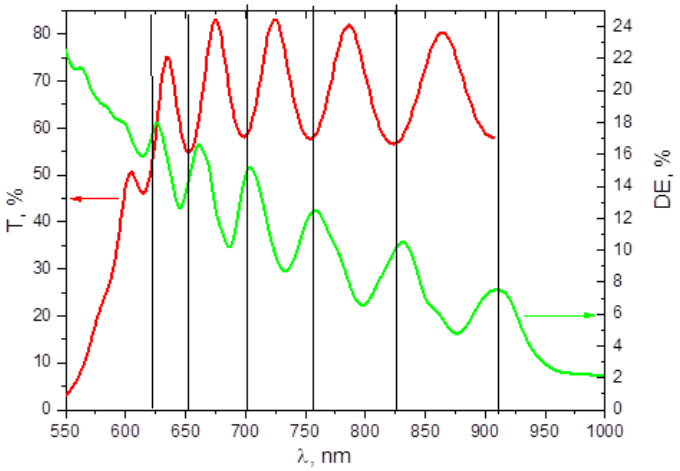

Fig. 2. The spectral dependence of transmittance T and diffraction efficiency *η* of NML structure As_2S_3–Se.

It was shown that the maximum values of the diffraction efficiency of gratings recorded in the NML structure As_2S_3–Se was observed in spectral region of 550nm.

A characteristic feature of the spectral dependence of the diffraction efficiency of gratings is non-monotonic decay of its values in the spectral region of 550-1000 nm. The observed variation of relief gratings diffraction efficiency of NML structure As_2S_3–Se can be associated with interference phenomena in a thin film for I_O and I_1 beams due to the different optical path for normally incident Io and for propagating on different angles I_1.

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