DIRECT RELIEF FORMATION DURING HOLOGRAPHIC RECORDING IN NANOMULTILAYERS As_2S_3/Se

G. Triduh[1,*], A.Prisacar[1], A.Meshalkin[1], V.Abashkin[1], E.Achimova[1], M.Enaki[2]
[1]*Institute of Applied Physics, Academy of Sciences of Moldova, str. Academiei 5, MD-2028, Chisinau, Moldova ,*
[2]*Technical University of Moldova, str. Studentilor 7, Chisinau, Moldova.*
E-mail: triduh@mail.ru

The process of obtaining of high-efficiency relief holographic gratings includes laser irradiation and chemical etching of photosensitive film in a special selective solution. This process can be greatly enhanced by the use of recording media that can change its thickness in the process of light exposure. This eliminates the chemical treatment process in obtaining of relief-phase gratings. The aim of this work was to study the process of direct relief formation of holographic gratings in multilayer structures As_2S_3/Se.

Nanomultilayers As_2S_3/Se were prepared by computer driven cyclic thermal vacuum deposition from two boats with As_2S_3 and Se on constantly rotated substrate. Control layers of Se and As_2S_3 were deposited at the same time onto the same substrate consequently through masks and used to check the composition and calculate the ratio of the sub-layer thicknesses in one modulation period. The control of the thickness layers of Se and As_2S_3 was carried out in-situ during the thermal evaporation by interference thickness sensor at λ=0.94 μm. Overlapping part of samples contains alternating nanolayers of As_2S_3 with thickness of 12nm and Se with thickness of 13nm. The total number of nanolayers was 250. Outside and internal rings of layers on the substrate contain pure compositions of Se and As_2S_3 consequently.

An interferometric holographic recording was used to expose grating on the As_2S_3 films and multilayer structure As_2S_3/Se. The holographic gratings with a period of d =1 μm were recorded by two converging laser beams with vertical polarization. The intensity ratio of recording beams 1:1 was used. CW DPSS single mode laser operated at 532 nm and power density 250 mW/cm^2 was used for recording. Diffraction efficiency changes were observed in transmission mode during the recording time. Diffraction efficiency η_{1tr} was measured in real-time at normal incidence of LD beam (λ=650 nm, P=0,1 mW) by monitoring the intensity of 1st order diffracted beam during the hologram recording. Holographic diffraction gratings with different efficiency were recorded in As_2S_3 layers and multilayer structure As_2S_3/Se and the depth of their relief was defined. Surface profiles of relief were studied by atomic force microscopy (AFM).

The obtained results on the kinetics recording of diffraction gratings in the control As_2S_3 layers show their high diffraction efficiency of 10% for 90 sec. of recording, however, the depth of the relief is only 4 nm, which corresponds to the average growth rate of the relief up to 0.04 nm/sec. Therefore this high diffraction efficiency of the obtained diffraction gratings is due to the large change in the refractive index of As_2S_3 layer with small change of their thickness under irradiation .

Diffraction gratings formed in As_2S_3/ Se multilayer structure have a higher efficiency -13% for 3600 sec recording time. Formed relief depth is equal to 100 nm which corresponds to the average rate of relief formation up to 0.03 nm/sec. The elevation of diffraction gratings profile by AFM indicates that initial linear range of exposure leads to the increase in the thickness of the As_2S_3/ Se structure with the speed of 0.06-0.07 nm/sec.

One of the possible explanations of this results consists in interdiffusion taking place between the components of multilayer structure. Irradiation by laser light with wavelength λ=532nm which corresponds to the optical band gap of the matrix material induces interdiffusion in multilayer structure As_2S_3/Se [1].

Thus the use of nano-layered structures As_2S_3/Se allows getting highly effective relief gratings under the action of laser radiation without the use of chemical treatment.

[1]. Csik, A. Kikineshi, D. L. Beke, I. A. Szabo, G. Langer, *J. Optoelectronics and Advanced Materials* **3**, 33 (2001)