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Investigations of transmission spectra of the new photopolymer compositions.

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ABSTRACT

Recently special attention has been given to the problem of the holographic registration of images and information with the purpose of a solution of various scientific and technical problems.

It is well known that carbazol containing polymers, for example, poli-N-carbazolylalcoxymethacrylate (poli-CAM), co-polymers CAM, polyepoxypropilcarbazol (PEPC), have been recommended very well as organic photoconductors, especially in the field of the creation of mediums for information registration, including holograms. The photochemical method of image recording of carbazole-containing polymers films attribute to famous methods of image recording.

Our research is aimed at finding of a new photopolymer compositions sensitive in the visible and infrared spectra. We have studied a photopolymer materials, which are doped by amorphous semiconductors. We have used As_2S_3, S, Se, GeSe as additives of the amorphous semiconductor, and PEPC, PVA, BMA as main polymers. These photopolymer films have been prepared by pouring from solutions. The photopolymer films have been applied both on transparent (polyethylenethereftalat) films and rigid substrates of optical glass. The samples have been obtained with the thickness in the range of 2 μm to 30 μm. The contents of different amorphous semiconductors have been maintained within the limit of 5 – 40 wt.% of the photopolymer. The variation of the concentration of each component and the transmission spectra have been studied for all the photopolymer films. The experimental measurements of its transmission spectra are evaluated in conjunction with its application for optical holographic recording in visible and infrared ranges. The optical transmission spectra have been measured in optical region from 0.8 μm to 3.0 μm by spectrum-photometer SPECORD 61 NIR and in region from 0.4 μm to 0.8 μm by spectrum-photometer SPECORD UV VIS.

Introduction

Several types of photopolymer systems for holographic recording have been reported in recent years. In the development of such high-quality recording materials many aspects must be considered, such as high sensitivity, simple chemical development, good spatial-frequency response, high diffraction-efficiency level, high signal-to-noise ratio (SNR), and temporal stability

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of the holographic material. Photopolymeric materials have the following advantages, such as self-development, high angular selectivity, or high resolution, that make them more suitable for applications like optical storage, holographic optical elements, optical computing, holographic interferometry, etc. Amorphous semiconductors including chalcogenide glasses have been attracted much attention in the field of optical communication and integrated optics. High transparency in the infrared spectral region, low phonon energy, high nonlinear properties, and high photosensitivity at near band-gap are important characteristics of these materials. In particular, the photosensitive effects have been extensively studied and several holographic elements, such as microlenses, diffraction and Bragg gratings, channel waveguides have been realized in fiber, bulk, and thin film obtained from these materials. Our research work is aimed to finding the new materials from polymers and amorphous semiconductors, which would have many advantages, such as a low cost, simplicity of making and good optical properties.

Experimental

We have obtained the photopolymeric compositions from the follow polymers: polyvinyl alcohol (PVA), polyepoxypropilcarbazol (PEPC), and styrene-butylmethacrylate (St-BMA). All of them have been dissolved using organic solvent such as toluene. Then we have added amorphous semiconductors such as As_2S_3, S, Se dissolved in inorganic solvent. Our compositions have been prepared by mixing the solution of the polymer and the solution of the amorphous semiconductor. All the samples have been prepared under normal laboratory conditions (20°C; relative humidity ≈40-60%). We have added the solution of the amorphous semiconductor to the solution of the polymer with the different concentration. The concentration of the semiconductor has been ranged from 1% to 30% by weight of polymer. The polymeric films have been obtained by pouring from the solutions. The polymeric films have been applied on flexible transparent (polyethylenethereftalat) films (with transparency ~80%) with 63 μm in thickness. After evaporation of the solvent on air the polymer films have been thoroughly dried in drying camber at T=40°C during 24 hours. The thickness of the films after drying has been from 3 μm to 30 μm. It is measured by a micrometer. Concentration and volume of the solutions can be varied to obtain the desired thickness values in the range of 1-100 μm.

We have measured the optical transmission spectra of these films in the optical region from 0.8 μm to 3 μm (near Infrared region) by spectrum-photometer SPECORD 61NIR, and in the visible region from 0.4 μm to 0.8 μm by spectrum-photometer SPECORD UV VIS.

Results and discussions

1) The films from polyvinyl alcohol polymer with adding arsenic sulfide have been obtained. The concentration of As_2S_3 has been varied from 1% to 20% by weight of polymer. The thickness has been about 3 μm. The transmission spectra in the visible and infrared region are presented in the Fig.1 and in the Fig.2. As we can see from Fig.1 a new band of absorption is appeared in the visible spectra of the polymer films with adding As_2S_3. It is in the region from 0.3 μm to 0.5 μm. The new band of absorption is appeared in the infrared spectra in the region from 2.8 μm to 3.3 μm (Fig.2). These absorptions are in direct proportion to concentration of As_2S_3.

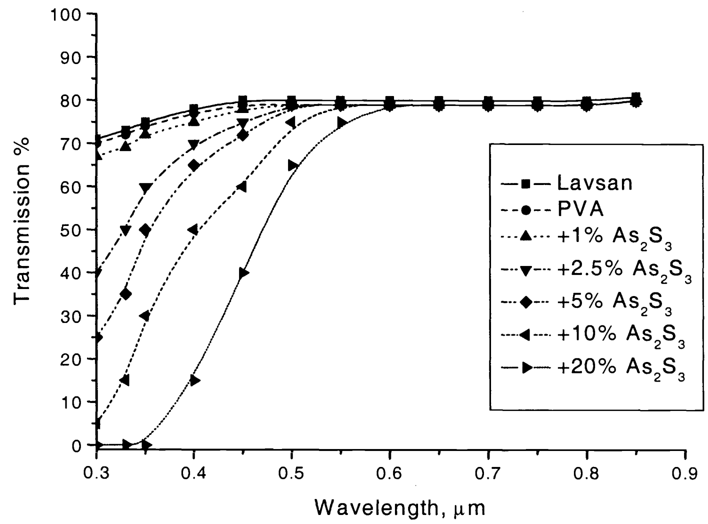

Figure 1. Transmission spectra of composition: PVA with adding the different concentration of As_2S_3

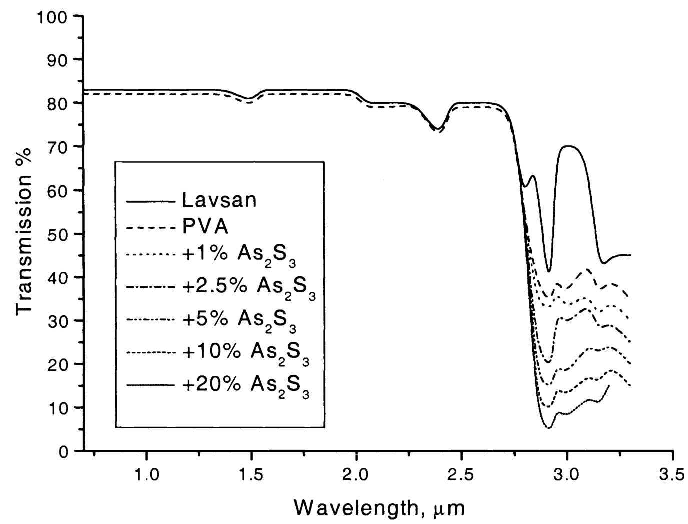

Figure 2. Transmission spectra of composition: PVA with adding the different concentration of As_2S_3

2) The films from polyepoxypropilcarbazol (PEPC) with addition containing electron-acceptor additivies of iodophorm type (CHI_3) and with addition of sulfur (S) have been received. The concentration of sulfur has been in range of 1%, and the concentration of iodophorm (CHI_3) - 10%. The thickness has been about 7 μm. The polymer films have been irradiated by laser beam at wavelength of 0.41 μm. The transmission spectra in the visible and infrared region of the irradiated and unirradiated samples are presented in the Fig.3 and Fig.4. As our experiments show, some changes exist in the visible spectra by influence of irradiation. The

irradiation leads to appearing a new region of absorption in the polymer compared with the unirradiated film. The maximum of visible absorption spectra is observed in the range of 0.65-0.67 μm. The photo-structural modifications are well visible in the spectra of visible region. There are no changes in the infrared region before and after irradiations.

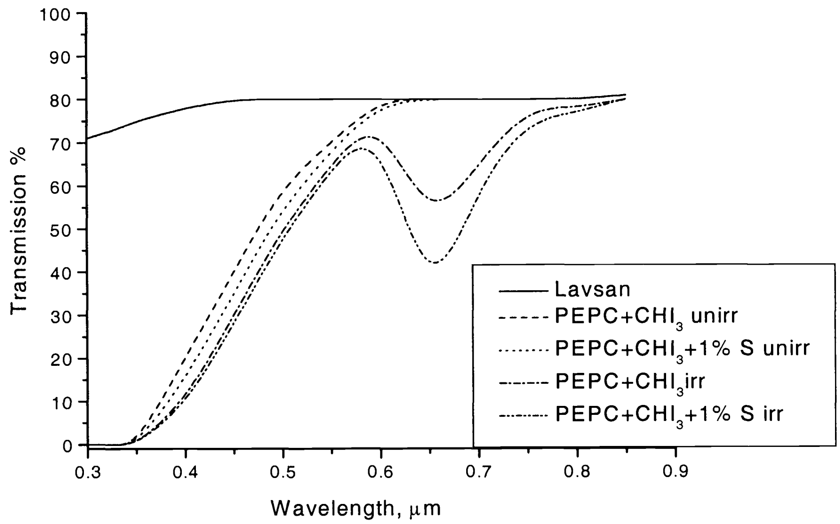

Figure 3. Transmission spectra of composition: PEPC+CHI_3 with adding S in 1% concentration before and after irradiation

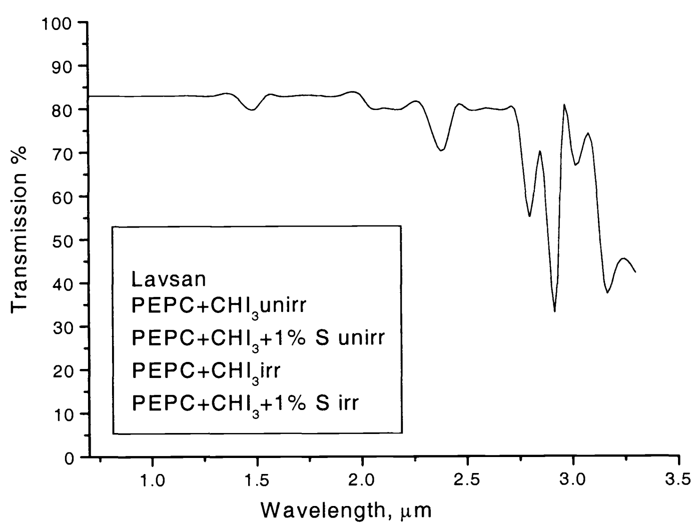

Figure 4. Transmission spectra of composition: PEPC+CHI_3 with adding S in 1% concentration before and after irradiation

3) The films from polyepoxypropilcarbazol (PEPC) with addition containing electron-acceptor additivies of iodophorm type (CHI_3) and with addition with arsenic sulfide (As_2S_3) have been received. The concentration of As_2S_3 has been varied from 0.5% to 1%. The thickness has been

about 10 μm. The polymer films have been exposed to the ultra-violet light with incident energy E=10-20 mW/sm^2 (mercury-quartz lamp PRK-4). During irradiation of the dry polymer film within 30 min the distance between the sample and the UV source has been maintained at 40 cm. The transmission spectra in the visible and infrared region of irradiated and unirradiated samples are presented in the Fig.5 and Fig.6. As it is shown in the Fig.5 the irradiation by UV light leads to appearing the new band of absorption in the range of 0.65-0.68 μm. No changes are shown in the infrared region.

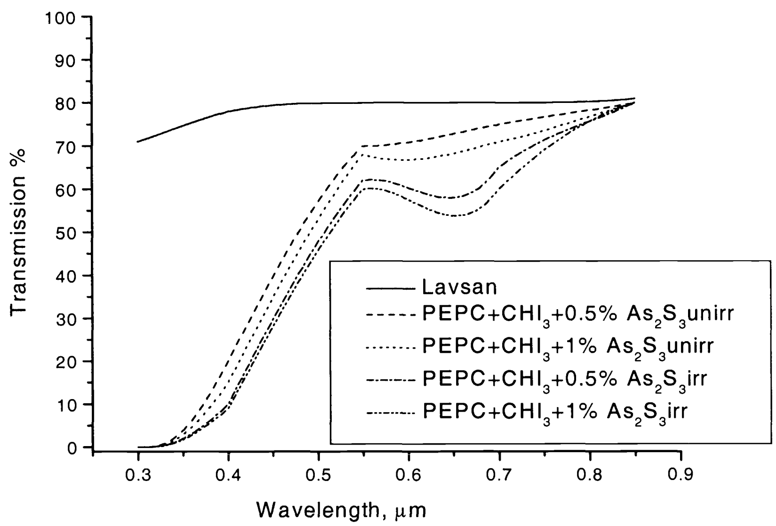

Figure 5. Transmission spectra of composition: PEPC+CHI$_3$ with adding As$_2$S$_3$ before and after irradiation

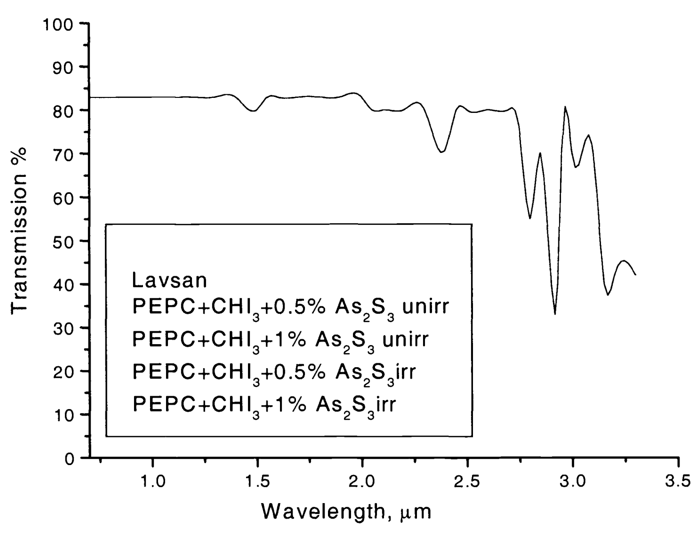

Figure 6. Transmission spectra of composition: PEPC+CHI$_3$ with adding As$_2$S$_3$ before and after irradiation

Conclusion

The new photopolymer compositions consisting of photopolymeric hosts doped with the amorphous semiconductors have been reported. We have synthesized, irradiated and measured transmission spectra of thin films of these new photopolymer compositions. The experimental measurements of the absorption characteristics are evaluated in conjunction with its potential applications for optical holographic recording. Further investigations, in particular the preparing and studying of the new compositions from different photopolymers and amorphous semiconductors, such as As_2Se_3, Ge_2Se_3, As_2Se_3 and other, are in the process.

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