Mass transport effect and surface relief formation in As_xS_{100-x} nanolayers

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Unique structural, electronic and optical properties have determined many various applications of chalcogenide glassy (ChG) materials. The large refractive indices and third-order optical nonlinearities of the chalcogenide glasses make them the best candidates for the photonic devices to ultrafast all-optical switching and data processing.Various applications have been proposed on the basis of the light sensitivity of non-crystalline chalcogenides, especially in amorphous thin film form. Photosensitivity is a key feature of chalcogenide glasses for phase-change memory, direct waveguide and grating writing.

Complex structural investigation of thin film surface nanolayers prepared from $As_{40}S_{60}$, $As_{45}S_{55}$ and $As_{50}S_{50}$ chalcogenide glasses using X-ray photoelectron (XPS) and Raman spectroscopy, near-bandgap laser light's influence on structural and compositional changes and their electronic structure was aim of the present work. In addition, the changes of surface morphology induced by laser light illumination were investigated using surface profilometry method. The difference in surface stoichiometry between amorphous As-S films and composition of corresponding target glasses was established and found to be related with the peculiarities in molecular constituent of gas phase during the deposition process, indicating that the type of molecules in vapor plays a crucial role in resulting film composition. Near bandgap laser illumination decreases the concentration of the homopolar S-S bonds in the structure of all As_xS_{100-x} (x = 40, 45, 50) nanolayers and decreases of the concentration of homopolar As-As bonds upon laser illumination in the structure of $As_{40}S_{60}$ and $As_{50}S_{50}$ films only. In contrast with $As_{40}S_{60}$ and $As_{50}S_{50}$ films, the contribution of As-S_2As and As-SAs_2 components and appearance of a new As-rich As-As_3 s.u. in the structure of $As_{45}S_{55}$ thin film during laser illumination were detected. This particular film ($As_{45}S_{55}$) demonstrate peculiarities in laser induced shift of the absorption edge, in Raman spectra and finally in effect of induced surface morphology transformation. Established, that the presence of As_4S_3 structures in the structure of $As_{45}S_{55}$ nanolayers results in laser induced mass transport effect observed for this material and can be useful for optical grating formation and related external nanofabrication technologies.

References

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