Temperature Studies of Optical Parameters of $(Ag_3AsS_3)_{0.6}(As_2S_3)_{0.4}$ Thin Films

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Ag-doped Ag–As–S chalcogenide glasses and films have found many current and potential applications. The high values of electrical (mostly ionic) conductivity in superionic Ag_3AsS_3–As_2S_3 glasses and composites in combination with a strong photosensitivity, attracts a great interest towards fabrication and studies of thin films on their base. The present investigation is aimed at the spectroscopic studies of transmission spectra, absorption spectra, refractive indices and their dispersion curves of $(Ag_3AsS_3)_{0.6}(As_2S_3)_{0.4}$ thin films at different temperatures.

Synthesis of $(Ag_3AsS_3)_{0.6}(As_2S_3)_{0.4}$ composite material which consists of crystalline Ag_3AsS_3 and glassy As_2S_3 was carried out at a temperature of 700°C for 24 h with subsequent melt homogenization for 72 h. $(Ag_3AsS_3)_{0.6}(As_2S_3)_{0.4}$ thin films were prepared by rapid thermal evaporation from the corresponding composite material at near 1350°C in vacuum (3×10^{-3} Pa) using a VU-2M setup. The film thickness was measured using an Ambios XP-1 profile meter. The transmission spectra were studied in the interval of temperatures 77–300 K by a MDR-3 grating monochromator; a UTREX cryostat was used for low-temperature studies.

With temperature increase the longwave shift of high-energy parts of transmission spectra and transmittance decrease at interference maxima are observed. Based on the interferential transmission spectra, the spectral dependences of absorption coefficient were obtained. It is shown that the optical absorption edge in the region of its exponential behaviour are described by Urbach rule. Temperature dependences of optical pseudogap E_g^* and Urbach enegry E_U for thin $(Ag_3AsS_3)_{0.6}(As_2S_3)_{0.4}$ films are well described within the framework of Einstein model. The main Urbach absorption edge parameters as well as the temperature dependences of optical pseudogap and Urbach energy E_U are determined.

The dispersion dependences of the refractive index for the thin films were obtained from the interference transmittance spectra. The slight dispersion of the refractive index is observed in the transparency region while it increases when approaching to the optical absorption edge region. It is shown that at temperature increase the refractive index increase.