The Effect of Hydrogen on the Optical, Structural Properties and the Crystallization of GeTe₂ Thin Films Prepared by RF Magnetron Sputtering

Ke Cao

ABSTRACT

Thin films of GeTe₂ were deposited on glass substrates using RF magnetron sputtering with various hydrogen flow rates in the growth chamber. Transmission data of deposited films were taken and used to determine optical constants (refractive index (n), extinction coefficient (κ), and absorption coefficient (α)) and the energies: $E_{\alpha_2}$, $E_{\alpha_3}$, Tauc band gap $E_{\text{Tauc}}$ and Urbach energy $E_U$. An increase of these energies was observed with increasing hydrogen flow rate. This increase is interpreted on the basis of the density of state model proposed by Mott and Davis.

An increase of network disorder due to the inclusion of hydrogen into the GeTe₂ thin films was determined from the $B^{1/2}$ parameter, Urbach energy and full width at half maximum of Raman vibrational modes.

The crystallization process induced by thermal annealing on GeTe₂ was studied. X-ray diffraction measurements were performed and the results suggest that crystallization of GeTe₂ occurs via a phase separation into Te and GeTe crystalline phases. This observation is in agreement with a previous report. The crystallization temperature increases with the addition of hydrogen. This increase is explained in terms of dangling bonds. A large change (approximately 60% decrease) of the optical transmission occurs after the phase change from amorphous to crystalline. This decrease is interpreted as a result of the observed phase separation.