Nanocomposites and nanomaterials

Compositional dependencies in the vibrational properties of amorphous Ge-Sb-Te phase-change chalcogenide alloys

K. Shportko[1], M. Wuttig[2], A. Stronski[1] and E. Venger[1]

[1] V. Lashkaryov Institute of Semiconductor Physics of NAS of Ukraine. Nauki av., 41, Kyiv 03028, Ukraine. E-mail: Konstantin@shportko.com

[2] Institute of Physics (IA), RWTH Aachen University, Sommerfeld str. 14, 52074, Aachen, Germany.

Chalcogenides attract much attention due to their properties that enable their technological applications, such as infrared optical elements, acousto-optic and all-optical switching devices, holography recording media etc [1]. Chalcogenide alloys with a remarkable contrast in their electrical and optical properties between the amorphous and crystalline states belong to the class of the phase-change materials [2]. These materials are promising for the new generation of data storages [3].

In this study we focused on the several amorphous Ge-Sb-Te chalcogenide alloys with systematic increase of the Ge-content along the pseudo-binary line between GeTe and Sb_2Te_3 (i.e. $(GeTe)_x(Sb2Te3)_{1-x}$): $GeSb_4Te_7$ (x=0.33), $GeSb_2Te_4$ (x=0.5), $Ge_2Sb_2Te_5$ (x=0.66), $Ge_3Sb_2Te_6$ (x=0.75) and GeTe (x=1). We employed Raman spectroscopy to investigate the compositional dependencies in the vibrational properties of selected alloys. For the quantitative analysis of the compositional dependencies we have performed the fit the obtained spectra with set of Gauss oscillators.

Systematic compositional changes in Ge-Sb-Te alloys result in the evolution of the observed Raman bands. Amplitudes of the Gaussians ascribed to the vibrations of $GeTe_{4-n}Ge_n$ (n = 1, 2) corner-sharing tetrahedra as well as Ge-based defective octahedral increase with the increase of Ge content, while the band which is directly linked to the Sb_2T_3 content in the studied GSTs simultaneously decreases and finally vanishes in the spectrum of GeTe. The shift of the strongest band in the Raman spectra of studied alloys can be interpreted in the term of the interplay of its component bands' intensities. Compositional trends in the intensities of Raman bands may enable one to predict vibrational properties of other amorphous Ge-Sb-Te alloys along the studied compositional line.

1. *Venger, E.F., Melnichuk, A.V., Stronski, A. V.* Photostimulated processes in chalcogenide glassy semiconductors and their practical application. // Academperiodika.-2007. -282.
2. *Ovshinsky, S. R.* Reversible Electrical Switching Phenomena in Disordered Structures // Phys. Rev. Lett.-1968.-**21**, N 20.-P. 1450-1453.
3. *Wuttig, M.* Phase change materials: Towards a universal memory?// Nat. Mater.-2008.-**4**, -P. 265-266.