References

[1] D. Yezli, M. Legouera, R. El Abdi, M. Poulain, and V. Burgaud, Mechanical, thermal, and optical properties of new chloroantimonite glasses in the Sb_2O_3–$PbCl_2$ –AgCl system, Materials Science (2016)

Influence of the phase state of $Ge_2Sb_2Te_5$ thin cover on the parameters of the optical waveguide structures

V. Kovaluyk[1], P. Lazarenko[2], S. Kozyukhin[3,4], P. An[1], A. Prokhodtsov[1,5], G. Goltsman[1,5], A. Sherchenkov[2]

[1]*Moscow State Pedagogical University, Moscow, Russia*
[2]*National Research University of Electronic Technology, Zelenograd, Russia,*
[3]*Kurnakov Institute of General and Inorganic Chemistry of RAS, Moscow, Russia,*
[4]*National Research Tomsk State University, Tomsk, Russia*
[5]*National Research University Higher School of Economics, Moscow, Russia*

Corresponding author: lpi@org.miet.ru

The fast switching time of Ge-Sb-Te thin films between amorphous and crystalline states initiated by laser beam as well as significant change of their optical properties and the preservation of metastable states for tens of years open wide perspectives for the application of these materials to fully optical devices [1], including high-speed optical memory [2].

Here we study optical properties of the $Ge_2Sb_2Te_5$ (GST225) thin films integrated with on-chip silicon nitride O-ring resonator. The rib waveguide of the resonator was formed the first stage of e-beam lithography and subsequent reactive-ion etching. We used the second stage of e-beam lithography combining with lift-off method for the formation of GST225 active region on the resonator ring surface. The amorphous GST225 thin films were prepared by magnetron sputtering, and were capped by thin silicon oxide on their tops. The length of the GST225 active region varied from 0.1 to 20 μm. Crystallization of amorphous thin films was carried out at the temperature of 400 °C for 30 minutes. Auger electron spectroscopy and transmission electron microscopy were used for studying composition and structure of investigated GST225thin films, respectively.

It was observed that crystallization of amorphous GST225 film lead to a decrease of the optical power, transmitted through the waveguide. Comparison of the optical transmittance of O-ring resonators before and after the GST225 deposition allowed to identify the change in the Q-factor and the wavelength peak shift. This can be explained by the differences of the complex refractive indexes of GST225 thin films in the amorphous and crystalline states. From the measurement data, the GST225 effective refractive index was extracted depending on the ring waveguide width of the resonator for a telecommunication wavelength of 1550 nm.

References

[1] M. Wuttig, H. Bhaskaran, T. Taubner, Phase-change materials for non-volatile, Nature Photonics, vol. 15, pp. 465 – 476 (2017)

[2] Z. Cheng, C. Rios, N. Youngblood, C.D. Wright, W. H.P. Pernice, H. Bhaskaran, Device-Level Photonic Memories and Logic Applications Using Phase-Change Materials, Adv. Mater., pp. 1802435 – 1802435 (2018)

THE PARAMETERS LOCAL STRUCTURE OF As – Ge – Se CHALCOGENIDE GLASSES

A.I. Isayev, S.I. Mekhtiyeva, H.I. Mamedova

Institute of Physics of Azerbaijan NAS, AZ 1143, H.Javid ave.,131, Baku, Azerbaijan

Corresponding author: physics.humay@mail.ru

The chalcogenide glass-like semiconductors (ChGS) out perform other functional materials in their unique electronic properties used for applications [1 -2]. They are transparent in wide spectral region, have high photosensitivity, optical nonlinearity, high value of refraction index and also they differ from other materials by technological process simplicity at preparation of different details on their base and chemical stability[3]. Advantage of ChGS also is caused by wide region of glass formation, possibility of unlimited doping and chemical composition variation that allows us to change the structure and obtain the material with optimal parameters [1]. However, the successful realization of applied tasks requires the obtaining of material with predicted properties and optimal parameters necessary for concrete purpose. It is known, that macroscopic properties of non crystalline materials are controlled by micro-structure peculiarities, i.e. short-range order and average one in atom disposition. The change of parameters of short-range and average orders, in particular, coordination number, length and type of chemical bonds, relative part of heteropolar and homopolar bonds, correlation length and etc. can be achieved by change of chemical composition that should be reflected on structure and electron properties [4].

The investigation of local structure and physical parameters of ChGS of As – Ge – Se system is the goal of the present work. The numerical values of correlation length, quasi-period in average order region, packing coefficient, compactness, average value of atomic volume, average coordination number, limitation number, cohesion energy are obtained using X-rays diffraction method and density measurement.

The parameters of local structure (correlation length and quasi-period in average order region) are defined by carrying out of experiments by X-ray beam diffraction and density of glass-like systems As – Ge – Se. The dependence of physical parameters (density, packing coefficient, compactness, molar volume average value, lone pair electron number, cohesion energy) on average coordination number and R parameter defining the bond character between atoms is established. The compositions corresponding to chemical percolation threshold and also compositions in which the glass state is flexible, highly-stressed and isostatically stressed are established using results of Phillips-Torp and Tichy theories.

References

[1] A.M. Andriesh, M. Bertolotti. Physics and applications of non-crystalline semiconductors in optoelectronics. Springer (1997). 481 p.