Physico-chemical nanomaterials science

Nanoinhomogenities in glassy $GeSe_4$-$GeTe_4$ caused by Bi and Ga incorporation

J. Szlęzak[1], L. Saturday[2], Ya. Shpotyuk[1,3], J. Cebulski[1], R. Golovchak[2]

[1] *Centre for Innovation and Transfer of Natural Sciences and Engineering Knowledge, University of Rzeszow, Rzeszow, 35-959, Poland*
E-mail: jaszlezak@ur.edu.pl

[2] *Department of Physics and Astronomy, Austin Peay State University, Clarksville, TN 37044, USA*

[3] *Department of electronics, Ivan Franko National University of Lviv, 107, Tarnavski str., 79017 Lviv, Ukraine*

Chalcogenide glasses (ChG) are known as one of the most convenient and inexpensive media for applications in the modern photonics [1,2]. Many Te- and Se-based glasses have been engineered to optimize the performance of different photonics devices. Conventionally, this goal is achieved by variation in chemical composition of complex ChG, which allows tailoring their physical properties to match the requirements.

However, significant improvement in the initial properties of ChG is possible due to design at the nanoscale, which opens the possibility for hybrid materials, combining two or more useful properties (mechanical, electronic, optical, magnetic, etc.) in one functional medium. In this regard, several chemical elements like Bi and Ga are found to modify ChG at the nanoscale by triggering local crystallization of amorphous matrix at the elevated temperatures.

In this work, we have studied devitrification processes caused by Bi and Ga additions in glassy $GeSe_4$-$GeTe_4$ by means of X-ray diffraction, nanoindentation and differential scanning calorimetry techniques. Crystallization of several Bi- and Ga-based selenide and telluride phases are identified and their crystallization kinetics are investigated. The created nanoinhomogeneities are shown to serve as a source of useful glass matrix modification for applications in optoelectronics.

1. *Eggleton B. J., Luther-Davies B., Richardson K.*, Chalcogenide photonics // Nature Photonics -2011.-**5**, -P. 141–148.
2. *Adam J-L., Zhang X. (Eds)*, Chalcogenide Glasses: Preparation, properties and application // Woodhead Publishing series in Electronic and Optical Materials -2014.