Physico-chemical nanomaterials science

Rare-earth doping on free-volume nanostructure of Ga-codoped glassy $(As/Sb)_2Se_3$

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Glassy arsenic selenides As-Se are known as promising materials for device application in IR photonics, optics and telecommunication [1]. An excellent transparency of these glasses from visible to far IR range (up to 18-20 m) allows using them for different applications including *in-situ* monitoring of biochemical reactions and far-IR waveguides for space telecommunication [2]. The rare-earth (RE) doping of such glasses significantly extend their functionality due to numerous radiative transitions appeared in the mid-IR range [3]. Thus, the RE doping attracts a great attention in photonics research community dealing with implementation of new functional media.

In this report, the nanostructure of RE-doped $Ga_2(As_{0.28}Sb_{0.12}Se_{0.6})_{98}$ glasses was studied using positron annihilation lifetime spectroscopy and transmission electron microscopy technique. It was shown that structural changes during Pr^{3+}-doping of $Ga_2(As_{0.28}Sb_{0.12}Se_{0.6})_{98}$ glass are related to occupation of intrinsic free-volume voids by embedded RE ions which are tightly connected with Ga-based tetrahedrons via strong covalent RE-Se/Te-Ga links. The observed changes in positron lifetime spectra correlates well with results obtained previously for RE-doped TAS-235 ($Te_2As_3Se_5$) glass [3]. The role of Sb-substitution effect in the RE-doping possibility for stoichiometric and non-stoichiometric arsenic selenide glasses is discussed.

1. *Bureau B., Zhang X.H., Smektala F., Adam J.L., et al.*, Recent advantages in chalcogenide glasses // J. Non-Cryst. Solids.-2004.-**345-346**.-P. 276-283.
2. *Cui S., Chahal R., Shpotyuk Ya., Boussard C.,et al.,* Selenide and telluride glasses for mid-infrared bio-sensing // Proc. SPIE.-2014.-**8938**.-P. 893805-1-9.
3. *Shpotyuk Ya., Ingram A., Shpotyuk O, Boussard-Pledel C., et al.,* Effect of rare-earth doping on the free-volume structure of Ga-modified $Te_{20}As_{30}Se_{50}$ glass // RSC Adv.-2016.-**6**.-P. 22797-22802.