Physico-chemical nanomaterials science

Nanoscale inhomogeneities mapping in Ga-modified arsenic selenide glasses

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Chalcogenide glasses (ChG), e.g. chemical compounds of chalcogens (S, Se or Te, but not O) with some elements from IV-V groups of the Periodic table (such as As, Sb, Ge) have found widespread application in modern IR photonics because of their superior transmittance in IR region up to 20-25 μm [1]. Rare-earth (RE) doping of ChG significantly improve their functionality due to numerous radiative transitions emitting in the near and mid-IR range [2]. Thus, such RE-doped glasses can be used to fabricate optical fiber sensors for bio-medical applications, CO_2 detection, control of chemical reactions, etc. However, RE solubility in ChG is very low, as a result RE ions clusterize and scatter the light instead of amplification [2]. This problem can be solved by introducing Ga or In into the ChG, but this process can be restricted by Ga-crystallization.

In this work, numerous experimental techniques were employed to study nanoscale mapping of inhomogeneities in Ga modified As_2Se_3 glasses within $Ga_x(As_{0.4}Se_{0.6})_{100-x}$ system. The appearance of inhomogeneities was observed in glasses with more than 3 % of Ga. The Ga_2Se_3 nanocrystallites being observed in Ga-modified selenide glass using scanning and transmission electron microscopy. The nanoindentation technique (CSM instrument) equipped with a Berkovitch-type tip was employed to study the surface nanohardness of these glasses. The Ga additions are shown to increase nanohardness, this effect attaining an obvious bifurcation trend in partly crystallized $Ga_5(As_{0.4}Se_{0.6})_{95}$ glass.

1. *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.
2. *Shpotyuk Ya., Boussard-Pledel C., Nazabal V., Chahal R., et al.,* Ga-modified As_2Se_3–Te glasses for active applications in IR photonics // Opt. Mater.-2015.-**46**.-P. 228-232.