Physical–Chemical Properties of Sulfur Enriched As–S–Ge Glasses Related to Middle-Range Order Structure

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Abstract

Ternary nonstoichiometric chalcogenide glasses in the As–S–Ge system along the pseudo-binary tie line AsS_3–GeS_4 in conjunction with stoichiometric binary compound As_2S_3 have been synthesized and characterized applying the EDX spectroscopy and XRD analyses. On the basis of experimental results of measured material density and velocity of ultrasound propagation, each glass composition has been evaluated the basic physical–chemical parameters, such as molecular weight, average molar volume, atomic packing

density and compactness, alongside longitudinal elastic modulus. Based on XRD patterns analysis the middle range ordering (MRO) parameters of the glass, such as “packing factor” and concentration of MRO domains have been computed and their compositional dependence revealed. As so far there are not many works devoted to establishing the correlation between MRO structure, basic physical parameters, and elastic properties of the glasses, this article is aimed to contribute to this gap by presenting the findings from a comparative study of the effect of material stoichiometry and composition on mentioned above MRO and basic physical parameters related to their elastic properties of the glass. It is shown the need to distinguish two kinds of materials in the pseudo-binary AsS_3–GeS_4 system: either the completely free or containing less than 7.7 at.% Ge glasses, showing a correlation between physical–chemical properties and MRO structure and all the others glasses, in which such correlation is missing. The elastic modulus of the Ge containing non-stoichiometric glasses linearly increases with atomic packing density increase, wherein for the Ge free glassy compositions the additional boosting of the elastic modulus occurs due to the effect of middle-range ordering on the molecular level.