Chalcogenide glasses – advanced nano-materials with still not completely resolved structure. Laser desorption ionization and mass spectrometry of clusters generated in gas phase for structure elucidation

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Chalcogenide glasses and theirs thin films or fibres have become attractive nano-materials in optics, optoelectronics, chemistry etc. as optical non-linear elements, memories, micro lenses, waveguids, bio- and chemical-sensors, novel optic materials, etc. Problems of theirs structure, properties, and applications have been reviewed [1]. Even if they are studied extensively using various physico-chemical methods, Raman and IR spectroscopy and/or mass spectrometry [2], etc. the structure is stil not completely resolved.

Laser desorption ionization time-of-flight mass spectrometry (LDI TOF MS) is powerful technique to follow the generation of clusters also from various solid inorganic materials (Figure 1, left) and might bring valuable information about solid phase structural fragments. It has has been widely used in our laboratory for the analysis of chalcogenide glasses and their thin films to analyse structural fragments of different chalcogenate glasses , e.g. erbium-doped Ga-Ge-Sb-S glass [3] or atomic switch memory Ge2Sb2Te5 bulk materials and its nano films [4].

In this work, possibilities and limitations of LDI and laser ablation synthesis (LAS) coupled with TOF MS will be illustrated and discussed using variety of examples of various chalcogenide glasses of different composition. For example, Figure 1 (right) shows LDI TOF mass spectrum concerning clusters detected from Ge-Ga-As-S glass doped with erbium. Detected clusters GaSb2SEr + and GaS2Er+ indicate how Er dopant is bound in the glass.

It will also be shown how common MALDI TOF MS instrumentation can be used as a synthetic device, a kind of synthetiser, for LAS synthesis of clusters to follow behaviour of chalcogenide glasses precursors and or theirs components. For example, the generation of new gold tellurides using nano-gold and tellurium as precursors via Laser ablation synthesis (LAS) has been reported recently [5] as well as generation of clusters of gold phosphides [6], gold arsenides [7], gold carbides [8] or ternary Au-Ag-Te clusters [9], for example.

Concluding, clusters produced via LDI of chalcogenide glasses and/or via laser ablation synthesis of chalcogenide glasses components and/or precursors and detected by TOF MS help to elucidate the structure of solid chalcogenide glasses. Structural fragments of different chalcogenide glasses will be shown and discussed.

The determined stoichiometry of detected clusters might accelerate further development of novel high-tech chalcogenide glass materials with unique properties.

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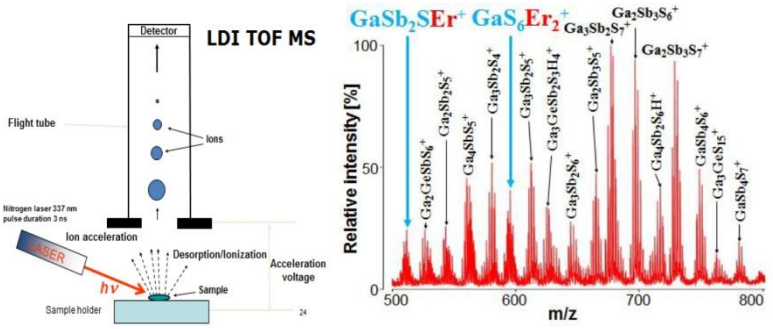

Figure: Scheme of LDI TOF MS analysis of solid sample (left) and an example of TOF mass spectrum concerning Ga-Ge-Sb-S glass doped with erbium [4].