# Chalcogenide glasses: preparation, applications, and laser desorption ionization time-of-flight mass spectrometric study

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Binary, ternary, or multi-component chalcogenide glasses and their thin films are important for medical surgery, military, optics, communications, internet, computers, material science, and various technological applications. Amorphous chalcogenide thin films can be prepared by different deposition techniques, typically by vacuum thermal evaporation, sputtering, chemical vapour deposition or spin-coating. Pulsed laser deposition is a prospective technique, being employed due to its simplicity, ease of process control, often stoichiometric transfer of target material to the films and the possibility to fabricate films of unusual composition. To increase understanding of the properties of thin films fabricated by plasma deposition techniques, more information concerning the physics of plasma plume is needed. The formation of clusters in plasma plume from different glasses by laser desorption ionization (LDI) or laser ablation (LA) was studied by time-of-flight mass spectrometry (TOF MS) in positive and negative ion modes.

**Binary As-Se glass**: Several $As_pSe_q$ singly charged clusters $As_3Se_q^+$ ($q$ =1–5), $AsSe_q^-$ ($q$ =1–3), $As_2Se_q^-$ ($q$ = 2–4), and $As_3Se_q^-$ ($q$ = 2–5) were found from As-Se glasses with the molar ratio As:Se in the range from 1:2 to 7:3.

**Ternary As-S-Se glass**: The LA of glasses of different composition leads to the formation of a number of binary $As_pS_q$, $As_pSe_r$ and ternary $As_pS_qSe_r$ singly charged clusters. Several series of clusters with the ratio As:chalcogen = 3:3 ($As_3S_3^+$, $As_3S_2Se^+$, $As_3SSe_2^+$), 3:4 ($As_3S_4^+$, $As_3S_3Se^+$, $As_3S_2Se_2^+$, $As_3SSe_3^+$, $As_3Se_4^+$), 3:1 ($As_3S^+$, $As_3Se^+$), and 3:2 ($As_3S_2^+$, $As_3SSe^+$, $As_3Se_2^+$), formed from both bulk and pulsed laser deposited nano-layer of ternary As-S-Se glass, were detected.

**Doped glass**: Effects of rare earth ions on chalcogenide glasses are intensively studied for several years. Rare earth ions in optical absorption or light emission exist a direct relation to the energies in ground and excited states of the electron system. Rare earth-doped chalcogenide glasses due to their strong luminescence and possible laser action are promising media for potential application in fibre amplifier and near- and mid- infrared laser devices. We have analyzed erbium doped quaternary Ga-Ge-Sb-S glass and several series of clusters were identified.

The stoichiometry of $As_pSe_q$, $As_pS_qSe_r$, and $Ga_lGe_mSb_nS_o^{+/-}$ clusters was determined via isotopic envelope analysis and computer modeling. The stoichiometry of clusters reflects to a certain extend chemical structure of glasses and thus TOF MS represents suitable experimental technique yielding important information about glasses chemical structure. The structure of some clusters is proposed and the relationship to the structure of the parent glasses (As-Se), as also suggested by Raman scattering spectra was demonstrated.