Absorption and Luminescence Spectra of Ga-based Chalcogenide Glasses

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Excellent optical properties of chalcogenide glasses make them interesting for optoelectronic devices in the visible (VIS) and, especially, in the near (NIR)- and mid-infrared (MIR) spectral regions. Special interest represents Ga-based chalcogenide glasses, such as Ga-Ge-As-S doped re-earth ions due to their potential applications as optical amplifiers for the 1.3 and 1.5 µm telecommunication windows and for fiber lasers.. In this paper we report the experimental results on absorption and emission spectra of $Ga_{1.7}Ge_{25}As_{8.3}S_{65}$ doped with Sm^{3+}, Nd^{3+}, Pr^{3+}, Dy^{3+} and co-doped with Ho^{3+}+Dy^{3+} rare-earth ions. Ge-Ga-As-S glassy systems are a good host materials for the rare-earth ions, have a large glass forming regions, high transmission in the visible and mid-IR regions of the spectrum, high refractive index (n=2.4÷2.5 at λ=0.63 µm). It was demonstrated that introduction of Ga in Ge-As-S play a decisive role preventing the glass against devitrification.

Fig.1 reporesents room-temperature transmission spectra of the base glass $Ga_{17}Ge_{25}As_{8.3}S_{65}$, and doped with different rare-earth species. Doping with Dy^{3+} ions shift the absorption edge in the high energy region, when doping with Nd^{3+} and Ho^{3+} ions shift the absorption edge in the low energy region. On the transmission spectra are clearly distinctly the absorbtion bands which appear as a result of the electron transitions on the levels of rare-earth ions.

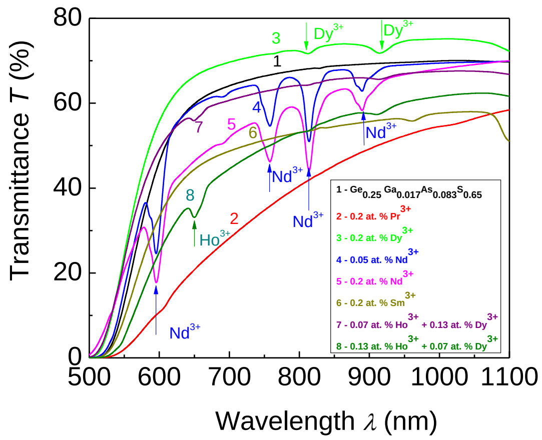

Fig.1. The transmission spectra of the $Ga_{17}Ge_{25}As_{8.3}S_{65}$ base glass and doped with different rare-earth species.

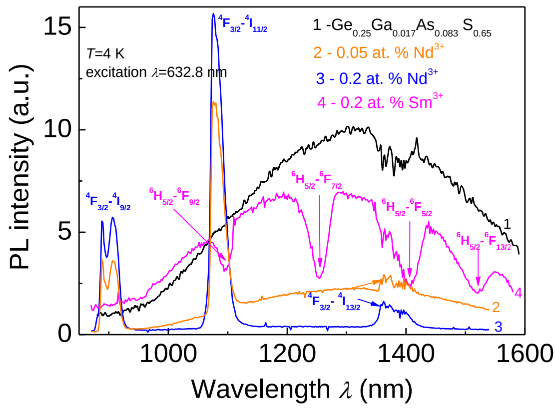

Fig.2. Low-temperature emission spectra $Ga_{17}Ge_{25}As_{8.3}S_{65}$ base glass and doped with Nd^{3+} and Sm^{3+}.

Fluorescence emission for the $Ga_{17}Ge_{25}As_{8.3}S_{65}$ base glass at around 1300 nm at T=4 K was observed (Fig.2) when pumping with λ=632.8 nm. A strong luminescence of Nd^{3+} and Sm^{3+} ions was observed around 1100 nm. For the glasses co-doped with: 0.07 at% Ho^{3+} + 0.13 at% Dy^{3+}, and co-doped with: 0.13 at% Ho^{3+} + 0.07 at% Dy^{3+}, two strong emission bands were observed: the first at λ~1190 nm was due to the $^5I_6\rightarrow{}^5I_8$ down-transition of the Ho^{3+} ion and the second at λ~1330 nm was due to the $^6H_{9/2}\rightarrow{}^6H_{15/2}$ down-transition of the Dy^{3+} ion. Low temperature (T=10 K) PL spectra of $Ga_{17}Ge_{25}As_{8.3}S_{65}$ that co-doped with 0.07 Ho^{3+}+0.13 Dy^{3+} (1) and 0.13 Ho^{3+}+0.07Dy^{3+} (2) in the visible region with the excitation wavelength λ=488 nm are shown in Fig.4. The measured low-temperature PL spectra showing the pronounced bands which are related to *4f-4f* transitions, and can be understood in terms of the non-radiative energy transfer mediated by deep energy states in resonance with the *4f* levels of RE^{3+} ions.

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