

PHOTOLUMINESCENCE OF Ga-Ge-As-S GLASSES DOPED WITH RARE-EARTH IONS

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Rare earth doped chalcogenide glasses are intensively investigated due to their possible potential applications as optical amplifiers for 1.3 and 1.5 μm telecommunication windows and fiber lasers. The $\text{Ga}_2\text{S}_3\text{-GeS}_2$ glassy system is a good host material for the rare-earth ions, has a large glass-forming region, high transmission in the visible region and high values of the glass transition temperature $T_g \sim 425^\circ\text{C}$. The aim of this paper is to investigate the absorption spectra, visible and the 1300 (1500 nm) photoluminescence (PL) from $\text{Ga}_{0.017}\text{Ge}_{0.25}\text{As}_{0.083}\text{S}_{0.65}$ glasses doped with Pr^{3+} , Dy^{3+} , Nd^{3+} , Sm^{3+} and co-doped with $\text{Ho}^{3+}/\text{Dy}^{3+}$ rare earth ions.

In $\text{Ga}_{0.017}\text{Ge}_{0.25}\text{As}_{0.083}\text{S}_{0.65}$ glasses doped with 0.2 at.% Sm^{3+} the strong room-temperature PL band situated around 750 nm when excited at 488 nm (${}^6\text{H}_{5/2} \rightarrow {}^4\text{G}_{7/2}$). Lowering of the temperature from $T=300\text{ K}$ to $T=10\text{ K}$ shifts the PL band from $\lambda=750\text{ nm}$ to $\lambda=650\text{ nm}$, i.e. to the (${}^4\text{G}_{5/2} \rightarrow {}^6\text{H}_{9/2}$) transition take place. For low doping concentration of 0.05 at.% Sm^{3+} the PL intensity at low temperature ($T=10\text{ K}$) strongly increase ($\sim 10^3$ times) in respect to the intensity at room temperature.

For $\text{Ga}_{0.017}\text{Ge}_{0.25}\text{As}_{0.083}\text{S}_{0.65}$ glasses doped with 0.2 at.% Dy^{3+} , the observed two PL bands situated at 665 nm and 790 nm can be attributed to the electron transitions of Dy^{3+} ion, ${}^4\text{F}_{9/2} \rightarrow {}^6\text{H}_{11/2}$ and ${}^4\text{F}_{5/2} \rightarrow {}^6\text{H}_{15/2}$, respectively. When the investigated sample is excited with light of $\lambda=950\text{ nm}$ (${}^3\text{H}_4 \rightarrow {}^1\text{G}_4$), for the glasses doped with 0.2 at.% Pr^{3+} we can observe the emission bands located at 1300, 1500 and 1650 nm that are characteristic for the Pr^{3+} ions transitions: ${}^1\text{G}_4 \rightarrow {}^3\text{H}_8$ (1300 nm) and ${}^3\text{F}_3 \rightarrow {}^3\text{H}_4$ (1500-1650 nm). A very narrow PL peak was detected in co-doped glasses $\text{Ho}^{3+}/\text{Dy}^{3+}$ the increasing of the PL intensity of the bands located at 1300 nm may be due to the electron transitions of Dy^{3+} levels (${}^6\text{F}_{11/2} \rightarrow {}^6\text{H}_{15/2}$), or Ho^{3+} levels (${}^4\text{F}_4({}^5\text{S}_2) \rightarrow {}^5\text{I}_6$). Besides the traditional energy transfer mechanisms (*resonant energy transfer, stepwise up-conversion, cooperative luminescence, cooperative energy transfer, and simultaneous photon absorption*), for interpretation of the experimental results the mechanism of energy transfer from the host glass to the rare-earth ions also is taken into account.