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Optical spectroscopy and local structure of the Nd^{3+} luminescence centres in glasses of the $\text{CaO-Ga}_2\text{O}_3\text{-GeO}_2$ system

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Keywords

germanate glasses, Nd^{3+} centre, optical absorption, luminescence, decay kinetics, extended X-ray absorption fine structure (EXAFS), local structure

Abstract

Optical absorption and luminescence spectra as well as luminescence kinetics of the Nd^{3+} centres in glasses with $\text{Ca}_3\text{Ga}_2\text{Ge}_3\text{O}_{12}:\text{Nd}$ composition, containing 0.2 and 1.0 wt% of the Nd_2O_3 were presented and analysed. The oscillator strengths and phenomenological intensity parameters Ω_t (Ω_2 , Ω_4 , and Ω_6) were obtained using standard Judd-Ofelt theory. Calculated Ω_t parameters, radiative transitions rates, branching ratios and radiative lifetime for Nd^{3+} centres in the glass with $\text{Ca}_3\text{Ga}_2\text{Ge}_3\text{O}_{12}$ composition were analysed and compared with corresponding Nd^{3+} parameters in their crystalline analogue with garnet structure. Experimental lifetimes are compared with those calculated, and quantum efficiency of Nd^{3+} centres from ${}^4F_{3/2}$ emitting level in the glass with $\text{Ca}_3\text{Ga}_2\text{Ge}_3\text{O}_{12}$ composition is estimated. Incorporation peculiarities and local structure of Nd^{3+} luminescence centres in the glass with $\text{Ca}_3\text{Ga}_2\text{Ge}_3\text{O}_{12}$ composition and corresponding $\text{Ca}_3\text{Ga}_2\text{Ge}_3\text{O}_{12}:\text{Nd}^{3+}$ garnet laser crystals are considered. On the basis of extended X-ray absorption fine structure (EXAFS) spectra (L_3 -edge) of rare-earth elements analysis it has been shown that Nd^{3+} luminescence centres in the $\text{CaO-Ga}_2\text{O}_3\text{-GeO}_2$ glass network occupy structural sites with the coordination number to oxygen $N = 6$.



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