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Spectral properties of Eu^{3+} ions in $Ca_3Ga_2Ge_3O_{12}$ and $Ca_3Ga_2Ge_4O_{14}$ crystals

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Optical absorption and photoluminescence spectra as well as the luminescence decay kinetics have been studied for $Ca_3Ga_2Ge_3O_{12}$ and $Ca_3Ga_2Ge_4O_{14}$ crystals doped with Eu^{3+} ions. The Stark structure of optical spectra for the compounds under study have been investigated using the concentration series method. Three types of Eu^{3+} activator centers have been revealed in $Ca_3Ga_2Ge_3O_{12}$:Eu^{3+} crystals within the activation concentration range of 0.1 to 3 at.% while one activation quasi-center type is formed in $Ca_3Ga_2Ge_4O_{14}$:Eu^{3+} crystals at the activator concentrations varying from 0.05 to at.%.

Исследованы спектры оптического поглощения, фотолюминесценции и кинетика затухания люминесценции кристаллов $Ca_3Ga_2Ge_3O_{12}$ и $Ca_3Ga_2Ge_4O_{14}$, активированных ионами Eu^{3+}. Методом концентрационных серий проанализирована штарковская структура оптических спектров исследуемых соединений. Показано, что в кристаллах $Ca_3Ga_2Ge_3O_{12}$:Eu^{3+} в области концентраций активатора 0.1–3 ат. % существуют три типа активаторных центров Eu^{3+}. В кристаллах $Ca_3Ga_2Ge_4O_{14}$:Eu^{3+} в области концентраций активатора 0.05–1 ат. % образуется один тип активаторного квазицентра.

To investigate the optical spectra of europium-doped crystals is of a considerable interest in connection with practical needs for new efficient and cheap luminophors in the red spectral region. At the other hand, the number of Eu^{3+} spectral lines, their intensities and spectral positions are extremely sensitive to minor changes in the crystal growing conditions, annealing in various media, irradiation, etc., and are always related to corresponding changes in the Eu^{3+} ion nearest neighborhood within the crystal lattice. Thus, those ions can be used as effective spectroscopic microprobes to study the structure of their nearest neighborhood.

The purpose of this work is to establish interrelations between spectral properties of $CaGa_2Ge_3O_{12}$ and $Ca_3Ga_2Ge_4O_{14}$ crystals doped with Eu^{3+} ions and their structure features, that is of interest both from applied and fundamental standpoint. The work continues investigations described in [1].

The $CaGa_2Ge_3O_{12}$:Eu^{3+} and $Ca_3Ga_2Ge_4O_{14}$:Eu^{3+} crystals were grown by Czochralski technique using a Donets-1 type growing equipment. Oxides Ga_2O_3, GeO_2, Eu_2O_3 and carbonate $CaCO_3$, all substances of special purity grade, were used as initial materials for calcium-gallium-germanium garnet and calcium gallogermanate. The activator Eu^{3+} ions were introduced into the melt as Eu_2O_3.

The optical quality $Ca_3Ga_2Ge_3O_{12}$:Eu^{3+} and $Ca_3Ga_2Ge_4O_{14}$:Eu^{3+} crystals were obtained within the activator concentration range 0.1–3 at.% and 0.05–1 at.%, respectively. The samples for examination were shaped as plane-parallel plates cut out in the (100) plane of $Ca_3Ga_2Ge_3O_{12}$:Eu^{3+} and (0001) one of $Ca_3Ga_2Ge_4O_{14}$:Eu^{3+}. The optical absorption and luminescence spectra were examined in unpolarized light at 300 and 80 K. The optical absorption was studied in the 40000 to 11000 cm^{-1} region using a Specord M-40 spectrophotometer. The photoluminescence spectra were recorded in the single photon accumulation mode using a SDL-2 spectral and luminescence complex. A DKsSh-150 xenon lamp was used as the excitation source. To exam-