ABSORPTION AND BIREFRINGENT PROPERTIES OF DOPED CALCIUM GALLOGERMANATE CRYSTALS

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Trigonal Ca-gallogermanate $Ca_3Ga_2Ge_4O_{14}$ (CGGO) crystals (space group P321) are very attractive due to their various optical properties. For example Ca-gallogermanate crystals activated with Cr^{3+}, Nd^{3+}, Er^{3+} are good materials for solid-state lasers. These crystals are optically positive ($n_e > n_o$), optically active and posses a significant optical birefringence (OB) and liner dichroism (LD).

We performed experimental measuring of absorption spectra for different polarization for CGGO: Cr^{3+} and CGGO: Mn^{3+}. It is well known that the Cr^{3+} ion has an electronic configuration $3d^3$. The ground state ^4F is split into the $^4A_2$, $^4T_2$, $^4T_1$ levels in a cubic field [1]. As the result most intensive bands in absorption spectra will be attributed to spin-allowed transitions $^4A_2 \rightarrow {}^4T_2$, $^4A_2 \rightarrow {}^4T_1$. Two main broad absorption bounds with peak position on 632 nm and 444 nm are observed in the absorption spectra and attributed to these transition. Using the peak positions of most intensive bands in absorption spectra the values of crystal field parameter Dq and Racah parameter B were calculated. In our case, a value of local field Dq = 0.197 eV, and Racah parameter B = 0.085 eV. Weakly intensive band with maximum of 487 nm can be attributed to the spin forbidden transition $^4A_2 \rightarrow {}^2T_2$ (this result correlates with calculation which have been done using Tanabe and Sugano diagrams).

On the other hand, for CGGO: Mn^{3+} (Mn^{3+}: $4d^4$, ^5D) one asymmetric broad band was observed in absorption spectra for different polarization. Accordingly to crystal field theory ground state ^5D is split into the ^5E_g and $^5T_{2g}$ in the cubic field and this band is attributed to the $^5E_g \rightarrow {}^5T_{2g}$ transition.

The linear dichroism spectra were obtained for wavelength interval 400-700 nm. In contrast, a technique for simultaneous measurements of OB and LD for fixed wavelength of light λ = 632.8 nm with a high-accuracy computerized polarimeter [2] is developed and applied to CGGO :Cr^{3+}, CGGO: Mn^{3+} crystals.

References

[1] Sviridov D. T., Sviridova R. L., Smirnov Yu. F. Optical spectra of transition metal ions in crystals, Nauka, Moscow, 1976 (in Russian).
[2] Shopa Y., Ftomyn N. Ukr. J. Phys. Opt. **7** (2006) 183.