OPTICAL STUDIES AND SPECTROSCOPIC PECULIARITIES OF DYSPROSIUM DOPED Gd_2SiO_5 SINGLE CRYSTALS

R. Lisiecki[1], P. Solarz[1], G. Dominiak-Dzik[1], W. Ryba-Romanowski[1], M. Berkowski[2], M. Głowacki[2]

[1] Institute of Low Temperature and Structure Research PAS ,Wrocław, Poland
[2] Institute of Physics PAS, Warsaw, Poland
E-mail: R.Lisiecki@int.pan.wroc.pl

The gadolinium silicate crystals doped with rare earth ions are attractive materials for spectroscopic measurements and the many applications for the sake of wide energy range of transparency, especially in UV. The rare earth admixtures can be conveniently incorporated into structure local position of gadolinium since the differences of ionic radii are relatively low. On account of structure properties of Gd_2SiO_5 crystal the lanthanide ions may occupy the two distinct sites with following point symmetry C_s and C_{3v}. The first of them is coordinated by seven oxygen ions and the nine oxygen vicinity is related to the site with the higher point symmetry. Owing to the physicochemical and luminescence characteristics GSO materials doped with Ce^{3+} are promising and very attractive scintillators especially for medical and nuclear physics areas [1]. Besides, taking into account the low symmetry and relatively large phonon energy the effective energy transfer and low up-conversion losses could be recognized for potential laser crystals $Gd_2SiO_5:Er^{3+}$ and $Gd_2SiO_5:Er^{3+}$, Yb^{3+} at 1.55 μm [2]. The scheme of energy levels of dysprosium reveals also potential laser channels in particularly employing the $^4F_{9/2} \rightarrow {}^6H_{13/2}$ transitions around 580 nm. The reliable spectroscopic measurements and analysis make it possible to evaluate of the preliminary laser qualities of $Gd_2SiO_5:Dy^{3+}$ crystals. Thus the absorption and emission spectra as well the decay kinetics of excited states for Gd_2SiO_5 doped with 1 and 5 at.% of dysprosium at temperature range 10-300K were measured and analysed. Accordingly, the positions of crystal field components of energy states of optically active ions were estimated. The values of radiative rates and branching ratios of $^4F_{9/2}$ luminescence were assessed using the phenomenological Judd-Ofelt theory. The temperature dependence of relaxation dynamics of luminescence level in $Gd_2SiO_5:Dy^{3+}$ could be revealed and discussed. Moreover the emission cross-section calculated for $^4F_{9/2} \rightarrow {}^6H_{13/2}$ transition of dysprosium indicates the possible energetic range of laser operation.

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References:

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