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PII: S0022-2313(18)30349-1
DOI: <https://doi.org/10.1016/j.jlumin.2018.04.017>
Reference: LUMIN15532

To appear in: *Journal of Luminescence*

Received date: 21 February 2018
Revised date: 6 April 2018
Accepted date: 9 April 2018

Cite this article as: S.P. Feofilov, A.B. Kulinkin, P.A. Rodnyi, V.M. Khanin and A. Meijerink, Disorder response of $3d^3$ ions zero-phonon lines in the luminescence spectra of Yttrium-Aluminum-Gallium garnet solid solution ceramics, *Journal of Luminescence*, <https://doi.org/10.1016/j.jlumin.2018.04.017>

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Disorder response of $3d^3$ ions zero-phonon lines in the luminescence spectra of Yttrium-Aluminum-Gallium garnet solid solution ceramics

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Keywords: solid solution garnet ceramics, impurity ions, zero-phonon lines, fluorescence spectroscopy

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Abstract

The zero-phonon R-line luminescence spectra of $3d^3$ ions (Cr^{3+} and Mn^{4+}) in a series of $Y_3Al_{5-5y}Ga_{5y}O_{12}$ ($0 \leq y \leq 1$) solid solution garnet ceramics were studied. Instead of increased inhomogeneous line broadening which is usually observed in solid solutions, discrete structure in the Cr^{3+} emission spectra is observed at lower values of y , whereas at high values of y the strong inhomogeneous broadening of the R-lines occurs and no discrete disorder response is observed. The results are explained based on the limited number of possible high-symmetry luminescent center geometries and the non-random preferential occupancy of tetrahedral lattice sites with gallium ions.

1. Introduction

The solid solution (mixed crystal) insulating crystals and ceramics doped with rare-earth and transition metal ions attract significant attention in optical spectroscopy studies. Solid solutions are especially interesting from the point of view of potential applications as scintillators, phosphors, laser materials and spectral hole-burning media because they allow variation of the physical properties of the material by variation of the composition. The structural disorder occurs in solid solutions due to the random distribution of ions in the crystal lattice sites. The inhomogeneous, i.e. related to the variations within the ensemble, broadening of electronic

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