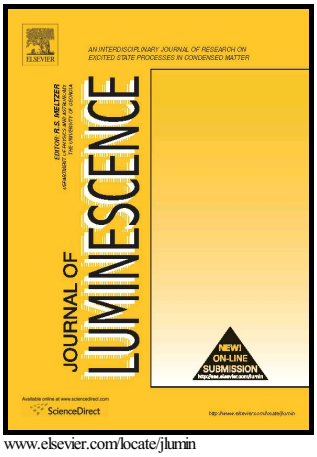

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Dipole – dipole and dipole – quadrupole interactions between Sm^{3+} ions in $K_4BaSi_3O_9$

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Abstract

$K_4BaSi_3O_9$ (KBSO) doped with Sm^{3+} was synthesized for the first time by conventional solid-state method. Results of XRD measurements confirm that the obtained powder is $K_4BaSi_3O_9$ single phase. The new material exhibits red luminescence with maximum at 641 nm under 407 nm excitation. At 300 K the luminescence intensity is quenched for Sm^{3+} concentration above 0.5%. The decay profiles revealed the non-radiative energy transfer between the Sm^{3+} ions. The interaction has dipole – dipole character for low Sm^{3+} concentrations (up to 1%) then dipole – quadrupole for higher dopant concentration (over 1%). The critical distances are 8.8 Å and 9.5 Å for dipole – dipole and the latter interactions, respectively. This phenomenon is explained by analyzing the probability of occupation of all possible sites available for Sm^{3+} in KBSO taking into account local charge compensation. The site occupation preference by Sm^{3+} ions depends on the distances between available cation sites.

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Keywords: Phosphors, solid state reactions, optical properties, optical spectroscopy, energy transfer, silicate

1. Introduction

$K_4BaSi_3O_9$ (KBSO) has become the object of our interest due to the fact that its structure is similar to modification II of $K_4SrSi_3O_9$ [1] and the studies on $K_4SrSi_3O_9$ doped with Sm^{3+} and Eu^{3+} gave very promising results [2,3]. The fact, that although the stoichiometric