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# Dipole – dipole and dipole – quadrupole interactions between $\text{Sm}^{3+}$ ions in $\text{K}_4\text{BaSi}_3\text{O}_9$

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## Abstract

$\text{K}_4\text{BaSi}_3\text{O}_9$  (KBSO) doped with  $\text{Sm}^{3+}$  was synthesized for the first time by conventional solid-state method. Results of XRD measurements confirm that the obtained powder is  $\text{K}_4\text{BaSi}_3\text{O}_9$  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  $\text{Sm}^{3+}$  concentration above 0.5%. The decay profiles revealed the non-radiative energy transfer between the  $\text{Sm}^{3+}$  ions. The interaction has dipole – dipole character for low  $\text{Sm}^{3+}$  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  $\text{Sm}^{3+}$  in KBSO taking into account local charge compensation. The site occupation preference by  $\text{Sm}^{3+}$  ions depends on the distances between available cation sites.

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

## 1. Introduction

$\text{K}_4\text{BaSi}_3\text{O}_9$  (KBSO) has become the object of our interest due to the fact that its structure is similar to modification II of  $\text{K}_4\text{SrSi}_3\text{O}_9$  [1] and the studies on  $\text{K}_4\text{SrSi}_3\text{O}_9$  doped with  $\text{Sm}^{3+}$  and  $\text{Eu}^{3+}$  gave very promising results [2,3]. The fact, that although the stoichiometric

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