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Structure and Photoluminescent Properties of B^{3+}-Doped $(Y_{0.9}Dy_{0.1})InGe_2O_7$ Phosphor

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A color-tunable, near-white-light-emitting, B^{3+}-doped $(Y_{0.9}Dy_{0.1})InGe_2O_7$ phosphor was synthesized using a solid-state reaction, and its structure and luminescent properties were determined. X-ray powder diffraction patterns showed that all of the diffraction peaks can be attributed to the monoclinic $YInGe_2O_7$ crystal structure for B^{3+} ion concentration up to 5 mol.%, and that the optimal concentration for B^{3+} doping is 3 mol.%. In the photoluminescent studies, increasing the B^{3+} ion concentration caused the intensities of both the excitation and emission peaks to increase and then decrease. In addition, the color tone changes gradually, from the near-white-light region, through greenish, and finally to yellowish. This change is caused by a decrease in the symmetry of the local structure around the Dy^{3+} ion when the B^{3+} ion in the host reaches the optimum concentration for the H_3BO_3 flux of 3 mol.%. When the B^{3+} content is increased further, the distinct difference in ionic radius between the lattice atoms and the substituent atoms causes the lattice to become distorted and the crystallinity of the $(Y_{0.9}Dy_{0.1})InGe_2O_7$ phosphor to decrease.

Key words: Yttrium indium germanate, phosphor, dysprosium, optical properties, H_3BO_3 flux

INTRODUCTION

Luminescent materials have many everyday applications, such as in fluorescent lighting, computer screens, and televisions.[1] In 1997, the first white-light-emitting diodes (WLEDs) became commercially available, and in recent years, applications for inorganic phosphors in various types of flat-panel display have been extensively studied.[2–8] Nichia Chemical and Osram control many of the patents for phosphors, so other manufacturers must invest in three-wavelength mixed white lights and the development of novel phosphors. Recently, much attention has been given to single-phase white-light-emitting phosphors,[9–12] which have great potential in white-light LED applications. The rare earth Dy^{3+} ion produces two dominant emission bands in the blue region, for the $^4F_{9/2} \rightarrow {}^6H_{13/2}$ transition, and the yellow region, for the $^4F_{9/2} \rightarrow {}^6H_{15/2}$ transition. The yellow emission for Dy^{3+} is especially sensitive to the local environment, while its blue emission is not. Therefore, by adjusting the yellow-to-blue intensity ratio value, it is possible to obtain a phosphor with near-white-light emission.[13,14]

The size and shape of phosphor particles affect their emission intensity and the efficiency of a device. In the conventional solid-state reaction method, the repetitive milling process used to produce

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