SUMMARY OF Ph.D. DISSERTATION

School Integrated Design Engineering	Student Identification Number	SURNAME, First name KASUYA, Ryo

Title

Glycothermal synthesis and characterization of nanophosphors for color conversion emitting devices

Abstract

The color conversion phosphors combined with the blue light emitting diode (LED) are used for the solid-state LED. Herein, the light scattering loss by particles decreases the photo-luminescence (PL) efficiency of the LED package. If the mean particle diameter is less than 50 nm, particles can be transparently dispersed in a matrix, showing the negligible scattering of visible light. However, the surface passivation is required for nanophosphors to suppress energy trapping by surface defects. In this thesis, for the purpose of preparing nanophosphors modified with organic species, the author focused on “glycothermal method”, in which a solvothermal reaction in a coordinating glycol solvent is used.

Chapter 1 summarizes the background and previous studies.

Chapter 2 describes the methods for characterization.

Chapter 3 describes the synthesis of $Y_3Al_5O_{12}:Ce^{3+}$ (YAG:Ce^{3+}) nanophosphor which can convert from blue light to greenish yellow light. Crystalline YAG:Ce^{3+} nanophosphor of 10 nm in diameter was prepared from aluminum isopropoxide and acetates of yttrium and cerium(III) by autoclave treatment in 1,4-butylene glycol (1,4-BG) at 300 °C for more than 1 h. The PL efficiency of YAG:Ce^{3+} increased with increasing the autoclave treatment time. The PL intensity was decreased by the thermal decomposition of organic species. Therefore, the surface modification possibly plays a significant role in the PL enhancement.

Chapter 4 describes the PL enhancement of crystalline YAG:Ce^{3+} nanophosphors by taking advantage of the surface capping effect of polyethylene glycol (PEG). When glycothermal synthesis was carried out in the mixture of 1,4-BG and PEG, the preferential coordination of PEG increased the PL efficiency of YAG:Ce^{3+}, and the proportion of octahedral coordination for Al decreased.

Chapter 5 describes the fabrication and optical characteristics of the transparent color conversion film containing YAG:Ce^{3+} nanophosphors. Judging from the result, the transparent film of YAG:Ce^{3+} nanoparticles has lower scattering loss in comparison with the film containing micron sized phosphors.

Chapter 6 describes the synthesis and characterization of scheelite-type $LiEuW_2O_8$ (LEW), which can convert from blue light to red light. Crystalline scheelite-type LEW was formed from phosphotungstic acid and metal acetates of lithium and europium(III) by autoclave treatment in 1,4-BG at 300 °C for 2 h. However, the secondary phase newly crystallized at room temperature in more than 1 day after preparation.

Chapter 7 describes the glycothermal synthesis of scheelite-type $NaEuW_2O_8$ (NEW) crystal without phase transformation. Scheelite-type NEW crystal was obtained by autoclave treatment at temperatures ranging from 200 to 300 °C for 2 h. The samples maintained single-phase even in 5 months after preparation. The sample prepared at the lower temperature had the higher content of organic species and the higher PL intensity. Thus, the surface modification by organic species improved the PL properties of scheelite-type NEW crystal.

Chapter 8 summarizes the results of this study and further prospect.