

Effect of Cu concentration on the luminescence of ZnS:Cu,Cl blue-green phosphor

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Abstract

ZnS:Cu,Cl phosphor was synthesized by solid-liquid state reaction with two firing steps. Each stage of the process was carefully monitored so that the final product was comparable to commercially-available phosphor. The effect of Cu²⁺-doping concentration has been investigated on the luminescence characteristics of ZnS:Cu,Cl blue-green phosphors for inorganic electroluminescent device.

1. Introduction

Inorganic electroluminescent (EL) devices have been used as backlights for some displays for long time [1]. In order to be a candidate for more various applications including backlight for flexible LCD, however, there are limitations in luminous efficiency, brightness and chromaticity to overcome. To get high-performance phosphors can be an approach, understanding their luminescence characteristics dependent on the synthesis conditions. EL and photoluminescence (PL) properties such as luminescence intensity and chromaticity of ZnS:Cu,Cl phosphors synthesized with different concentration of activator, Cu²⁺, was studied in this work.

2. Experimental

The powders of ZnS:Cu,Cl phosphor were synthesized by solid-liquid state reaction with two firing step. Cu²⁺ concentration added in ZnS at the 1st blending step differed in the range of 0.02 and 0.20 mol% (relative to ZnS), and Cu²⁺ concentration at the 2nd blending step was fixed at 0.4 mol% based on the

results of previous work [2]. A proper quantity of NaCl, MgCl₂·6H₂O and BaCl₂·2H₂O was mixed with ZnS host material and Cu²⁺ activator. These chloride materials are needed not only as flux but also as a co-activator. The mixed sample was heat-treated at 1100°C with an extra amount of sulfur, followed by washing and drying. After the resulting product was ground with Cu²⁺ precursor, it was treated at 750°C, washed, and dried.

The structure and morphology of phosphor particles and their PL properties were studied by means of X-ray diffraction (XRD), field emission scanning electron microscope (FESEM) and PL emission spectra. The phosphor samples were excited with UV light $\lambda_{exc} = 352$ nm. Emission spectra were recorded on Minolta CS-1000. Using the obtained phosphor powders, EL devices were fabricated by screen-printing method. PL and EL spectra of the phosphors with various copper concentrations were investigated.

3. Results and discussion

Both of PL and EL intensities of the ZnS:Cu,Cl phosphor increased with increase of Cu concentration, and decreased when Cu was added over 0.13 mol% (Figure 1). 0.13 mol% Cu-added sample at the 1st blending step showed the highest EL intensity, 164 cd/m² at an operating condition of 100V, 400Hz, having a main emission peak at 508 nm and a color coordinate at $x = 0.1947$, $y = 0.4426$ of green region, while the PL intensity was 107 cd/m² by 352 nm-excitation with a main emission peak at 501 nm and a color coordinate at $x = 0.1893$, $y = 0.4345$. The more Cu was added, the more the color coordination was green-shifted from blue region (Figure 2).

Further investigation such as the Cu concentration effect at the 2nd blending step and the flux effect on the EL characteristics is in progress.

high-performance phosphors comparable to those commercially available were prepared, which exhibit high luminescence intensity and good chromaticity.

4. Summary

The luminescence characteristics of ZnS:Cu,Cl green-blue emitting phosphor is dependent on copper concentration. The more Cu was added at the 1st blending step for synthesis of ZnS:Cu,Cl phosphor, the more the color coordination was green-shifted from blue region. Based on well-optimized process,

5. References

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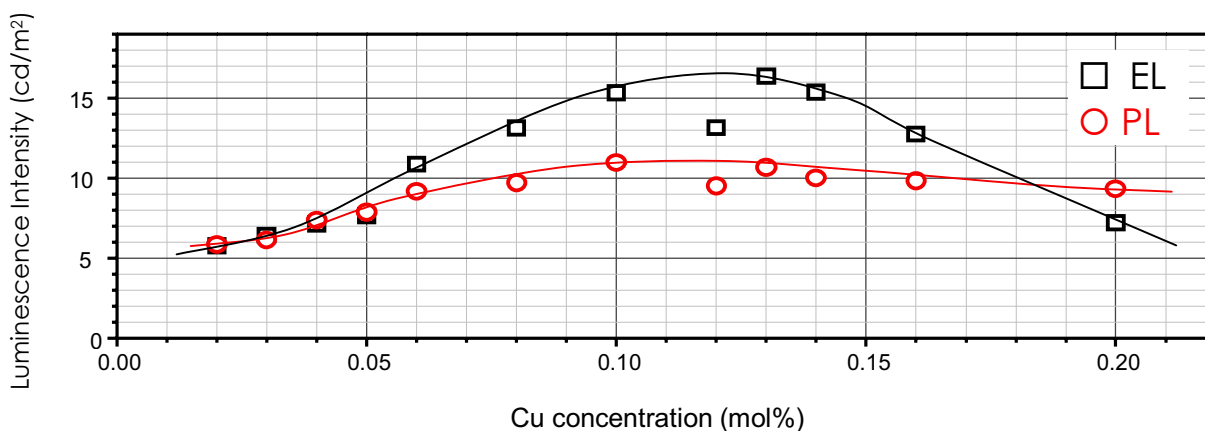


Fig. 1. EL and PL intensities of ZnS:Cu,Cl phosphors synthesized with different Cu concentration.

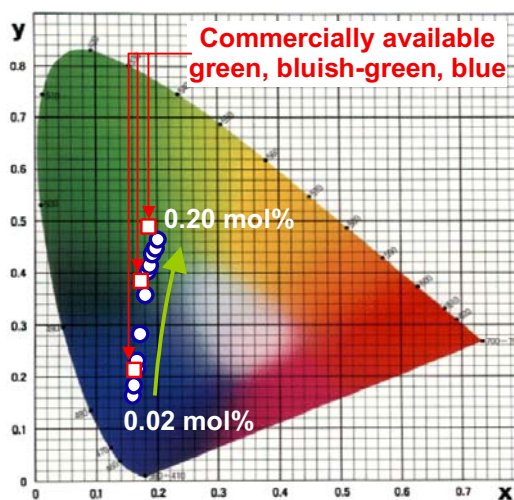


Fig. 2. EL color coordinates of ZnS:Cu,Cl phosphors synthesized with different Cu concentration.