Electroluminescent Properties of ZnₙMg₁₋ₙS:Mn Thin Films

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1. Introduction
ZnₓMg₁₋ₓS and ZnₓMg₁₋ₓS:Mn ternary compound is suitable for the short wavelength optoelectronic application such as laser diodes and electroluminescent displays in the green to ultraviolet region of the spectrum. We have clarified solid solubility of the ZnₓMg₁₋ₓS ternary solid solutions[1, 2]. Immediately after our report, electroluminescence of ZnₓMg₁₋ₓS:Mn thin films has been reported in which blue shift of Mn emission has been described[3, 4, 5]. We have studied fundamental luminescent properties including composition dependence of photoluminescence[6, 7, 8, 9, 10].

In this paper, for the first time we have described photoluminescent properties of ZnₓMg₁₋ₓS:Mn ternary compound and application to ZnₓMg₁₋ₓS:Mn thin film electroluminescence(TFEL) device.

2. Experimental
ZnₓMg₁₋ₓS:Mn thin films have been deposited on a quartz glass substrate by a conventional diode-type rf sputtering system. Mixtures of ZnS+Mn powder and Mg metal have been used as targets. The details of the deposition procedure has already been reported[11, 12]. ZnₓMg₁₋ₓS:Mn TFEL devices with a conventional double-insulating structure have been fabricated.

3. Experimental Results and Discussion
The PL and PLE spectra have been investigated. Fig.1 shows the composition dependence of the dominant PLE peak energy and the peak energy of the Mn²⁺ emission[13] for the ZnₓMg₁₋ₓS:Mn(0.5mol%) thin films. The PLE peak energy is assignable to the band gap possibly with excitonic effect. Therefore the excitonic band gap energy of the ZnₓMg₁₋ₓS can be described by the relation; E₉(x)=4.9-1.16x. Also the Zn composition, x, dependence of the Mn²⁺ emission peak energy is shown by the relation; E₉(x)=2.25-0.15x(eV). The peak energy of Mn²⁺ emission is linearly approximated by the composition x, hence Mn²⁺ emission peak shift may be caused by the intrinsic nature of the host materials.

Fig.2 shows electroluminescence spectra
from EL devices with ITO/Si$_3$N$_4$/Zn$_x$Mg$_{1-x}$S:Mn/Si$_3$N$_4$/Al structures. EL emission has showed blue peak shift with the increase of Mg composition[3].

In Fig.1 are also shown composition dependence of EL peak energy in addition to PL results. PL and EL peak energy seem to show similar tendency with the increase of Mg composition.

We have observed electroluminescence spectra of Zn$_x$Mg$_{1-x}$S TFEL devices prepared by radio frequency sputtering for the first time.

4. Conclusion

In summary, photoluminescence and electroluminescence properties have been described for Zn$_x$Mg$_{1-x}$S:Mn with the composition x covering whole range (0≤x≤1) by employing radio frequency sputtering. Remarkable dependence of Mn$^{2+}$ emission in Zn$_x$Mg$_{1-x}$S on the composition has been elucidated. Zn$_x$Mg$_{1-x}$S:Mn TFEL is promising as pure green emitting devices.

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References